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ABSTRACT COLLECTION

INNOVATION INSIGHTS FOR SUSTAINABLE AGRICULTURE.

3rd International Symposium on Innovation and Technology in the Phosphate Industry.

May 18th – 20th, 2015, Marrakesh, Morocco

SYMPHOS

2015

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EDITO

The International Symposium on Innovation and Technology in the Phosphate Industry (SYMPHOS) is a biennial event of worldwide reference dedicated to all the key players of phosphates and derivatives industry. This highly technological and scientific event aims to honor innovation, technology, trends in upgrading processes of phosphates and derivatives, research and development perspectives for the phosphate sector.

SYMPHOS is also an exchange platform for different stakeholders operating in the mining industry, phosphates beneficiation, chemical processing, sulfur and sulfuric acid production, ammonia, fertilizers, biotechnology, phosphate materials, and corrosion protection systems, food safety issues and environmental stakes related to industrial exploitation and development of innovative processes.

SYMPHOS 2015 affirms the continuity of the previous two editions (May 2011 and May 2013), a symposium focused on Innovation, Science and Technology. It's also an event that will open up more on biotechnology, specific fertilizers, fertilizers of the future, and slow & controlled releases.

Given the success of the last two editions, the expansion of the SYMPHOS community that continues to grow and the need for Symphos community to discuss new technologies and developed technological innovations, the 3rd International Symposium on Innovation and Technology in the Phosphates Industry will be held on the 18th, 19th and 20th of May 2015 in Marrakesh.

OCP GROUP

World leader in the phosphates market, OCP is the largest exporter of phosphate and phosphoric acid in the world and a major exporter of phosphate fertilizers. The Group has to its credit a large reserve of phosphates in Morocco, the largest in the world according to USGS. With its industrial and commercial presence across 5 continents, OCP plays a central role in the settlement areas of its mining and processing activities. The Group employs around 20,000 people and generated a turnover of $ 4,9 billion US in 2014.

OCP offers one of the widest ranges of phosphate qualities for various uses. With nearly a century of industrial development history and strong positions in the global phosphate market, this duality allows the group to have a unique position and unmatched flexibility to meet the growing demand of food needs.

OCP Group acts worldwide for a sustainable and eco-friendly agriculture. It provides farmers with phosphate fertilizers and helps them develop a rational fertilization to protect their soils. As a major player in global agriculture, OCP plays a leading role in the process of improving agricultural productivity in Africa.

PLENARY SESSIONS SPEAKERS

MR. ROBERT B. TUCKER
PL1: May 18th 10am – 11am

Presentation Title:
Innovation is Everybody's Business

Position:
President of Innovation Resource, U.S.A.

Often called the Corporate Innovation Guru, Robert Tucker is an internationally recognized thought leader in the field of innovation. Formerly an adjunct professor at the University of California, Los Angeles, Tucker is president of The Innovation Resource Consulting Group, based in Santa Barbara, California. Since 1986, he has been an advisor on innovation strategy to leading companies such as American Express, Intel, Nokia and to such diverse organizations as Japan Marketing Association, the government of Taiwan, Hargraves Institute of Innovation (Australia), and the Ministry of Economic Development of Russia.

Tucker's pioneering research in interviewing over 50 leading innovators was first published in the book Winning the Innovation Game in 1986. Since then, he has continued to research and publish widely on the subject, and is a frequent contributor to publications such as The Journal of Business Strategy, Strategy & Leadership, and Harvard Management Update.

He has appeared on CBS News, the PBS series, Taking the Lead and most recently on CNBC's The Business of Innovation, hosted by Maria Bartiromo. His four part series Lessons in Excellence will air during early 2008 on India's CNBC Network 18. His numerous books include the international bestseller, Managing the Future: 10 Driving Forces of Change for the New Century, which has been translated into 13 languages, Driving Growth Through Innovation, and his latest, Innovation is Everybody's Business: How to Make Yourself Indispensable in Today's Hypercompetitive World.

MR. JEAN-PIERRE DAL PONT

PL2: May 18th 2pm – 2:45pm

First Presentation Title:
The Manufacturing plant of the future: new approaches to the Process Industries

Second Presentation Title:
Chemical and Process System Engineering contribution to Sustainability

Position:
President, Process Engineering French Company, France.

2013: General Secretary of ESBES (Paris) (Biotechnologies Europe).
2008: General Secretary of EFCE (Paris) 27 countries 100,000 members (Chemical Engineering-Europe).
2009: President of the French Company of Process Engineering.
2007 - 2014: President of AAA Students ENSIC.
2006: President of Chemists Experts company of France –recognized for its public service.
2001- 2009: General Delegate of FCPE.
1996 - 2000: Vice-President Industriel Rhodia, Asia Pacific. Based in Singapore Management 20/30 Factories divided into AP including a dozen in China; Engineering – Investments - Organization - Operations.

MR. ANDRÉ P. KOTLAREVSKY

PL3: May 19th 8:30am – 9:15am

Presentation title:
Extracting Value through Operations Excellence

Position:
CEO, DuPont OCP Operations Consulting, Morocco

André Kotlarevsky runs a consulting firm specializing in the transformation of work culture with services and technologies that bring sustainable improvements in safety, operational and environmental performance. This company established in Morocco since 1 January 2014, is a 50/50 joint venture between OCP and DuPont.

Mr. Kotlarevsky has integrated DuPont in 1987 in Paris (France) in the technical polymers organization, where he had assignments in the areas of commercial & marketing. After spending 2 years in Northern Ireland in the DuPont UK Ltd Maydown factory production, Mr. Kotlarevsky has held marketing positions, product manager, logistics and supply chain in Belgium and Switzerland, between 1995 and 2002.

In 2003, he joined the DuPont Sustainable Solutions Division in Geneva (Switzerland) as EMEA Fulfillment Chief and assumes responsibility for Business Development, before heading DuPont Sustainable Solutions in Moscow, for Russia, Ukraine and Kazakhstan from 2010 to 2013. Mr. Kotlarevsky joined DuPont Sustainable Solutions in Morocco, in Casablanca, in June 2013.

MR. SÉBASTIEN RAOUX

PL4: May 19th 2pm – 2:45pm

Presentation title:
Climate change: an update on the road to Paris and implications for the phosphate industry and the agriculture sector

Position:
President & CEO, Transcarbon International
President, Transcarbon Africa Middle East, Argentina

Sébastien Raoux is a climate change and sustainable development expert who has been distinguished for his substantial contribution to the work of the United Nations Intergovernmental Panel on Climate Change (IPCC), which received the 2007 Nobel Peace Prize along with former Vice President Al Gore "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change."

Sébastien Raoux earned a Ph.D. in Physics from the University of Bordeaux (France), and a Juris Doctor degree from the Santa Clara University School of Law (California, United States). He is a member of the California Bar Association.

MR. RACHID YAZAMI

PL5: May 20th 8:30am – 9:15am

Presentation title:
Phosphates and Derivatives for Lithium Ion Battery Application

Position:
Professor, Energy Research Institute (ERIAN), Nanyang Technological University of Singapore

Academic and Entrepreneurial Positions:
- Since 1985: Research Director at "Centre National de la Recherche Scientifique", CNRS, France,
- 1985-2000: Scientific Research Team Leader, Department of Electrochemistry, ENSEEG, Grenoble National Polytechnics Institute (INPG) and CNRS
- 2000-2010: Visiting Associate in Materials Science and in Chemistry at the California Institute of Technology (Caltech) in collaboration with the Jet Propulsion Laboratory (JPL/NASA),
- Since 2007: Founder and President of CFX Battery, Inc., a startup company on primary and rechargeable lithium and fluoride batteries, CA, USA
- Since 2010: Visiting Professor at NTU and Battery Research Program Director, at ERIAN, NTU
- 2011: Founder and Director of KVI PTE LTD, Singapore

MR. THIERRY ZOMAHOUN

PL6: May 20th 2pm – 2:45pm

Presentation Title:
Africa and AIMS: Bridging the Skills Gap in Science, Technology, Engineering and Mathematics (STEM)

Position:
President & CEO African Institute for Mathematical Sciences - Next Einstein Initiative (AIMS-NEI), Canada

Thierry holds an Executive MBA from McGill-HEC Montreal, an MPhil in Development Studies from the University of Geneva and an MA from the National University of Benin (West Africa). He is currently reading his PhD in Political Science at University of Guelph.

Founding Executive Director and current President and CEO of African Institute for Mathematical Sciences (AIMS), Thierry is a senior executive with over 20 years of successful track record in educational and scientific program administration, business startups and microenterprise development in Africa, Asia, Latin America and the Caribbean.

KEYNOTE SPEAKERS

MR. PAUL LEVER

KN1: May 18th 2:45pm – 3:15pm

Presentation title:
A Vision for the Future of Mining: The Role of Technology

Position:
Professor, CRCMining, & School of Mechanical and Mining Engineering, University of Queensland, Australia

Professor Paul Lever became a director in May 2012 when he was appointed Chief Executive Officer of CRCMining.
Paul held several positions at CRCMining prior to becoming CEO that included Research Director, VP for Business Development and Program Leader.

Before joining CRCMining in July of 2000 he was head of the Mining and Geological Engineering department at the University of Arizona.

His research interests include the fields of robotic and automated mining systems, smart mining machines and systems, and intelligent data analysis techniques. He has worked on projects that include; (1) intelligent control algorithms for an automated (Robotic) excavator, and (2) developing the science of bucket/material interactions to improve the performance of large excavators.

Professor Lever obtained a BSc in Mining Engineering from the University of Witwatersrand in Johannesburg, and received his MSc and Ph.D. in Mining Engineering from the Colorado School of Mines.

MR. THOMAS LAGER

KN2: May 18th 3:15pm – 3:45pm

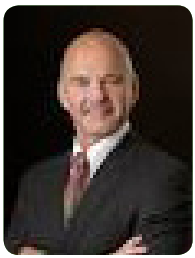
Presentation title:
Managing Innovation & Technology in the Process Industries: current practices and future perspectives

Position:
Affiliated Professor, EMINES-School of Industrial Management, Mohammed VI Polytechnic University, Benguérir, Morocco

Thomas Lager is an affiliated professor in Management of Innovation & Technology at EMINES – School of Industrial Management, at the Université Mohammed VI Polytechnique in Morocco. He was previously affiliated professor in Innovation Management at the Grenoble Ecole de Management in France. He was formerly the founder, adjunct professor and director of the Centre for Management of Innovation and Technology in Process Industry (Promote) at the Luleå University of Technology in Sweden.

He holds an MS degree in Mining Engineering from the Royal Institute of Technology KTH, Sweden. He has a PhD in Mineral Processing and a PhD in Business Administration and Economics from the Luleå University of Technology. He has served as a section head at the National Industry Board in Sweden.
Mr Lager has also served 15 years in Process Industry, mainly in the capacities of Production Engineer in Sweden and Africa, and an R&D Manager in the Swedish mining industry.

MR. GARTH KIRKHAM



KN3: May 19th 9:15am – 9:45am

Presentation title:
CIM Definitions, Standards, Best Practices and NI43-101

Position:
President, Canadian Institute of Mining (CIM/ICM), Canada

With over 30 years of experience, Mr. Kirkham is the principal of Kirkham Geosystems Ltd. that specializes in 3D computer modeling and resource/reserve estimations at the preliminary assessment, pre-feasibility and feasibility study stages of mining projects.

He obtained a Bachelor's degree in Science from the University of Alberta in 1983. He is a Professional Geoscientist in British Columbia, Alberta, the Northwest Territories and Nunavut, Ontario and Manitoba.

He is CIM President Elect and will serve as President in 2015-2016. He is also Chair of the CIM Best Practices Committee and Chair of the Geoscientist Canada, Securities Committee.
He has also served two terms on Council at APEGBC and is Vice-Chair of the Geoscience Committee.

MR. JAMAL CHAOUKI

KN4 May 19th 9:45am – 10:15am

Presentation title:
Energy and Chemicals from Biomass & Waste: the State of the Art

Position:
Professor, Polytechnic School of Montreal, Canada

Jamal Chaouki obtained his engineering degree from ENSIC in Nancy, France in 1980 and Ph.D. degree from Polytechnic, Montreal. He was also post-doc fellow at UBC Vancouver from 1985 to 1986. Professor Chaouki is full professor from 1995 at Polytechnic School of Montreal. He has supervised more than 70 Ph.D. and Master Students and more than 40 post-docs. He published more than 350 reviewed articles in refereed journals and in different reviewed proceedings and more than 400 other scientific articles and edited 6 books. He has more than 13 patents on different processes. He is now editor of the « Chemical Product and Process Modeling ».

He is also director of Bio refinery Center and member of the Canadian Academy of Engineering. He has co-chaired 8 International Conferences including the 8th World Congress of Chemical Engineering 2009 where he has acted as technical director. He is now supervising 30 researchers (22 Ph.Ds, 4 PDFs, 3 research associates and 1 researcher). He is a member of the Polytechnic School Board and several companies. He is consultant for at least 20 national and international companies. He is a principal shareholder of NSREC-Total Group in hydrodynamic modeling of multiphase processes at extreme conditions.

MR. FABRICE RENARD

KN5 May 19th 2:45pm – 3:15pm

Presentation title:
Precision Phosphorus Fertilization

Position:
Innovation Director, PRAYON S.A., Belgium

Fabrice Renard studied Chemical Engineering and Business Administration at the University of Liège. He joined the group Prayon in 1991.

After different positions in Belgium and Morocco as process engineer, financial controller, plant manager, marketing manager, he started ten years ago the development of a global innovation process for the Company.

As Chief Innovation Officer, he is in charge of Innovation, Research & Development and IP for the group Prayon
As Chief Oerating Officer of beLife, a joint company with Umicore, developing Lithium Iron Phosphate for the battery industries, he is in charge of the commercial strategy and the operations.
In addition, he is member of the board of various SME and start-up: THT (probiotics), Symbiose (molecular biomimetics) and Solustep (water treatment).

MRS. HASNA BOUTZIL & MR SAAD MIKOU
KN6: May 19th 3:15pm – 3:45pm

Presentation title:
Developing OCP Innovative Industrial Ecosystems

Position:
Corporate Purchasing Manager, OCP S.A., Morocco
Monitoring & Development Purchasing Manager, OCP S.A., Morocco

MR. JULIAN HILTON

KN7: May 20th 9:15am – 9:45am

Presentation title:
Value-add, critical materials and the waste hierarchy: policy drivers in the phosphate fertiliser market

Position:
Chairman, Aleff Group, United Kingdom

Chairman Aleff Group, London, founded in 1992 with Dr. Malika Moussaid. Strategic planning, sustainability and business strategy. Extensive experience in the MENA region. Specializes in NORM industry life-cycle management (phosphates, uranium, oil, gas and rare earths), including residues and wastes.
Co-principal investigator, "Stack Free by '53 – Safe Beneficial Uses of Phosphogypsum" (2005-2011); lead consultant IAEA Phosphate Industry Safety Report (2013).
Chair IAEA – OECD UxP Expert Working Group. Co-convenor IFA NORM/ Phosphogypsum Working Group.
Widely published; frequent speaker at international conferences.

MR. SEAN DESSUREAULT

KN8 May 20th 9:45am – 10:15am

First Presentation Title:
Bringing big data to the mine face: using mobile apps and integrated data at all levels of the mine

Second Presentation Title:
Transforming workplace culture and clearing bottlenecks through mobile technology, integrated business intelligence, and process change

Position:
President, MISOM Technologies Inc., Tucson, USA
Associate Professor, Mining Engineering Department, University of Arizona

Dr. Sean Dessureault is an associate professor at the University of Arizona, engaged in applied research related to mining information systems. He directs the Mine Intelligence Research Group (MIRG) lab having real-time and historical data warehouses from several mining companies, an integrated monitoring room for remote mine optimization, and uses cloud and local servers in big-data research in both industrial and sustainability/social media applications (www.mirg.arizona.edu).

He founded MISOM technologies Inc., a technology company that designs and implements integrated data solutions and mobile apps (www.misom.com). He is a recognized expert in both underground and surface mobile fleet automation, big-data in mining and data-driven sustainability. Dr. Dessureault was awarded the Foundation of the South West American Mining Hall of Fame Medal of Merit under 40 for his academic and entrepreneurial work supporting the technological transformation of mining.

MR. MICHAEL WIENKER

KN 9: May 20th 2:45pm – 3:15pm

Presentation title:
The Computerized Maintenance Management System (CMMS) – an essential tool for World Class Maintenance

Position:
Maintance & CMMS Professional, ThyssenKrupp Industrial Solutions AG, Germany

Michael Wienker is CMMS & Planning Specialist of ThyssenKrupp Industrial Solutions AG, based in Essen, Germany.

In the area of Asset Management Processes, Michael is experienced in the development and use of predictive Maintenance Solutions and Computerized Maintenance Management Systems (CMMS e.g. IBM Maximo, SAP-PM, Oracle EAM, Mex Maintenance Experts).
His experience includes the Implementation of Maintenance Processes such as Workflow processes, Shutdown processes and Reliability processes. Michael conducted performing Maintenance Process Audits (MPA) at different worldwide clients.

Michael Wienker holds a Master degree as Mechanical Engineer and he also graduated with a Bachelor degree of Mechatronical Engineering at the University of Applied Sciences in Wilhemshaven. Michael served an apprenticeship as "Mechatronics Technician" and he also gained two years practical experience at the Power Plant of the International Energy Provider E.ON in Wilhelmshaven, Germany.

MR. JEAN-CLAUDE CHARPENTIER

KN10: May 20th 3:15pm – 3:45pm

Presentation title:
What kind of Modern "green" Chemical Engineering is required in the Framework of Global Trade, Sustainability and Industry Technical Innovation Demand?

Position:
Former President, European Federation of Chemical Engineering, CNRS/ ENSIC, Université de Lorraine, France

-Professor of Chemical Engineering and Directeur de Recherche CNRS Classe Exceptionnelle Émérite, Laboratoire Réaction et Génie des Procédés, CNRS/ENSIC/ Université de Lorraine (2006-)
-Directeur (Dean) and Founder of Ecole Supérieure de Chimie, Physique Electronique de Lyon (ESCPE Lyon) (1994-2005) and Professor of Chemical Engineering (catalytic gas-liquid-solid reactors)
-Director (Dean) of Ecole Supérieure de Chimie Industrielle de Lyon (ESCIL Lyon) (1992-1997)
-Scientific Director of the department of Engineering Sciences at CNRS (1985-1992)
-Director of Ecole Nationale Supérieure des Industries Chimiques (ENSIC Nancy) (1983-1985)
-Director of Centre de Perfectionnement des Industries Chimiques (CPIC/ENSIC) (1980-1995)
-Founder and Head of the research group «Réacteurs polyphasiques catalytiques gaz-liquide-solide», Laboratoire des Sciences du Génie Chimique (CNRS/ENSIC Nancy) (1970-1985)
-President of the Scientific Committee of Société Française de Génie des Procédés (SFGP) (1997-2002)
-President of European Federation of Chemical Engineering (EFCE) (2002-2006)
-Scientific fields of researches: Multiphase gas-liquid-solid reactors, Sustainable (Green) process engineering applied to green chemistry, Engineering sciences
-220 scientific publications including 118 in international journals, 128 oral presentations in international congresses including 63 as invited plenary (or opening plenary) lecture
-Editor of Entropie, Techniques de l'Ingénieur, Associate-Editor of Chemical Engineering Science (UK), Chemical Engineering & Technology (D), Recent Patents on Chemical Engineering Journal (USA), International Journal of Petroleum Technology USA), Current Environmental Engineering (USA), and Processes (CH)
-Member of the scientific committee of several industry companies
-Honorary Fellow IChemE (UK), Fellow de AIChE (USA), Honorary Fellow of CSCE (Cz), Member of Academia Europeae

WORKSHOPS

SAFETY MANAGEMENT

KARAM 1 Room
Workshop 1
Chair: Mr Berady Jalal, Responsable Hygiène, Sécurité, Environnement, OCP, Morocco
Co-Chair: Mr Zad Mohamed, Responsable Develeppement Durable, OCP, Morocco

4:15pm - 4:35pm	WS1: «HSE management on construction site in the phosphate industry», Dominique BARICHEFF, Sales Development Officer, ARIA TECHNOLOGIES, France
4:35pm - 4:55pm	WS2: «Story of an HRS sulfuric unit», Abdenour JBILI, Methods Engineer, Abdelaziz LAHMADI, Process Engineer, OCP, Morocco
4:55pm - 5:15pm	WS3: "Protect and Sustain" certification of OCP», Ahmed SADIK, Health, Safety and Environment Manager and Protect and Sustain Responsable, Axe Centre, OCP, Morocco
5:15pm - 5:35pm	WS4: «Le Projet Zéro incident un moteur pour réaliser l'excellence Globale à l'axe Nord «, Abdelkader ALOUANI, Responsable Hygiène Sécurité Environnement, Direction Exécutive, Axe Nord, OCP, Morocco
5:35pm - 5:55pm	WS5: «The Task Force experience to accelerate the deployment of HSE standards in Jorf Lasfar «, Mohammed ZAD et Sanae AZZAOUI, Responsables HSE, OCP, Maroc
5:55pm - 6:15pm	WS6: «South Africa's Mining Industry Safety Journey – A personal perspective», Wilco UYS, Professional Mining Engineer, Bethal, South Africa, George BASSON, Executive Chairman, DUST-A-SIDE, South Africa
6:15pm - 6:55pm	Discussions / Recommendations

PHOSPHOGYPSUM

KARAM 2 Room
Workshop 2
Chair: Mr Julian HILTON, Chairman Aleff Group, UK
Co-Chair: Mr Abdelhak KABBABI, Environment Manager, Sustainability Department, OCP, Morocco

4:15pm - 4:35pm	WS1: «Multiple benefits from salt-affected lands ameliorated by phosphogypsum», Qadir MANZOOR, United Nations University Institute for Water, Environment and Health (UNU-INWEH), Ontario, Canada
4:35pm - 4:55pm	WS2: «Phosphogypsum free process for manufacture of phosphatic fertilizers,NPK/DAP- Concept Paper», Dr Iyer RAMAKRISHNAN, R&D, 4R Technologies, India
4:55pm - 5:15pm	WS3: «Phosphogypsum recycling, as structural in a Phosphoric acid plant business model», Anas LAHLOU, Jorf Fertilizers Company V, Jorf Lasfar, Morocco
5:15pm - 5:35pm	WS4: «Phosphogypsum as fertilizer: Impact on crop, soil & environment», Khalil EL MEJAHED, Université Mohammed VI Polytechnique, Benguérir, Maroc
5:35pm - 5:55pm	WS5: «Frame Work for Mainstreaming phosphogypsum use in Road Construction in Morocco», Yahia BOUABDELLAOUI, IAV. Hassan II, Rabat, Morocco
5:55pm - 6:35pm	Discussions / Recommendations

PHOSPHATE GEOLOGY

KARAM 1 Room
Workshop 3
Chair: Mr Essaid JOURANI, Responsable Recherche Géologique et Minière, OCP, Maroc
Co-chair: Mr Abdelhak KHERBECHE, Professor, LCME, USMBA - Fès, Maroc

10:45am - 11:05am	WS1: «The Phosphates of Morocco, a nonesuch window on the vertebrate paleobiodiversity during the key Cretaceous-Tertiary transition (70,6 to 46,6 million years), state of art and future perspectives», Nour-Eddine JALIL, Professeur, Sorbonne University, France
11:05am - 11:25am	WS2: «The «Dérangements» in the phosphate series in the Khourigba area (Morocco): Evidence for karstification along the NE border of the basin?», Michel SÉRANNE, Professeur, Université Montpellier, France
11:25am - 11:45am	WS3: «Relationship between the oxidation degree of the organic matter and gangue type in Djebel Onk phosphates, Algeria», Mohamed DASSAMIOUR, Université Ferhat Abbas Sétif, Algérie
11:45am - 12:05pm	WS4: «Sédimentologie et stratigraphie séquentielle des cortèges phosphatés d'âge Maastrichtien-Yprésien du gisement de Benguérir, Maroc», Mustapha MOUFLIH, Professor, FS Ben M'sick, Casablanca, Morocco
12:05pm - 12:25pm	WS5: «Characterization and Valorization of Tozeur-Nefta Phosphate Deposit (Southwestern Tunisia)», Wissem GALLALA, Assistant Professor, Science University of Gabès, Tunisia
12:25pm - 12:45pm	Discussions / Recommendations

NUTRIENT PLANT INTERFACE

KARAM 2 Room
Workshop 4
Chair: Mr Mohamed BADRAOUI, Director General of Morocco's National Agronomic Research Institute (INRA), Morocco
Co-chair: Ms Ilham LRHCHA, Responsible Environment, OCP

10:45am - 11:05am	WS1: «Multimicrobial inoculants: mycorrhizal fungi and associated bacteria for an optimal use of phosphate fertilizers», Silvio GIANINAZZI, INOCULUMplus sas, France
11:05am - 11:25am	WS2: «Management and Development of Soil Microbial Resources for Sustainable Development», Ibrahima NDOYE, Centre de Recherche de Bel-Air, Dakar, Sénégal.
11:25am - 11:45am	WS3: «Mycorrhiza-Based Inoculants, a Sustainable Solution for Global Food Security», Mohamed HIJRI, Institut de recherche en biologie végétale, Université de Montréal, Canada
11:45am - 12:05pm	WS4: «Development of a biological phosphate fertilizer to improve wheat (Triticum astivum) production in Mali», Amadou Hamadoun BABANA, Professor, Université des Sciences, Mali
12:05pm - 12:25pm	WS5: «Bio Fertilizers for Food Safety Production in Georgia», Dr. Kakha NADIRADZE, Association for Farmers Rights Defense, Georgia
12:25pm - 12:45pm	WS6: «Symbiotic rhizobacteria for improving of the agronomic effectiveness of phosphate fertilizers», Khalid OUFDOU, Professor, University Cadi Ayyad, Marrakech, Morocco

PHOSPHATE GEOLOGY

KARAM 1 Room
Workshop 5
Chair: Mr El Hassane CHELLAI, Professeur Université Cadi Ayyad Marrakech, Maroc
Co-Chair: Mr Youssef DAAFI, Chargé de recherche géologie centre, OCP, Morocco

4:15pm - 4:35pm	WS6: «Chemostratigraphic constrains on the phosphate series of the Ouled Abdoun Basin in Morocco based on stable isotope and trace element compositions of fossil remains», László KOCSIS, Professor, University Brunei Darussalam, Brunei
4:35pm - 4:55pm	WS7: «Geology and Mineralogy of Phosphorite Concretions in the Ma'an area, south Jordan», Khalid TARAWNEH, Faculty of Engineering, Al Hussein Bin Talal University, Jordan
4:55pm - 5:15pm	WS8: «Preliminary data of REE in Algerian phosphorites: a comparative study and paleo-redox insights», Rabah KECHICHED, Professor, Université Kasdi Merbah, Oaurgla, Algérie
5:15pm - 5:35pm	WS9: «The Geological Society of Africa, more than 40 years of Geoscience services in Africa: Future challenges», Hassan M HELMY, GSAf Vice President for Northern Africa, Egypt, Youssef DRIOUCH, GSAf Councillor for northern Africa, Morocco
5:35pm - 5:55pm	Discussions / Recommendations

AGRICULTURE IN AFRICA

KARAM 2 Room
Workshop 6
Chair: Mrs Fatiha CHARRADI, Responsable Fonds d'innovation pour Agriculture, OCP, Maroc
Co-Chair: Mr Abdelmonim EL KANIT, Agronomical marketing Analyst, OCP, Morocco

4:15pm - 4:35pm	WS1: «Diagnosis of phosphorus requirements for cocoa soils in Côte d'Ivoire», Louis KOKO, Soil fertility scientist, CNRA Divo, Programme Cacao, Côte d'Ivoire
4:35pm - 4:55pm	WS2: «IPNI North Africa Challenges in nutrient management under rainfed agriculture of Morocco», Mohamed EL GHAROUS, Consulting Director, IPNI North Africa, Morocco
4:55pm - 5:15pm	WS3: «Ethiopia Transforming Small Farm Holders livelihood through the application of custom made fertilizer», Hezekiel TASSE, Ethiopian Agricultural Transformation Agency and Ministry of Agriculture of Ethiopia, Addis Ababa, Ethiopia
5:15pm - 5:35pm	WS4: «Carte de fertilité des sols du Maroc et ses relations avec les pays africains», Riad BALAGHI, INRA, Morocco
5:35pm - 5:55pm	WS5: «Efficacy Evaluation of two NPKS Fertilizer Formulations of OCP on Three Important Food Crops in Smallholder Farming in Kenya», Esther GIKONYO, Kenya Agricultural Research Institute KARLO, Kenya
5:55pm - 6:15pm	WS6: Jacob MWALE, Zambia
6:15pm - 6:55pm	Discussions / Recommendations

DIGITAL MINING

KARAM 1 Room
Workshop 7
Chair: Mr Hicham GUELLAF, Responsable Support Axe Centre, OCP, Maroc
Co-Chair: Mr Abdellah MAHSOUN, Chef de Projet Performances Mines, OCP, Maroc

10:45am - 11:05am	WS1: «CODELCO DIGITAL: history advances and challenges» Marco ORELLANA, CIO Corporate, Codelco, Chile
11:05am - 11:25am	WS2: «Transforming Workplace Culture and Clearing Bottlenecks through Mobile Technology, Integrated Business Intelligence, and Process Change», Dr. Sean DESSUREAULT, President, MISOM Technologies Inc. & Associate Professor, University of Arizona, USA
11:25am - 11:45am	WS3: «Cisco Experience on Digitalizing the Mine», Dean SMITH, Vertical Manager in Mining & Industrial Plants Digitalizing covering Europe, Middle, CISCO, UK
11:45am - 12:05pm	WS4: «Intelligent Mine - Optimization, guidance, robotics.», Mikhail MAKEEV, Project director, VIST Group, Russia
12:05pm - 12:25pm	WS5: «Evolving Dragline Fleet Application: Techniques To Reduce Cost», Randy GOVIER, Caterpillar Global Mining, South Milwaukee, USA
12:25pm - 12:45pm	WS6: «Disruptive Innovation in Digital Mining», Alexander CONTI, Technology Strategy, Accenture Plant and Commercial Services, Brazil
12:45pm - 1:05pm	WS7: «Mobile weighing systems and data transmission: Save time and money - optimize processes - reduce costs», Mustapha KOUMIH, Area Sales Manager PFREUNDT GmbH, Germany
1:05pm - 1:25pm	Discussions / Recommendations

CONFERENCES

KARAM 2 Room
CONFERENCES
Chair: Dr Habiba Chakir, Director, International Partnerships and Government Relations, Canada

10:45am - 11:05am	Conference 1: «Exploration of sulfur and potash in Morocco: state of play», Addi AZZA, Ingénieur Général, Ex-Chef du « Projet Soufre », Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement, Morocco
11:05am - 11:25am	Conference 2: «Innovation in the Phosphate Industry: A review and analysis of patents relating to the Phosphate industry», Bob STEMBRIDGE, Senior Patent analyst, Thomson Reuters, UK
11:25am - 11:45am	Conference 3: «Competitive drivers in the phosphates business», Hatfield Oliver Director of Fertilizer Research, Integer Research, Invicta House, United Kingdom

PARTICIPANTS LIST

FIRST NAME	NAME	COMPANY / ORGANISM
Douglas	SEGOVIA	A.R. WILFLEY & SONS, INC.
Manu	SRIVASTAVA	A.R. WILFLEY & SONS, INC.
Chakib	LAZRAK	AKZO NOBEL COATINGS S.A.
Mohamed	SALKI	AKZO NOBEL COATINGS S.A.
Guillaume	OSOUF	ALLGAIER WERKE GMBH
Reda	GUESSOUS	ALLGAIER WERKE GMBH
Anas	BARAHIOUI	AMITECH MAROC
Michel	OBERLÉ	APSYS
Taoufik	EL MAHI	APSYS
Todd	PARKER	ARRMAZ
Joseph	CHRISTENSON	ARRMAZ
Abdelkrim	CHELLAH	ATLAS COPCO MAROC
Faouzi	BELGHARBIA	ATLAS COPCO MAROC
Marco	SONNENSCHEIN	AUMUND HOLDING B.V.
Youssef	EL OUAFI	AUMUND HOLDING B.V.
Ad	ROETGERING	BASF
Tiny	KOELEWIJN	BASF
Marco	POSENATO	BEDESCHI
Pietro	DE MICHIELI	BEDESCHI
Tahar	SEFRIOUI	BLAIR RUBBER COMPANY
Tom	BOGART	BLAIR RUBBER COMPANY
Benoit	LAROCHE	BONFIGLIOLI FRANCE
Luca	TIOZZO	BONFIGLIOLI FRANCE
Nicolas	RODET	BRAY CONTROLS
Robert	GERWIEN	BRAY CONTROLS
Hassan	HAIDA	CADEX
Mohamed	ALIOUALI	CADEX
Latif	BENHAMMOU	CALVO SEALING MAROC
Victor	CALVO LEON	CALVO SEALING MAROC
Hakim	NEJJAR	CCIC
Isabelle	SANTINI	CECA

Isabelle	BIRKEN	CECA
Stéphane	REY	CHAUVIN
Robert	MACIEL	CHEMETICS INC
Moumen	CHAGRAOUI	CHEMETICS INC
Mohammed	BILAL	COLAS MAROC (GTR)
Mickael	LEDIRAISON	COLAS MAROC (GTR)
Rafael	MIER	CYTEC INDUSTRIES
SA	RAVISHANKAR	CYTEC INDUSTRIES
Fouad	DOUIRI	DELATTRE LEVIVIER MAROC
Michael	VERGIN	DELATTRE LEVIVIER MAROC
Jaouad	SOUFIANI	DEUTSCHE TECHNICAIR
Omar	EL ALJ	DEUTSCHE TECHNICAIR
Nadia	BETTAR	DUPONT OCP OPERATIONS CONSULTING
Yacine	SALIHY	DUPONT OCP OPERATIONS CONSULTING
Laurent	PALIERNE	ECOPHOS SA
Yannick	VANCOPPENOLLE	ECOPHOS SA
Abdelaziz	KADIRI	ELEPHANT VERT
Yann	MIEGE	ELEPHANT VERT
Ismail	LABIDI	EMERSON NETWORK POWER INDUSTRIAL SYSTEMS SAS
Nicolas	LECOURT	EMERSON NETWORK POWER INDUSTRIAL SYSTEMS SAS
Tom	WISNIEWSKI	EUROPEAN FILTER CORPORATION
Alain	HENRARD	EUROPEAN FILTER CORPORATION
Jean-Luc	DEPLANQUE	FIVES FCB
Jérôme	PORTAL	FIVES FCB
Gabriele	GHIRINGHELLI	FLSMIDTH MILANO
Thomas	DUBRULLE	FLSMIDTH WADGASSEN GMBH
Martina	TRAEGER	FRIATEC AKTIENGESELLSCHAFT
Mohamed	HABIBI	FRIATEC AKTIENGESELLSCHAFT
Alberto	DEL RIO	GARAY RECUBRIMIENTOS
Miguel	IZAGUIRRE	GARAY RECUBRIMIENTOS
Jean-Jacques	BOZEC	GEA WESTFALIA SEPARATOR FRANCE SAS
Ruediger	GOEHMANN	GEA WESTFALIA SEPARATOR GROUP GMBH
Abdelkoudous	KHALESS	GRAPHITE INDIA LIMITED
Sunil	KSHATRIYA	GRAPHITE INDIA LIMITED
Felix	HANDERMANN	HAYNES INTERNATIONAL
Francesco	OPESSI	HAYNES INTERNATIONAL

Taj	LARAQUI	HOWDEN FRANCE
Laurent	VASSEUR	HOWDEN FRANCE
Abdallah	BELHCEN	HTDS
Mohammed	BENTOUMI	HTDS
Pierre	COLON	I-CARE
Hassan	EL AMRANI	I-CARE
Jarir	NIZAR	INDUPROJ
Abdel	MAOUI	JFI (HASLER-LUMPP-RPA)
Erik	LOISEAU	JFI (HASLER-LUMPP-RPA)
Ivan	GILGADO	KAO CORPORATION S.A.
Xavier	RIUS	KAO CORPORATION S.A.
Cherradi	KAZAR	KAZAR MAROC
Aurélia	GONZALEZ	LABBE
Thomas	LABBE	LABBE
Francois	HEBERT	LECHLER FRANCE
Serge	CORBEL	LECHLER FRANCE
Ali	BENNANI DAKHAMA	LES ÉQUIPEMENTS INDUSTRIELS (LEI)
AHMED	BENNANI DAKHAMA	LES ÉQUIPEMENTS INDUSTRIELS (LEI)
Jan	BOND	MAHLE IF
Samir	BELBACHIR	MAHLE IF
Giovanni	MARCHESI	MECS
Thierry	MARIN	MECS
Jaafar	EL YASSINI	MERSEN
Laurent	TRABLY	MERSEN
Benjamin	ROHART	METSO
Bernard	MENTEYNE	METSO
Franck	BOURILLON	MORET INDUSTRIES GROUP
Julien	GREENHALGH	MORET INDUSTRIES GROUP
Jean-Philippe	GLORIES	MPC
Kamal	JAIDI	MPC
Gareth	HALSTEAD	MULTOTEC (PTY) LTD
Wilna	HOFFMAN	MULTOTEC (PTY) LTD
Fernanda	DIAS	NAQ GLOBAL COMPANIES
Prakash	MATHUR	NAQ GLOBAL COMPANIES
Andreas	HENSSEN	NEUMAN & ESSER GMBH
Mohamed Hichem	MOSBAH	NEUMAN & ESSER GMBH

Faraj	DAOUDI	NEYRTEC MINERAL
Salim	ATTAYE	NEYRTEC MINERAL
Frederic	NECTOUX	NORD DRIVE SYSTEMS
Abdelali	HAMRI	NORD DRIVE SYSTEMS
Karim	AMOR	OMIC
Abdelbaki	KHAMSINE	OUTOTEC
Fatima	CHOAIBI	OUTOTEC
Bruno	RECKMANN	PFREUNDT GMBH
Mustapha	KOUMIH	PFREUNDT GMBH
Dennis	NOLAN	POLYCORP LTD.
Tom	SHEWFELT	POLYCORP LTD.
Leruth	DENIS	PRAYON
Dominique	MARECHAL	PRAYON
Benoit	JAMET	SAACKE BRULEURS INDUSTRIELS
Laurent	MAUDHUY	SAACKE BRÛLEURS INDUSTRIELS
Patrick	LOPES	SAMSON REGULATION
Abderrahmane	BOUGRINE	SAMSON REGULATION
Hans	BOUDWIJN	SANDVIK MATERIALS TECHNOLOGY
Johan	WALLIN	SANDVIK MATERIALS TECHNOLOGY
Anouar	BEN ABDALLAH	SICK FRANCE
Richard	BLOT	SICK FRANCE
Hicham	HADDOU	SIEMENS
Sara	BENABACHIR	SIEMENS
Markus	HOFMANN	SMDM
Amine	LAHRICHI	SMDM
Patrick	TASSIN	SNF SAS
Willy	DURAND	SNF SAS
Claudio	FORNICIOV	SOLEX THERMAL SCIENCE INC.
Neville	JORDISON	SOLEX THERMAL SCIENCE INC.
Khalid	EL BARAKAT	SPHINX ELECTRIC
John	DUFFY	SPRAYING SYSTEMS CO.
Maroun	EL MEDAWAR	SPRAYING SYSTEMS CO.
Didier	JUNG	SULZER POMPES PROCESS FRANCE
Jean-Michel	LLEU	SULZER POMPES PROCESS FRANCE
David	TORELLI	TECOFI
David	OUNDJIAN	TECOFI

Farid	AMROUNI	TESMEC S.P.A.
Daniel	RIVARD	TESMEC S.P.A.
Alessandro	AMBROSSIO	THERMO RAMSEY ITALIA
Samir	BENMOUSSA	THERMO RAMSEY ITALIA
Georg	PAHLENKEMPER	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Sandra	ROMBACH	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Christopher	ROBBEN	TOMRA SORTING GMBH
Jens-Michael	BERGMANN	TOMRA SORTING GMBH
Jihane	ABOUDAHAB	TRACTAFRIC EQUIPMENT MAROC
Said	MAZOUZ	TRACTAFRIC EQUIPMENT MAROC
Khalid	BOUJNANE	TRELLEBORG INDUSTRIE SAS
Luca	COLOMBO	TRELLEBORG INDUSTRIE SAS
Mohamed	BAOU	VEGA TECHNIQUE
Baptiste	BIRY	VEGA TECHNIQUE
El Kaitouf	MAAELAYNINE	WEIR MINERALS EUROPE
Mohamed	SAIAD	WEIR MINERALS EUROPE
Adil	GUENNAI	WELDING ALLOYS
Guy	CLEMENT	WELDING ALLOYS
Osagie Sylvester	AIGBE	WENGFU (GROUP) CO., LTD.
Zhuanming	YANG	WENGFU (GROUP) CO., LTD.
Abilio	GASPAR DE BARROS	WESTECH ENGINEERING, INC.
Abdou	BA	ABB
Khaled	TORBEY	ABB
Saadi	BENTOUMI	ABB
Said	DALDALOU	ABB
Youssef	KHOUYI	ABB
Abdellah	NAHDI	ABB SWITEZRLAND LTD.
Vincent	PERROT	ACM (ATELIERS DE CHAUDRONNERIE DE MONPLAISIR)
Oloutayo David	HOUESSOU	ADONAI UNIVERSITY
Christian	BOURHIS	AKZONOBEL
Ramzi	DEKHIL	ALKIMIA
Wejdène	AMORRI ZEHRI	ALKIMIA
Alejandro	MOLINA	AMITECH MAROC
Hicham	SEKKAT	AMITECH MAROC
Nick	CROFTS	AMITECH MAROC
Zineb	OUARDA	AMITECH MAROC

El Hassane	TAJ	AMITECH MAROC
Farooq	ELLAHI	ANDRITZ SEPARATION
François	FEVRIER	ANDRITZ SEPARATION
Luis Fernando	DIEGO OGUIZA	ANIVI INGENIERIA
Abdulsalam	ALABDULSALAM	ARASCO
Christopher	DAY	ARRMAZ
Daniel	PARTIN	ARRMAZ
David	KESELICA	ARRMAZ
Guoxin	WANG	ARRMAZ
Jeffrey	BARBER	ARRMAZ
Md. Chakib	KABBAJ	ATLAS CIT
Zakaria	EL ADNANI	ATLAS CIT
Jean-Baptiste	CORONA	ATLAS COPCO DRILLING SOLUTIONS LLC
Ali	EL KANBI	ATLAS COPCO MAROC
Samir	AHSSAINE	ATLAS COPCO MAROC
Dirk	HENSEL	BASF SE
Alan	MARTIN	BASTECH, LLC
Thomas	COURTNEY	BASTECH, LLC
Simon	INGLETHORPE	BC INSIGHT
Graeme	COUSLAND	BEGG COUSLAND ENVIROTEC LTD.
Christian	REDL	BERTSCHENERGY
Oguntade	OLAKUNLE AYOBAMI	BIGVISION GROUP
Jarellah	SEFRIOUI	BLAIR RUBBER COMPANY
Zakaria	BELRHZAL	BLAIR RUBBER COMPANY
Jean-Pierre	PRIAN	BRGM ORLÉANS FRANCE
Roderick	CANT	BUSS CHEMTECH AG
Francis	NEMETH	C.B.V.
André	BRASSINE	CANAL ENGINEERS SPRL/BVBA
Luc	VAN QUATHEM	CECA
Hassan	CHATER	CEGELEC
Adil	BENNANI	CGA
Mohamed	TAHAR MÉHARI	CHAKETMA PHOSPHATES SA
Taoufik	MANSOURI	CHAKETMA PHOSPHATES SA
Issouf	ABDOU MAHAMADOU	CHOTTANI INTERNATIONAL

Jean-Baptiste	AGNES	CLAUDIUS PETERS TECHNOLOGIES SAS
Jean-Christophe	HOLFERT	CLAUDIUS PETERS TECHNOLOGIES SAS
Lhoussain	OUTIFA	CMG MANAGEM
Ahmed	ZAKAR	CMG « MANAGEM »
Franck	INDO	COFIREP
George	BASSON	COLAS GTR
Louis	LEDOUX	COLAS GTR
Bouchaib	SAFIR	COLAS MAROC GTR
Faiçal Lahmamsi	LAHMAMSI	COLAS MAROC GTR
Patrick	RIVAUD	COLAS MAROC GTR
Vincent	GROSSI	COLAS MAROC GTR
Gerard	D'AQUIN	CON-SUL, INC.
Ahmet	TEOMAN	CYTEC
Cyril	BOURGET	CYTEC INDUSTRIES FRANCE SARL
Gregory	FLIEG	CYTEC INDUSTRIES, INC.
Robert	ALLEN	DASSAULT SYSTEMES GEOVIA LTD
Gaetan	DELFOSSE	DE SMET ENGINEER & CONTRACTORS
Philippe	AGOSTI	DE SMET ENGINEER & CONTRACTORS
Guy	DAVISTER	DE SMET ENGINEERS & CONTRACTORS
Emmanuel	LENAIN	DEGREMONT
Olivier	COURT-GIRARD	DEUTSCHE TECHNICAIR
Sofiane	DJEBARI	DEUTSCHE TECHNICAIR
Nicolas	BARKHUYSEN	DSI AFRICA (PTY) LTD
Richard	MARTINEZ	DUPONT SUSTAINABLE SOLUTIONS
Kris	VAN DAMME	ECOPHOS SA
Zouhair	KANOUNI	EMBASSY OF CANADA TO MOROCCO
Chafik	KRAIMA	ENECON MAROC
Ghyles	DJOUDI	ENSIVAL MORET
Arnaud	CRESPON	ENSIVAL MORET SERVICE MAGHREB
Souad	ZYADE	ESTC
Frank	MARIAGE	FASKEN MARTINEAU DUMOULIN S.E.N.C.R.L.
Saqib	RAZA	FATIMA FERTILIZER COMPANY LIMITED
Mamadou	SYLLA	FLOWSERVE SALES INTERNATIONAL
Mohammed	MRABET	FLOWSERVE SALES INTERNATIONAL
Dietmar	DI KIRCHEBNER	FLSMIDTH KREBS GMBH
Roland	DI OBERROITHER	FLSMIDTH KREBS GMBH

Riccardo	AVESANI	FLSMIDTH MILANO SRL
Matthias	SCHMIDT	FLSMIDTH WADGASSEN GMBH
Philippe	BONFILS	FLSMIDTH WADGASSEN GMBH
Abderrahmane	LYAMANI	FONDATION PHOSBOUCRAÄ
Fouad	EL ALAMI	FORTRADE
Saïd	EL ALAMI	FORTRADE
Raiz	BASHEERUDDIN	FURNACE FABRICA (INDIA) LTD.
Laurent	FOULON	FXL INTERNATIONAL
Mouna	LAHLOU KITANE	FXL INTERNATIONAL
Xavier	FOULON	FXL INTERNATIONAL
Luca	GAFFURI	GAMBAROTTA GSCHWENDT
Amari	ABDELHALIM	GCT
Nadia	GHALLAB	GRAPHITE INDIA LIMITED
Benhafsia	RIDHA	GROUPE CHIMIQUE TUNISIEN
Derbel	ANOUAR	GROUPE CHIMIQUE TUNISIEN
Hassairi	JAMEL	GROUPE CHIMIQUE TUNISIEN
Jean-Pierre	DUPUY	GTR CASABLANCA
Ghali	LARAQUI	HOWDEN France
Kees	LANGEVELD	ICL FERTILIZERS
Philippe	BABUIN	ICRGARAY GROUP
Volker	ANDRESEN	IFA
António	FERREIRA	ISPT INDUSTRIAL SERVICES
João	MARQUES	ISPT INDUSTRIAL SERVICES
David	IVELL	JACOBS ENGINEERING
Thomas	SCHANZE	JACOBS ENGINEERING
Michel	JAMEY	JFI (HASLER-LUMPP-RPA)
Abeer	RADAWEEN	JORDAN PHOSPHATE MINES COMPANY
Enas	DIEABS	JORDAN PHOSPHATE MINES COMPANY
Hassan	RAWASHED	JORDAN PHOSPHATE MINES COMPANY
Mutaz Qamoh	QAMOH	JORDAN PHOSPHATE MINES COMPANY
Omar	AL-ORJANY	JORDAN PHOSPHATE MINES COMPANY
Andrey	SHIBNEV	JSC PHOSAGRO-CHEREPOVETS
Yaroslav	ELIN	JSC PHOSAGRO-CHEREPOVETS
Joan	RIAZA	KAO CORPORATION
Samuel	GIMENEZ	KAO CORPORATION, S.A.
Abdelilah	ELBAHRAOUI	KIMIA

Yassine	MELLOUK	KSB MAROC
Alain	JACQUET	LAFARGE CENTRE DE RECHERCHE
Beqrawi	NABIL	LASRY MAROC
Antoine	AOUN	LEBANON CHEMICALS COMPANY
Antoine	DOUMET	LEBANON CHEMICALS COMPANY
Simon	MATTA	LEBANON CHEMICALS COMPANY
Mathias	RAYO	MAGOTTEAUX
Emmanuel	BRUNIAU	MAGUIN
Abderahman	KADDAMI	MANAGEM
Hakim	FAQIR	MANAGEM
Ken	KERSHAW	MECS
Pascal	DU BOIS D'ENGHIEN	MECS
Eric	MOUGIN	MERSEN
Fernand	CHOLHOT	MERSEN
Reda	JERID	MERSEN
Sophie	BACH	MERSEN
Mohamed	JERID	MERSEN MAROC
Angel	COLLADO	MK ENERGIES
Johan	MANKA	MK ENERGIES
Joseph	KLINE	MOSAIC FERTILIZER, LLC
Karen	SWAGER	MOSAIC FERTILIZER, LLC
Mark	KORETCHKO	MOSAIC FERTILIZER, LLC
Werner	GOEMINNE	MP MITSUBISHI HITACHI POWER SYSTEMS GROUP
Wim	SCHELFAUT	MP MITSUBISHI HITACHI POWER SYSTEMS GROUP
Hicham	EL ARJAOUI	MULTOTEC (PTY) LTD
Mithlesh	MATHUR	NEELAM AQUA & SPECIALITY CHEM (P) LTD
Jamal	KADDOURA	NEUMAN & ESSER GMBH
Evgenii	KUZNETSOV	NIUIF INSTITUTE MOSCOW
Maksim	TCIKIN	NIUIF INSTITUTE MOSCOW
Evgenii	SHIBANOV	OAO PHOSAGRO RUSSIA
Gustav	KILDEN	OUTOTEC
Juergen	ERB	OUTOTEC
Juha	KEMPPAINEN	OUTOTEC
Sebastian	STORBACKA	OUTOTEC
Mohamed	TIZLA	OUTOTEC MOROCCOLLC
Saad	LAGOUITI	PARKER HANNIFIN SAS

Vittorio	STANCO	PARKER HANNIFIN TWIN FILTER
Abdeljalil	MOUHAFID	PHOSBOUCRAA
Hassan	TAOUANI	PLUS TRADE
Bill	FULK	POTASHCORP
George	PIEGOLS	POTASHCORP
Timothy	JESTNESS	POTASHCORP
Laurent	BECKERS	PRAYON
Caprara	YVES	PRAYON S.A
Desmet	ERIK	PRAYON S.A
Germeau	ALAIN	PRAYON S.A
Gevers	FRÉDERIC	PRAYON S.A
Renard	VALERIE	PRAYON S.A
Willems	ISABELLE	PRAYON S.A
Claudia	TOUSSAINT	PRAYON SA
Mohamed Amine	BERRADA	PRAYTECH MAROC
Collin	MARC	PROFILE (PRAYON S.A)
Legros	PAUL-HENRI	PROFILE (PRAYON S.A)
Martin	ANDRÉ	PROFILE (PRAYON S.A)
Van Erck	VALERIE	PROFILE (PRAYON S.A)
Gabriel	DAMIEN	PRT (PRAYON S.A)
Haddou	HDACH	REMINEX – MANAGEM GROUP
Jean Claude	SOLER	REMITEC
Said	SBAI	REMITEC
Sara	AJLANE	REMITEC
Michael	MAGERSTAEDT DR.	ROSEN SWISS AG
Jamal Eddine	AIT MANNA	S.M.D.M
Mohamed	SERRAJ	S.M.D.M
Mohamed	ERRAFAI	SAACKE BRULEURS INDUSTRIELS
April	MONTERA	SABIA
Khalid	BENHAMOU	SAHARA WIND
Christian	LAURENT	SAI SOCIÉTÉ D'ACOUSTIQUE INDUSTRIELLE
Daniel	GULLBERG	SANDVIK MATERIALS TECHNOLOGY
Abdulaziz	AL URAINI	SAUDI ARABIAN MINING COMPANY (MAADEN)
Abdulrahman	AS-SADLAN	SAUDI ARABIAN MINING COMPANY (MAADEN)
Mehdi	NAJID	SEDRIC S.A.
Luc	PARENT	SEFAR BDH

Anand	REDDY	SENMIN
Gaelle	MABIALA	SENMIN
Iman	SARMADI	SEPRO MINERAL SYSTEMS
Bruno	LISENA	SICK FRANCE
Bart	LAPLASSE	SIEMENS
Ikbal	SBITI	SIEMENS
Mohamed	NASSIR	SIEMENS
Bruno	GOUTAGNY	SISTEC
Quentin	OLIVIER	SNC-LAVALIN
Sergio	JOAO	SNC-LAVALIN INC.
Maxence	MIRABEAU	SNC-LAVALIN INTERNATIONAL
Wassim	EL-SADDIK	SNC-LAVALIN INTERNATIONAL
Robert	GUEZ	SNF
Dennis	KENNEDY	SNF FLOMIN INC.
Serhat	KELES	SNF FLOMIN INC.
Fethi	HCHIFA	SOCIETE CHAKETMA PHOSPHATES S.A
Kais	MANSOURI	SOCIETE CHAKETMA PHOSPHATES S.A
Chedli	TRIKI	SOCIÉTÉ SEAM
Mahmoud	ETTRIKI	SOCIETE SEGOR
Bertrand	BOUZET	SOFRECO
Yves	DOLLE	SOFRECO
Jean-Marc	REICHLING	SOLEX THERMAL SCIENCE INC.
Fréderic	CARENCOTTE	SOLVAY
Jiawen	DING	SOLVAY
Joao	ALVES	SOPAC SA
Nuno	SILVA	SOPAC SA
Herve	GUICHERD	ST EQUIPMENT & TECHNOLOGY LLC
Jean-Marc	LABORDERIE	SULZER POMPES FRANCE
Federico	BALLY	SULZER PUMPS
Matti	RIKKA	SULZER, PUMPS EQUIPMENT, WATER BUSINESS UNIT.
Imad	ULLAH	TAHA ENTERPRISES
Tahir Hassan	KHAN	TAHA ENTERPRISES
Norbert	NEUMANN	TAKRAF GMBH
Philippe	MALSAN	TECHNIP
Arun Jothi	MR. A	TECTON ENGINEERING & CONSTRUCTION LLC
Subramaniam	MR. M	TECTON ENGINEERING & CONSTRUCTION LLC

Rajiv	TALKAL	TENOVA DELKOR
Flavio	VILLA	TESMEC SPA
Marcello	MANENTI	TESMEC SPA
Ismaeel	BOLAJI	THE UNIVERSITY COLLEGE HOSPITAL
Srinivasa Viswanath	BATTULA	THERMAL SYSTEMS (HYD) PVT.LTD.
Matthias Hermann	BRANDAU	THERMAL SYSTEMS GMBH
Guenther	SLADEK	THERMO FISHER SCIENTIFIC
Kristian	MATILLA	THERMO FISHER SCIENTIFIC
Nazih	ZIADE	THERMO FISHER SCIENTIFIC (ECUBLENS) SARL
Enrique	SABATE	THERMO RAMSEY ITALIA SRL
Houda	SAROUAOU	THOMSON REUTERS
Christophe	KRAUTH	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Dr. Richard	SAURE	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Olaf	KRASKA	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Rudolf	EL-HAYEK	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Stéphane	ROSANVALLON	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Virginie	EMKEYES	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Emanuel	PORTA	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
K.S	RAO	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Manuel	DANGELA	THYSSENKRUPP INDUSTRIAL SOLUTIONS AG
Stephane	DUMONT	TRELLEBORG INDUSTRIE SAS
Haubruge	ERIK	ULG
Leroy	PASCAL	ULG
Javier	SUAREZ ESTIVARIZ	ULMA CONVEYOR COMPONENTS
Rachid	YAHYAOUI	UNIVERS MED PREMIER
Aurore	RICHEL	UNIVERSITÉ DE LIÈGE
Bach Kim	NGUYEN	UNIVERSITÉ DE LIÈGE
Patrick	SHARROCK	UNIVERSITÉ DE TOULOUSE
Omar	TANANE	UNIVERSITE HASSAN II CASABLANCA
Abdeslam	EL BOUARI	UNIVERSITÉ HASSAN II DE CASABLANCA, FACULTÉ DES SCIENCES BEN M'SIK
Hatim	ZINEB	UNIVERSITY CHOUAIB DOUKKALI
Jim	HUTCHINS	VERMEER
Allal	EL FASSI EL FIHRY	VOITH TURBO
Marwan	KARAKI	WEIR MINERALS LEWIS PUMPS

Black	KEN	WEIR MINERLAS LEWIS PUMPS
Abderahman	TIFROUTE	WELDING ALLOYS
Yang	SANKE	WENGFU (GROUP) CO., LTD.
Andreas	MARQUARDT	WIRTGEN GMBH
Robert	TUCKER	Innovation Ressource
Yahya	BOUABDELLAOUI	IAV Hassan II
Jim	HUTCHINS	Vermeer
Mahendra	SINGH WALDIA	Caterpillar
Abdul Razac	SANE	Université de Toulouse
Mohamed	ZAHOUILY	MAScIR
Saqib	RAZA	Fatima Fertilizer Company
Mohamed	EL GHAROUS	IPNI
Riad	BALAGHI	INRA
Jacob	MWALE	
Thierry	MARIN	Dupont
Mark	GILBREATCH	Roy Pickrem Crescent Technology
Thomas	DAHLKE	Buss ChemTech AG
A. Adriano	UREÑA	Ollearis, S.A.
Abderrahim	SOLHY	UM6P
Achim	SCHÖNFELDER	ThyssenKrupp Industrial Solutions AG
Adam	PANAYI	Integer Research
Addi	AZZA	Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement, Maroc
Alain	ROLLAT	Rhodia/Solvay
Alain	DREVETON	AD Process Strategies Sàrl
Albert	SOTTO	TAL INSTRUMENTS
Alexander	CONTI	Accenture
Alexandre	DURAND	Prayon
Amadou Hamadoun	BABANA	Université des Sciences, desTechniques et des Technologies de Bamako (USTTB)
Amal	BELLARBI	Jacobs Engineering SA
Amine Ghali	BENNA	SKF France
Anas	LAHLOU	Jorf Fertilizers Company V
Andre	KOTLAREVSKY	DuPont OCP Operations Consulting
Andrey	GLUSHKO	Federal State Unitary Enterprise "State Scientific-Research Institute of Chemical Reagents and High Purity Chemical Substances" (IREA)

Ange	NZIHOU	Mines Albi
Avdhesh	MATHUR	Naq Global Companies
Aziza	BENABOUD	Ecole Royale Navale
Barthelemy	NYASSE	University of Bamenda cameroon
Benoît	VAN MASSENHOVE	Prayon
Bernardo	SIZA VIEIRA	Sandvik Materials Technology
Bob	STEMBRIDGE	Thomson Reuters
Casper	VITTRUP FRANDSEN	Haldor Topsoe A/S
Chakib	BOUALLOU	MINES ParisTech
Curtis	GRIFFIN	PegasusTSI, Inc.
Daniel M.	GAGNON	Met-Chem Canada Inc,
Dean	SMITH	CISCO SYTEMS
Doan	PHAM MINH	Ecole des Mines d'Albi-Carmaux
Dominique	BARICHEFF	Aria Technologies
Donal S.	TUNKS	Phosphatics LLC
Dr. Sean	DESSUREAULT	MISOM Technologies Inc.; and University of Arizona
Eric	JORDA	Arkema
Ester	GIKONYO	Kenya Agricultural Research Institute KARLO
Fabien	BROCHETON	Numtech
Fabrice	RENARD	Prayon
Fakher	JAMOUSSI	CNRSM Tunisie
Faïz	OUMGHAR	LEICA GEOSYSTEMS
Frank	DARDEMANN	LOESCHE Innovative Engineering
Frank	HRACH	ST Equipment & Technology
Garrett	PALMQUIST	DuPont Sustainable Solutions
Garth	KIRKHAM	Canadian Institute of Mining (CIM/ICM)
Gerhard	PRACHT	FRIATEC Aktiengesellschaft
Habib	SMIDA	faculté des sciences de sfax Tunisie
Henning	URCH	BASF SE
Hermann-Josef	VOLK	Wirtgen Group
Herve	GORISSE	DEGREMONT INDUSTRY
Hezekiel	TASSE	Ethiopian Agricultural Transformation Agency and Ministry of Agriculture of Ethiopia
Houda	AZZOUZI	MANAGEM
Ibrahima	NDOYE	Université Cheikh Anta Diop de Dakar (UCAD)
Ismael	SAADOUNE	Université Cadi Ayyad Marrakech

Jamal	CHAOUKI	Ecole Polytechnique de Montreal
James	BYRD	Jacobs Engineering Inc.
Jan	ALBRECHT	Outotec
Jean-Claude	CHARPENTIER	CNRS/ENSIC/Université de Lorraine
Jean-Claude	SERBON	FLSmidth Wadgassen GmbH
Jean-Pierre	DAL PONT	SFGP société française de Génie des Procédés
Jens-Michael	BERGMANN	Tomra Sorting GmbH
Jose Roberto	NUNHEZ	State University of Campinas
Joseph	SYKES	Maptek
Juan A	GONZALEZ LEON	Centre de Recherche Rhône-Alpes ARKEMA
Juan Pablo	BELTRAN	National University of Buenos Aires.
Juha	TIMPERI	Outotec
Julian	RUSCONI	Paterson & Cooke Consulting Engineers
Julian	HILTON	Aleff Group
Kaj	JANSSON	Outotec
Kakha	NADIRADZE	Association for Farmers Rights Defense
Kathleen	BROWN	Spraying Systems Co
Kechiched	RABAH	Faculté des hydrocarbures, des energies renouvelables et des sciences de la terre et de l'univers
Khalid	AL TARAWNEH	AL Hussein Bin Talal University, Faculté of engineering, mining engineering department
Khalid	OUFDOU	Cadi Ayyad university, Faculty of Sciences Semlalia
Khalil	EL MEJAHED	Université Mohammed 6
Khoudir	ALLAL	SERVITHEN
Koko	LOUIS	National Agronomic Research Center (CNRA)
L. Louis	RENEVEY	ROSEN Intelligent Plastic Solutions
Lev	FILIPPOV	Georessouurces Laboratory in Nancy (Université de Lorraine-CNRS)
Luis	RUDOLPHY	Outotec
László	KOCSIS	Universiti Brunei Darussalam
Manzoor	QADIR	University Institute for Water, Environment and Health (UNU-INWEH)
Marco	ORELLANA	CODELCO
Mario	BERNARDINI	CNIM GROUP
Mattias	ASTHOLM	Outotec
Merja	PARSSINEN	Sulzer, Pumps Equipment, Water Business Unit
Mette	DOEBEL	FLSmidth A/S

Michael	KEMMERICH	Outotec
Michael	FENTON	Jacobs & CHEMETICS INC
Michael	WIENKER	ThyssenKrupp Industrial Solutions AG
Michael	HASCHKE	G.U.B. Ingenieur AG
Michel	SÉRANNE	Géosciences Montpellier
Mike	PARSONS	Blair Rubber Company
Mikhail	MAKEEV	VIST Group
Mohamed	DASSAMIOUR	Univesity of Ferhat Abbas Setif 1
Mohamed	HIJRI	Université de Montréal
Mustapha	KOUMIH	PFREUNDT GmbH
Mustapha	MOUFLIH	FST Ben M'sick
Muthanna H.	AL-DAHHAN	Missouri University of Science and Technology
Nathalie	LYCZKO	Ecole des Mines d'Albi
Nicolas	VAN LIERDE	Prayon
Nikolaj	KNUDSEN	Haldor Topsoe A/S
Norbert	WEFERLING	WefConsult GmbH
Nour-Eddine	JALIL	MUSEUM NATIONAL D'HISTOIRE NATURELLE
Patel	GHANSHYAMPRA-SAD MANIBHAI	CIFC (India) Pvt Ltd. (Rahimtula Group of Companies)
Paul	LEVER	CRCMining
Rachid	HAKKOU	Laboratoire de Chimie des matériaux et de l'Environnement
Rachid	YAZAMI	Nanyang Technological University, Energy Research Institute (ERIAN)
Rafal	WALECKI	ABB
Ramakrishnan	IYER	4 R Technologies
Randy	GOVIER	Caterpillar Global Mining, South Milwaukee, USA
Ray	WILL	IHS Chemical
Reik	WINKEL	ThyssenKrupp Industrial Solutions AG
Roger	SUMMERHAYS	WesTech Engineering Inc.
Saifaoui	W DRISSI	Université Hassan 2, FST Ain Chok
Silvio Giovanni	GIANINAZZI	INOCULUMplus sas
Stéphane	TORRENS	DNVGL
Stéphane	TROESCH	Epur Nature
Stéphane	PELLET-ROSTAING	CNRS / ICSM
Sébastien	RAOUX	Transcarbon International
T. Alan	HATTON	MIT

Tatiana	ZAKOLODINA	Moscow State Humanitarian-Economical University
Thierry	ZOMAHOUN	The African Institute of Mathematical Sciences
Thomas	LAGER	EMINES - School of Industrial Management
Tibaut	THEYS	Prayon
Timperi	JUHA	Outotec
Tom	BROUWERS	MECS
Tyler	J BERENS	ATLAS COPCO MAROC
Vaughn	ASTLEY	Dr Phosphate Inc
Wilco	UYS	COLAS MAROC (GTR)
Wissem	GALLALA	Département des Sciences de la Terre, Faculté des Sciences de Gabès, Tunisie
Younes	ESSAMLALI	Mascir
Lhachmi	KHAMAR	OCP S.A.
Slimane	MANAR	OCP S.A.
Mohamed	KADDARI	OCP S.A.
Mohamed Aimad	BOUGDIF	OCP S.A.
Chaimaa	BENSKOURA	JESA
Hasna	BOUTZIL	OCP S.A.
Kamal	SAMRANE	OCP S.A.
Abdelghani	GASMI	OCP S.A.
Ahmed	SADIK	OCP S.A.
Hicham	BAHA	OCP S.A.
Abdelkader	ALOUANI	OCP S.A.
Asri	MANSOUR	OCP S.A.
Youssef	DAAFI	OCP S.A.
Sanae	AZZAOUI	OCP S.A.
Zouhair	HAFID	OCP S.A.
Abdelaziz	LAHMADI	OCP S.A.
Abdenour	JBILI	OCP S.A.
Saad	MIKOU	OCP S.A.
Hanane	MOURCHID	OCP S.A.
Dr Priscilla	NELSON	Colorado School of Mines
Hicham	BOUZEKRI	MAScIR
Tijani	BOUNAHMIDI	EMI
Mohamed	BADRAOUI	INRA
Amit	ROY	IFDC

Habiba	CHAKIR	African Institute for Mathematical Sciences
Mohammed	EL ASRI	Faculté des Sciences et Techniques
Mohamed	SMANI	de R&D Maroc
Abdelhak	KHERBECHE	LCME / USMBA - Fès
Lahcen	BIH	FST ERRACHIDIA
Bill	WILSON	Mining Llc
MOHAMMED	ZAIN	AFA
Rachid	MRABET	INRA
Volker	ANDRESEN	IFA
Ahmed	SOUISSI	Département Génie des procédés / EMI Rabat
Adil	DIANI	Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement
Ahmed	BOUHAOUSS	FSR-UM5R
Hassan	HELMY	GSAF
Youssef	DRIOUCH	GSAF
El Hassane	CHELLAI	Speaker
Carlos	VILLARROEL	CODELCO
Rachid	BOULIF	OCP S.A.
Jamila	ADANI	OCP S.A.
Hind	BERNOUSSI	OCP S.A.
Kenza	GASSIB	OCP S.A.
Hakima	BATTAL	OCP S.A.
Aziz	MOQADEM	OCP S.A.
Ikram	BENHALIMA	OCP S.A.
Hind	BENZEKRI	OCP S.A.
Mohamed	AARAB	OCP S.A.
Abderahim	AATOUF	OCP S.A.
Omar	ABADI	OCP S.A.
Mohammed	ABBOUDE	OCP S.A.
Alaa	ABDELLAOUI MAAN	OCP S.A.
Ahmed	ABDENBAOUI	OCP S.A.
Jaouad	ABISOUROUR	OCP S.A.
Sofia	ABOUCHRAA	OCP S.A.
Hassan	ABOUDRARENE	OCP S.A.
Meroaune	ABOUELFAOUARIS	OCP S.A.
Adel	ABOUS	OCP S.A.

Younes	ABROUQ	OCP S.A.
Jamal	AFKIR	OCP S.A.
Hicham	AGGADI	OCP S.A.
Abelmajid	AGOUZOUL	OCP S.A.
Younes	AINANE	OCP S.A.
Idir	AIT HSSAINE	OCP S.A.
Jamal	AIT KHOUYA	OCP S.A.
Khalid	AIT LHAKEM	OCP S.A.
Hassan	AIT OUAZZOU	OCP S.A.
Samir	AIT ZAID	OCP S.A.
Noureddine	AJIM	OCP S.A.
Hanane	AKHAIAT	OCP S.A.
Mokhtar	AKONADE	OCP S.A.
Driss	AKRIM	OCP S.A.
Noafeh	AL MAKFALJI	OCP S.A.
Sanae	ALAMI AFILAL	OCP S.A.
Mbarek	AMAGHZAZ	OCP S.A.
Mohamed	AMALHAY	OCP S.A.
Jamal	AMALIK	OCP S.A.
Mohamed	AMALIK	OCP S.A.
Jihane	AMARI	OCP S.A.
Jaouad	AMHARECH	OCP S.A.
Driss	AMOUZIGH	OCP S.A.
Omar	AMRAOUZA	OCP S.A.
Najem	ANADIF	OCP S.A.
Mounia	AOUAD	OCP S.A.
Soukaina	AOUINA	OCP S.A.
Youssef	AQID	OCP S.A.
Marwane	ARRASSEN	OCP S.A.
Ahmed	ATTYUB	OCP S.A.
Hicham	AYAD	OCP S.A.
Ali	AZERGUI	OCP S.A.
Youness	AZRIB	OCP S.A.
Er-Rafa	AZZAZ	OCP S.A.
Alae-Eddine	AZZOUZI	OCP S.A.
Mohammed	BADAS	OCP S.A.

Badr	BADR EL AMRANI	OCP S.A.
Amine	BAGHRI	OCP S.A.
Ayoub	BAHAIDA	OCP S.A.
Fouad	BAHBOUHI	OCP S.A.
Saloua	BARGACH	OCP S.A.
Abdelaziz	BARZANI	OCP S.A.
Zineb	BELAABID	OCP S.A.
Saloua	BELHABCHIA	OCP S.A.
Ayoub	BELMIR	OCP S.A.
Salah Eddine	BEN BAADI	OCP S.A.
Abdelaziz	BEN EL BOU	OCP S.A.
Mokhtar	BEN EMBAREK	OCP S.A.
Jamal	BENAISSA	OCP S.A.
Fayçal	BENAMEUR	OCP S.A.
Adil	BENBAOUALI	OCP S.A.
Hameda Mohssine	BENCHEKROUN	OCP S.A.
Abdelhakim	BENDAHANE	OCP S.A.
Mohammed Kamal	BENHAMMOU	OCP S.A.
Afaf	BEN-HSSINE	OCP S.A.
Mohamed	BENKAMOUN	OCP S.A.
Hicham	BENKIRANE MTITOU	OCP S.A.
Samir	BENNOUNA LOURIDI	OCP S.A.
Mouna	BENQLILOU	OCP S.A.
Amal	BENRQYA	OCP S.A.
Saâd	BENZAKOUR	OCP S.A.
Adil	BENZIDIYA	OCP S.A.
Jalal	BERADY	OCP S.A.
Ali	BERKA	OCP S.A.
Achraf	BERNOUSSI	OCP S.A.
Achraf	BERRADA	OCP S.A.
Younès	BIYADI	OCP S.A.
Salah	BOUBAKRI	OCP S.A.
Mostafa	BOUCHAOUIR	OCP S.A.
Hamid	BOUDDOU	OCP S.A.

Houssine	BOUHIAOUI	OCP S.A.
Abdelali	BOUKACHABINE	OCP S.A.
Fouad	BOUKAISSI	OCP S.A.
Youssef	BOULAHYA	OCP S.A.
Rkia	BOULAM	OCP S.A.
Salah	BOUMAHDI	OCP S.A.
Mohamed	BOUMESSHOUL	OCP S.A.
Abdeljalil	BOURRAS	OCP S.A.
Mohamed	BOUSSETA	OCP S.A.
Abdelghani	BOUTABBA	OCP S.A.
Abbas	BOUZAFOUR	OCP S.A.
Mohamed	BOUZIDI	OCP S.A.
Brahim	BOUZZIT	OCP S.A.
Hassan	CHADLI	OCP S.A.
Mesbahi Younes	CHAHID	OCP S.A.
Khalid	CHAKIR	OCP S.A.
Abeljalil	CHAKIR	OCP S.A.
Ahmed	CHAKIR	OCP S.A.
Mohamed El Imame	CHAME	OCP S.A.
Mohammed Abdelfattah	CHARIF CHEFCHAOUNI	OCP S.A.
Mustapha	CHAROUIT	OCP S.A.
Fatiha	CHARRADI	OCP S.A.
Oussama	CHEDAD	OCP S.A.
Mohammed	CHEHTANE	OCP S.A.
Salah Eddine	CHEKROUN	OCP S.A.
Eddaoui	CHEMESDDINE	OCP S.A.
Siham	CHERKAOUI	OCP S.A.
Ouidad	CHKAIL	OCP S.A.
Abdelhadi	CHNANI	OCP S.A.
Mohammed	CHOUBAILI	OCP S.A.
Rachid	CHOUCHANE	OCP S.A.
Sanjay Ganpatro	CHOUDHARY	OCP S.A.
Mehdi	CHOUIKH	OCP S.A.
Dounia	CHRAIBI	OCP S.A.

Abdessamad	DAAYF	OCP S.A.
Imane	DADEN	OCP S.A.
Said	DADI	OCP S.A.
Ibtissam	DANNOUN	OCP S.A.
Loubna	DAOUDI NEJM	OCP S.A.
Faris	DERIJ	OCP S.A.
Faris	DERRIJ	OCP S.A.
Driss	DHIBA	OCP S.A.
Abdelhakim	DRIOUICH	OCP S.A.
Hicham	ECHAARANI	OCP S.A.
Mohamed	ECHARQI	OCP S.A.
Abdelhak	EDDOUBI	OCP S.A.
Badredine	EL ABID AMRANI	OCP S.A.
Nor-Eddine	EL ALLAM	OCP S.A.
Mohammed	EL AMMARI	OCP S.A.
Mohamed Amine	EL BAGHATI	OCP S.A.
Ali	EL BAGHATI	OCP S.A.
Ahmed	EL BAHAR	OCP S.A.
Abdellatif	EL BAKKALI	OCP S.A.
Med Salem	EL BOUKHARY	OCP S.A.
Yusra	EL BOUKILI	OCP S.A.
Mustapha	EL FAQIR	OCP S.A.
Abdelhamid	EL FATTAHI	OCP S.A.
Fatima Zahra	EL FRIEKH	OCP S.A.
Hassan	EL GHOUGHA	OCP S.A.
Hicham	EL HABTI	OCP S.A.
Aziz	EL HADDANI	OCP S.A.
Omar	EL HALOUI	OCP S.A.
Annas	EL HAMESS	OCP S.A.
Mustapha	EL HAOUCHI	OCP S.A.
Said	EL HAYANY	OCP S.A.
Larbi	EL HILALI	OCP S.A.
Brahim	EL IDRISSI	OCP S.A.
Asmaa	EL IDRISSI BOULAKRAMS	OCP S.A.
Abdelmounim	EL KANIT	OCP S.A.

Brissam	EL KHALFI	OCP S.A.
Mostafa	EL KHOMSI	OCP S.A.
Mohammed	EL KHOUAKHI	OCP S.A.
Abdelhamid	EL KINANI	OCP S.A.
Hamid	EL MAHFOUDI	OCP S.A.
El Houssine	EL MAHFOUDI	OCP S.A.
Mehdi	EL MALEM	OCP S.A.
Abdelaziz	EL MALLAH	OCP S.A.
Adil	EL MAMOUN	OCP S.A.
Mehdi	EL MANIARI	OCP S.A.
El Habib	EL MANSOUR	OCP S.A.
Chouaib	EL MANSOURI	OCP S.A.
Meryem	EL MEHDI	OCP S.A.
Sami	EL MESLOUHI	OCP S.A.
El Mustapha	EL MESSAOUDI	OCP S.A.
Mohammed	EL MIDAOUI	OCP S.A.
Youssef	EL MOKADEM	OCP S.A.
Taoufik	EL MORABIT AMGHAR	OCP S.A.
Mounir	EL MOUNSIF	OCP S.A.
Mohamed	EL OUALI	OCP S.A.
Abdeladim	EL OUARDI	OCP S.A.
Mouhsine	EL SOSSA	OCP S.A.
Omar	EL YAAGOUBI	OCP S.A.
Yassine	EL YASSAMI	OCP S.A.
Moulay Hafid	EL YAZIDI	OCP S.A.
Firas	ELAOUNI	OCP S.A.
Abdelkrim	ELBAZ	OCP S.A.
Ilias	ELFALI	OCP S.A.
Bouazzaoui	ELJABBAR	OCP S.A.
Fouad	ELKADI	OCP S.A.
Souad	ELKHADRI	OCP S.A.
Nada	ELMAJDOUB	OCP S.A.
Mohammed	ELOUAZGUITI	OCP S.A.
Mehdi	ERRACHIQ	OCP S.A.
Abderrahim	ERRAIS	OCP S.A.

Karim	ERRAMI	OCP S.A.
Safaa	ESSAWABI	OCP S.A.
Abderrahmane	ETAHIRI	OCP S.A.
Hassan	ET-TAFS	OCP S.A.
Mohamed	ETTAKI	OCP S.A.
Adil	ETTANGI	OCP S.A.
Samira	EZZAHAR	OCP S.A.
Kacem	EZ-ZOUGARI	OCP S.A.
Abdelali	FAIK	OCP S.A.
Brahim	FAKIR	OCP S.A.
Mohamed	FARHANE	OCP S.A.
Ahmed	FARSI	OCP S.A.
Mohamed	FATIH	OCP S.A.
Zakaria	FERRAQ	OCP S.A.
Hassan	FESSAS	OCP S.A.
Azzeddine	FILALI	OCP S.A.
Abdelghani	FILALI	OCP S.A.
Issam	GHOUWATI	OCP S.A.
Abdelhak	GOUDANI	OCP S.A.
Adil	GOURARI	OCP S.A.
Yahya	GRIMAH	OCP S.A.
Hicham	GUELLAF	OCP S.A.
Abdelilah	HADDADI	OCP S.A.
Mouad	HADRI	OCP S.A.
Abdelmajid	HAIMOUD	OCP S.A.
Mohamed	HALLOUZI	OCP S.A.
Saidabdesammad	HAMRANI	OCP S.A.
Hassan	HAMRI	OCP S.A.
Ahmed	HAMRI	OCP S.A.
Youssef	HAMZA	OCP S.A.
Aziz	HARIS	OCP S.A.
Abdelaziz	HARRATI	OCP S.A.
El Maati	HASOUN	OCP S.A.
El Rbi	HASOUN	OCP S.A.
Anass	HASSAINATE	OCP S.A.
Omar	HASSAR	OCP S.A.

Hicham	HASSOUNE	OCP S.A.
Amani	HATIM	OCP S.A.
Noureddine	HIMMAD	OCP S.A.
Abdel Ali	HOUBBADI	OCP S.A.
Omar	HOURI	OCP S.A.
Mohamed	HQABI	OCP S.A.
Nabil	HRANI	OCP S.A.
El Habib	ID HAMMOU	OCP S.A.
Mounir	IFRAK	OCP S.A.
Ahmed	IFTIKHAR	OCP S.A.
Abderrahmane	IGOURZAL	OCP S.A.
Imane	EL ANDALOUSSI	OCP S.A.
Laila	INOUSS	OCP S.A.
Yassin	JALAL	OCP S.A.
Lhoucine	JAMAI	OCP S.A.
Abdelali	JANNATI	OCP S.A.
Tarik	JEBBARI	OCP S.A.
Jaouhar	JEBRIL	OCP S.A.
Nore-Ddine	JERROUM	OCP S.A.
Hamza	JIHAD	OCP S.A.
Es-Said	JOURANI	OCP S.A.
My Brahim	JOUTI	OCP S.A.
Abdelhak	KABBABI	OCP S.A.
Khadija	KABBABI	OCP S.A.
Hicham	KABBAJ	OCP S.A.
Hicham	KARIME	OCP S.A.
Mohamed	KARMOUNI	OCP S.A.
Youssef	KASMI	OCP S.A.
Oussama	KHADIRI YAZAMI	OCP S.A.
Nasreallah	KHAIRY	OCP S.A.
Mohammed	KHAJIJ	OCP S.A.
Khaoula	KHALESS	OCP S.A.
Yassine	KHALFI	OCP S.A.
Kamal	KHAMLACH	OCP S.A.
M'Hamed	KHELLA	OCP S.A.
Mehdi	KHOULOUD	OCP S.A.

Salaheddine	KNOUZI	OCP S.A.
Abdelali	KOSSIR	OCP S.A.
Khadija	KRIMI	OCP S.A.
Rabie	LABIAD	OCP S.A.
Yassine	LAGHZIOUI	OCP S.A.
Fatima Zohra	LAHIANI	OCP S.A.
Mohcine	LAHMIDI	OCP S.A.
Khadija	LALAM	OCP S.A.
Khalil	LAMGHARI	OCP S.A.
Mustapha	LAMIM	OCP S.A.
Mohamed	LARGOU	OCP S.A.
Elmostafa	LARHRABLI	OCP S.A.
Mehdi	LASLAMI	OCP S.A.
Zouhir	LATIFI	OCP S.A.
Mohamed	LECHGAR	OCP S.A.
Faissal	LEFRERE	OCP S.A.
Aziz	LEMHAMDI	OCP S.A.
Mohammed	LOUHZ	OCP S.A.
Ilham	LRHCHA	OCP S.A.
Youssef	LYAMOUDI	OCP S.A.
My Bensalem	MAAROUFI	OCP S.A.
Ikram	MACHKIR	OCP S.A.
Malak	MADRANE	OCP S.A.
Ibtissam	MAFHOUM	OCP S.A.
Omar	MAGHFOUL	OCP S.A.
Said	MAGHRANI	OCP S.A.
Brahim	MAGHRAOUI	OCP S.A.
Said	MAHBOUB	OCP S.A.
Ahmed	MAHROU	OCP S.A.
Abdellah	MAHSOUN	OCP S.A.
Dounia	MAKHCHANE	OCP S.A.
Khalid	MAKRAN	OCP S.A.
Driss	MANSOUR	OCP S.A.
Maoulainine	MAOULAININE	OCP S.A.
Hamid	MAZOUZ	OCP S.A.
Imane	MEDIA	OCP S.A.

Fatima-Zahra	MEDIOUNI	OCP S.A.
Boujemaa	MESFIOUI	OCP S.A.
Nawal	MEZIATI	OCP S.A.
Mohammed	MEZROUI	OCP S.A.
Fouad	MHIRECH	OCP S.A.
Brahim	MOFID	OCP S.A.
Bouchra	MOFLIH	OCP S.A.
Khadija	MORSLI	OCP S.A.
Amine	MOUNIR ALAOUI	OCP S.A.
Chakour	MOUNTASSIR	OCP S.A.
Said	MOUQADEM	OCP S.A.
Ghizlane	MOUSSAMIH	OCP S.A.
Issam	MOUSSAOUI	OCP S.A.
Ahmed	MOUSSAOUI	OCP S.A.
Abderrahim	MOUSTAOUI	OCP S.A.
Nadia	MRABAT BARNOUSSI	OCP S.A.
Ahmed	M'SSALI	OCP S.A.
Soufiane	NACHET	OCP S.A.
Adil	NADRI	OCP S.A.
Youssef	NAHID	OCP S.A.
Imane	NAJMI	OCP S.A.
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Mehdi	OUKACH	OCP S.A.

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Brahim	RAMDANI	OCP S.A.
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Siham	SAMHANE	OCP S.A.
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Nicolas	BAC	Metso
Vincent	PAYAN	METSO
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Mr RENARD Fabrice	Directeur Innovation PRAYON
Mr. Abdelkader ALOUANI	HSE Manager – Executive direction "Axe Nord" - OCP S.A.

SYMPHOS 2015

TECHNICAL PROGRAM OF SYMPHOS 2015

SUNDAY, MAY 17TH 2015

4pm - 7pm	Registration

MONDAY, MAY 18TH 2015

8am - 9:30am	Reception and Registration
PLENARY: MINISTERS' ROOM - OPENNING CEREMONY	
9:30am - 12pm	Welcome & Introduction
	Opening Plenary Session: Robert TUCKER, President of Innovation Resource, Best-Selling Author of «Managing the Future», USA
	Coffee break
	Exhibition area inauguration
12pm - 2pm	Lunch
PLENARY: MINISTERS' ROOM	
2pm - 2:45pm	PL2: «The Manufacturing Plant of the Future: new approaches to the Process Industries», Jean-Pierre DAL PONT, President SFGP, France
2:45pm - 3:15pm	KN1: «A Vision for the Future of Mining: The Role of Technology», Paul LEVER, Professor, CRCMining - School of Mechanical and Mining Engineering, University of Queensland, Australia
3:15pm - 3:45pm	KN2: «Managing Innovation & Technology in the Process Industries: Current practices and future perspectives», Thomas LAGER, Professeur, EMINES – School of Industrial Management, Mohammed VI Polytechnic University, Benguerir, Morocco
3:45pm - 4:15pm	Coffee break

MINISTERS' ROOM
Chairpersons:
Dr Priscilla NELSON, Dept. Head and Professor, Department of Mining Engineering, Colorado School of Mines, USA
Mr Faris DERRIJ, Director, Gantour site, OCP S.A., Morocco

MINING TECHNOLOGIES	
4:15pm - 4:35pm	CO1: «Electrostatic beneficiation of phosphate ores: review of past work and discussion of an improved separation system», Frank HRACH, Director, Process Engineering, ST Equipment & Technology LLC, USA
4:35pm - 4:55pm	CO2: «Evaluation of alternative Mining Methods at OCP», Daniel M. GAGNON, Directeur Général Mines, Met-Chem Canada Inc, Abdellah MAHSOUN, Directeur Projets, OCP Group, Morocco

4:55pm - 5:15pm CO3: «Grade Control and Stockpile Management at Benguerir Phosphate Mine: a new approach to resources optimization», Mansour ASRI, OCP Group, Benguerir, Morocco

5:15pm - 5:35pm CO4: «Outotec HIGmillTM – Optimization of stirred milling technology», Mattias ÅSTHOLM, Product Manager HIG mills, Outotec, Sweden

5:35pm - 5:55pm CO5: «Sustainable Dry Grinding Of Phosphate Rock With LOESCHE Vertical Roller Mills», Frank DARDEMANN, Manager, LOESCHE Innovative Engineering, Germany

5:55pm - 6:15pm CO6: «3D Technologies for Surveying, Monitoring & Mining», Faïz OUMGHAR, Sales Engineer and 3D solutions responsible, Leica GEOSYSTEMS, Paris, France

6:15pm - 6:35pm CO7: «1D 2D 3D Radar Technology for Safety, Operator Assistance and Automation», Dr. Reik WINKEL, indurad GmbH, Germany

6:35pm - 6:55pm CO8: «Advantages of using surface miners compared to conventional excavation methods», Flavio VILLA, Chief Engineer - Trencher Division, Tesmec S.p.A., Italy

FEZ 01 ROOM

Chairpersons:
Mr Yves CARPARA, General Manager, Prayon S.A., Belgium
Mr Brahim RAMDANI, Director of Jorf Lasfar Site, Morocco

PHOSPHORIC ACID

4:15pm - 4:35pm CO1: «Plant profitability improvement thanks to production team and engineering offices synergy: a case study in Prayon production site», Nicolas VAN LIERDE, Laurent BECKERS, Prayon Technologies S.A., Belgium

4:35pm - 4:55pm CO2: «Jacobs New Process for Removing Iron from Phosphoric Acid», Stephen HILAKOS, James BYRD, Jacobs Engineering Inc., USA

4:55pm - 5:15pm CO3: «Increasing the filtration rate of phosphoric slurry by using mineral additives», Slimane MANAR & Jaouhar JEBRIL, Maroc Phosphore Safi, OCP, Morocco

5:15pm - 5:35pm CO4: «Thickening, filtration and Clarifying in Phosphoric Acid industry», Roger Summerhays, International Sales Manager, WesTech Inc. Salt Lake City, UT, USA

5:35pm - 5:55pm CO5: «Impacts of Al_2O_3/P_2O_5 Ratio on Gypsum Crystal Growth and Phosphoric Acid Plant Operation», Curtis GRIFFIN, Process Engineering Supervisor, Pegasus TSI, USA

5:55pm - 6:15pm CO6: «Water Management, Towards Minimum Impact Concentrators», Kaj JANSSON, Outotec Oy, Finland

6:15pm - 6:35pm CO7: «Development of CALS-technology for the phosphoric acid of high purity», Andrey GLUSHKO, R&D Centre "Fine Chemicals", Russian Federation

6:35pm - 6:55pm CO8: «Comparison of different ways of Desulfatation used in OCP phosphoric acid plants», Hanane MOURCHID, Responsible of Phosphoric Production, Maroc Phosphore Safi, OCP, Morocco

FEZ MY DRISS 1ER ROOM

Chairpersons:
Mr Redouane EL OMRI, Responsible Industrial Development OCP S.A., Morocco
Mr Jean-Claude CHARPENTIER, Former President European Federation of Chemical Engineering, CNRS / ENSIC / University of Lorraine, France

INDUSTRIAL MANAGEMENT

4:15pm - 4:35pm	CO1: «Chemical and Process System Engineering contibution to Sustainability», Jean-Pierre DAL PONT, President SFGP, France
4:35pm - 4:55pm	CO2: «Phosphate Enterprise Optimization», Donal S. TUNKS, President, Phosphatics LLC, USA
4:55pm - 5:15pm	CO3: «Technology transfer mechanisms and Best features to achieve those transfers», Barthélémy NYASSE, Vice-Chancellor and Professor, University of Bamenda, Cameroon
5:15pm - 5:35pm	CO4: «Stockyard Operation and Automation,The Role of Advanced Automation Technologies in Supply Chain Management for Bulk Materials», Mette DOBEL, Global Product Manager, Quality solutions, FLSmidth Denmark, Germany
5:35pm - 5:55pm	CO5: « Déploiement de l'OPS (OCP_Production_System), la voie vers l'excellence opérationnelle: Cas pratiques et résultats terrain du site de Gantour», Abdelghani GASMI, Hicham BAHA, Mohamed Aimad BOUGDIF, OCP GROUP, Gantour Site, Morocco
5:55pm - 6:15pm	CO6: «System researches of the development of phosphoric industry of Russia», Dr Tatiana ZAKOLODINA, Head of department, Moscow state humanity-economical university, Moscow, Russian Federation
6:15pm - 6:35pm	CO7: «The Management of the Environment during the realization of industrial projects: Case of ODI's Project OCP Group –Jorf Lasfar Site», Amal BELLARBI, Responsible of Environnement, Jacobs Engineering S.A., Morocco
6:35pm - 6:55pm	CO8: «Water management in phosphoric acid: a processes comparison», Tibaut THEYS, General Manager PRT, Prayon Technologies, Belgium

FEZ MÉRINIDES ROOM

Chairpersons:
Mr Rachid YAZAMI, Ph. D. Professor and Principal Scientist, Nanyang Technological University, Singapore
Mr Hicham BOUZEKRI, Ph D, Chief Executive Officer, MASCIR, Morocco

PHOSPHATE MATERIALS

4:15pm - 4:35pm	CO1: «2020 cathode materials cost competition: Lithium Iron Phosphate, the promising best candidate for Energy Storage System», Fabrice RENARD, Directeur Innovation, Prayon S.A., Belgium
4:35pm - 4:55pm	CO2: «Electrode materials based on phosphates as a suitable way for clean energy storage», Ismael SAADOUNE, Professeur, Université Cadi AYYAD, Marrakesh, Morocco

4:55pm - 5:15pm	CO3: «Phosphates: versatile products for environmental and energy applications», Ange NZIHOU, Professeur, Toulouse University, Mines Albi, France
5:15pm - 5:35pm	CO4: «Catalysis by Phosphates: a Sustainable Route», A. SOLHY, Full professor, Mohammed VI Polytechnic University, Benguerir, Morocco
5:35pm - 5:55pm	CO5: «Production of sodium dihydrogeno-phosphate (NaH2PO4) and sodium trimetaphosphate (Na3P3O9) using sodium chloride (NaCl) and orthophosphoric acid (H3PO4)», Doan PHAM MINH, Assistant professor, Toulouse University, Mines Albi, France
5:55pm - 6:15pm	CO6: «Commercial organophosphorus chemicals: Status and new developments», Norbert WEFERLING, Technical Director, WefConsult GmbH, Germany

KARAM 1 ROOM

Workshop 1
Chair: Mr Jalal BERADY, Responsible Security, Environnement, Jorf Lasfar, OCP, Morocco
Co-Chair: Mohammed ZAD, Responsible of Sustainability Department, OCP, Morocco

SAFETY MANAGEMENT

4:15pm - 4:35pm	WS1: «HSE management on construction site in the phosphate industry», Baricheff Dominique, Sales development officier, ARIA TECHNOLOGIES, France
4:35pm - 4:55pm	WS2: «Story of an HRS sulfuric unit», Abdenour JBILI (methods engineer), Abdelaziz LAHMADI (Process ingineer), OCP Group, Safi site, Morocco
4:55pm - 5:15pm	WS3: "Protect and Sustain certification of OCP», Ahmed SADIK, Health, Safety and Environment manager and Protect and Sustain Responsable, Central Axis, OCP Group, Morocco
5:15pm - 5:35pm	WS4: «Le Projet Zéro incident un moteur pour réaliser l'excellence Globale à l'axe Nord», Abdelkader ALOUANI, Responsable Hygiène Sécurité Environnement, Direction Exécutive Axe Nord, OCP, Morocco
5:35pm - 5:55pm	WS5: «The Task Force experience to accelerate the deployment of HSE standards in Jorf Lasfar», Mohammed ZAD and Sanae AZZAOUI, HSE Responsibles, OCP Jorf Lasfar Nord, Morocco
5:55pm - 6:15pm	WS6: «South Africa's Mining Industry Safety Journey – A personal perspective», Wilco UYS, Professional Mining Engineer, Bethal, South Africa, George BASSON, Executive Chairman, DUST-A-SIDE, South Africa

KARAM 2 ROOM

Workshop 2
Chair: Mr Julian HILTON, Chairman Aleff Group, United Kingdom
Co-Chair: Mr Abdelhak KABBABI, Environment Manager, Sustainability Department, OCP, Morocco

PHOSPHOGYPSUM

4:15pm - 4:35pm	WS1:»Multiple benefits from salt-affected lands ameliorated by phosphogypsum», Qadir MANZOOR, United Nations University Institute for Water, Environment and Health (UNU-INWEH), Ontario, Canada

4:35pm - 4:55pm	WS2: «Phosphogypsum free process for manufacture of phosphatic fertilizers, NPK/DAP- Concept Paper», Dr Iyer RAMAKRISHNAN, R&D, 4R Technologies, India
4:55pm - 5:15pm	WS3: «Phosphogypsum recycling, as structural in a Phosphoric acid plant business model», Anas LAHLOU, Jorf Fertilizers Company V, Jorf Lasfar, Morocco
5:15pm - 5:35pm	WS4: «Phosphogypsum as fertilizer: Impact on crop, soil & environment», Khalil EL MEJAHED, Mohammed VI Polytechnic University, Benguerir, Morocco
5:35pm - 5:55pm	WS5: «Frame Work for Mainstreaming phosphogypsum use in Road Construction in Morocco», Yahia BOUABDELLAOUI, IAV. Hassan II, Rabat, Morocco
5:55pm - 6:15pm	Discussions / Recommendations

7:30pm	**Welcoming Cocktail**

TUESDAY, MAY 19TH 2015

PLENARY: MINISTERS' ROOM

8:30am - 9:15am	PL3: «Extracting Value through Operations Excellence», Mr André P. KOTLAREVSKY, CEO DuPont OCP Operations Consulting, Morocco
9:15am - 9:45am	KN3: «CIM Definitions, Standards, Best Practices and NI43-101», Mr Garth KIRKHAM, President Elect, Canadian Institute of Mining (CIM), Canada
9:45am - 10:15am	KN4: «Energy and Chemicals from Biomass & Waste: the State of the Art», Mr Jamal CHAOUKI, Professor, Polytechnique University Montréal, Canada
10:15am - 10:45am	Coffee break

MINISTERS' ROOM

Chairpersons:
Mr Houssine BOUHIAOUI, Director of Khouribga site, OCP S.A., Morocco
Mr Daniel GAGNON,CEO Mines, Met-Chem Canada Inc., Canada

MINING TECHNOLOGIES

10:45am - 11:05am	CO9: «Wirtgen drives the development of surface mining», Hermann-Josef VOLK, Wirtgen GmbH, Germany
11:05am - 11:25am	CO10: «Three Barrier Solution», Amine Ghali BENNA, SKF, France
11:25am - 11:45am	CO11: «Precision surface mining, the next steps», Jim HUTCHINS, Senior Application Engineer, Vermeer, USA
11:45am - 12:05pm	CO12: «Evolution of Technology on the Blasthole Drill», Tyler J BERENS, USA
12:05pm - 12:25pm	CO13: «Application of Cast Blasting in Moroccan Phosphate Mines», Mansour ASRI, Youssef DAAFI, OCP Group, Benguerir, Morocco
12:25pm - 12:45pm	CO14: «The features and benefits of Caterpillar Large Mining Trucks», Mahendra Singh WALDIA, Product Performance Engineer for Large Mining Trucks, Caterpillar, USA

FEZ 01 ROOM

Chaipersons:
Mr Tijani BOUNAHMIDI, Professor «Ecole Mohammedia des Ingénieurs», Morocco
Mr Mohamed AMALHAY, Director of IMACID, OCP, Morocco

CHEMICALS MODELISATION

10:45am - 11:05am	CO1: «An overview of state of the art consequence and risk modelling approaches for the process industries», Stéphane TORRENS, DNVGL, France
11:05am - 11:25am	CO2: «The use of Computational Fluid Dynamics for Heat Transfer and Impeller Design in Mixing Applications», José Roberto NUNHEZ, Professor of Chemical Engineering, UNICAMP – State University of Campinas, Brazil

11:25am - 11:45am	CO3: «Dynamic Simulation of Phosphoric Acid Filtration», Donal S. TUNKS, President, Phosphatics LLC, USA
11:45am - 12:05pm	CO4: «Crystallization of Calcium Sulphate during Phosphoric Acid Production: Modeling Particle Shape and Size Distribution», T. Alan HATTON, Massachusetts Institute of Technology, United Kingdom & Kamal SAMRANE, OCP, Morocco
12:05pm - 12:25pm	CO5: «Plant Operability Optimization through Dynamic Simulation, a Case Study focused on Phosphoric Acid Concentration Unit», Alexandre DURAND, Prayon S.A., Belgium
12:25pm - 12:45pm	CO6: «The use of the CFD for the hydrodynamic flow diagnostic and study in a Phosphoric Acid Reactor», Lhachmi KHAMAR, Kamal SAMRANE, R&D, OCP Group, Morocco

FEZ MY DRISS 1ER ROOM

Chairpersons:
Mr Ange NZIHOU, Director Centre RAPDOSEE, Ecole de Mines Albi, France
Mr Jamal CHAOUKI, Professor, Ecole Polytechnique, Montréal, Canada

ENERGY

10:45am - 11:05am	CO1: «Phosphate-based materials for energy storage», Abdoul razac SANE, Université de Toulouse, Mines Albi, France
11:05am - 11:25am	CO2: «The Theoritical and experimental Study of a Thermal Method for Seawater Desalination by Solar & Wind energy», D. Saifaoui, W. DRISSI, Laboratoire physique appliquée et Energies Renouvelables, Casablanca, Maroc
11:25am - 11:45am	CO3: «Energy Recovery and Valorization in the Phosphate Industry by Absorption Machines», Mario BERNARDINI, Head of Sales & Marketing, Absorption Chillers, Heat Pumps, Heat Recovery Systems, France
11:45am - 12:05pm	CO4: «Gas Turbine: Optimization of Energy Production and High Efficiency by Using Power Electronics», Aziza BENABOUD, Enseignante chercheure, Royal Navy School, Casablanca, Morocco
12:05pm - 12:25pm	CO5: «Improving energy efficiency in the chemical industry by using high efficiency motors: case study», Mohamed KADDARI, University Chouaib Doukkali, ENSA El Jadida, (LabSIPE), Morocco

FEZ MÉRINIDES ROOM

Chairpersons:
Mr Jean-Pierre DAL PONT, President SFGP, France
Mr Ahmed ZNIBAR, Responsible of Mines & Treatment Projects, OCP, Morocco

SLURRY

10:45am - 11:05am	CO1: «Construction of slurry pipelines», Juan Pablo BELTRAN, Education: Industrial Engineer – National University of Buenos Aires, Argentina
11:05am - 11:25am	CO2: «Modelling and simulation of slurry phosphate thickening», Chaimaa BENSKOURA, Process engineer, Jacobs-esa, Morocco
11:25am - 11:45am	CO3: «The Design and Engineering of the 187 km Khouribga to Jorf Lasfar Phosphate Slurry Pipeline», Julian RUSCONI, Senior Engineer, Paterson & Cooke, Anis LAKHOUAJA, Jacobs, Mustafa KOPUZ, Tekfen, South Africa

11:45am - 12:05pm	CO4: «Maroc Phosphore III-IV: PAP adaptation to phosphate slurry with process improvement», Benoit VAN MASSENHOVE, Process Manager, Prayon Technologies, Belgium
12:05pm - 12:25pm	CO5: «High performance elastomer pipe coatings in phosphate, oil sands, and dredging slurry lines: field experience», Louis L. RENEVEY, ROSEN Intelligent Plastic Solutions, ROSEN Swiss AG, Switzerland

KARAM 1 ROOM

Workshop3
Chair: Mr Essaid JOURANI, Responsible of Mines and Geological Research, Morocco
Co-Chair: Mr Abdelhak KHERBECHE, Professor, LCME, USMBA - Fez, Morocco

PHOSPHATE GEOLOGY

10:45am - 11:05am	WS1: «The Phosphates of Morocco, a nonesuch window on the vertebrate paleobiodiversity during the key Cretaceous-Tertiary transition (70,6 to 46,6 million years), state of art and future perspectives», Nour-Eddine JALIL, Professeur, Sorbonne Universities, France
11:05am - 11:25am	WS2: «The «Dérangements» in the phosphate series in the Khourigba area (Morocco): Evidence for karstification along the NE border of the basin», Michel SÉRANNE, Professor, Montpellier University, France
11:25am - 11:45am	WS3: «Relationship between the oxidation degree of the organic matter and gangue type in Djebel Onk phosphates, Algeria», Mohamed DASSAMIOUR, University Ferhat Abbas Sétif, Algeria
11:45am - 12:05pm	WS4: «Sédimentologie et stratigraphie séquentielle des cortèges phosphatés d'âge Maastrichtien-Yprésien du gisement de Benguérir, Maroc», Mustapha MOUFLIH, Professor, FS Ben M'sick, Casablanca, Morocco
12:05pm - 12:25pm	WS5: «Characterization and Valorization of Tozeur-Nefta Phosphate Deposit (Southwestern Tunisia)», Wissem GALLALA, Assistant Professor, Science University of Gabès, Tunisia
12:25pm - 12:45pm	Discussions / Recommendations

KARAM 2 ROOM

Workshop 4
Chair: Mr Mohamed BADRAOUI, Director General of Morocco's National Agronomic Research Institute (INRA), Morocco
Co-Chair: Ms Ilham LRHCHA, Environment Responsible, OCP, Morocco

NUTRIENT PLANT INTERFACE

10:45am - 11:05am	WS1: «Multimicrobial inoculants: mycorrhizal fungi and associated bacteria for an optimal use of phosphate fertilizers», Silvio GIANINAZZI, INOCULUMplus sas, France
11:05am - 11:25am	WS2: «Management and Development of Soil Microbial Resources for Sustainable Development», Ibrahima NDOYE, Research Center Bel-Air, Dakar, Senegal

11:25am - 11:45am	WS3: «Mycorrhiza-Based Inoculants, a Sustainable Solution for Global Food Security», Mohamed HIJRI, Institut de recherche en biologie végétale, Université de Montréal, Canada
11:45am - 12:05pm	WS4: «Development of a biological phosphate fertilizer to improve wheat (Triticum astivum) production in Mali», Amadou Hamadoun BABANA, Professeur, Université des Sciences, Mali
12:05pm - 12:25pm	WS5: «Bio Fertilizers for Food Safety Production in Georgia», Dr. Kakha NADIRADZE, Association for Farmers Rights Defense, Georgia
12:25pm - 12:45pm	WS6: «Symbiotic rhizobacteria for improving of the agronomic effectiveness of phosphate fertilizers», Khalid OUFDOU, Professor, University Cadi Ayyad, Marrakesh, Morocco
12:45pm - 2pm	**Lunch**

PLENARY: MINISTERS' ROOM

2pm - 2:45pm	PL4: «Climate change: An update on the road to Paris and implications for the phosphate industry and the agriculture sector», Mr Sébastien RAOUX, President & CEO, Transcarbon International, President, Transcarbon Africa Middle East, Argentina
2:45pm - 3:15pm	KN5: «Precision Phosphorus Fertilization», Mr Fabrice RENARD, Directeur Innovation, Prayon S.A, Belgium
3:15pm - 3:45pm	KN6: «Developing OCP Innovative Industrial Ecosystems», Mme Hasna BOUTZIL, Responsable Achats Corporate, Mr Saad MIKOU, Responsable Veille et Développement Achats, OCP, Morocco
3:45pm - 4:15pm	**Coffee break**

MINISTERS' ROOM

Chairpersons:
Mr Mohammed EL ASRI, Professor, FST Fès, Morocco
Mr Mohammed CHEHTANE, Responsable Production MEA, Beni Idir, OCP, Morocco

MINING BENEFICIATION

4:15pm - 4:35pm	CO1: «Dust – Considerations When Handling Formed Sulfur in Bulk», Gerard D'AQUIN, President Con-Sul, USA
4:35pm - 4:55pm	CO2: «On-Line Light Element Analyzer for Phosphate Beneficiation», Juha TIMPERI, Outotec, Finland
4:55pm - 5:15pm	CO3: «Production of lightweight aggregates from phosphate washing sludge of Gafsa phosphate basin (Tunisia)», Fakher JAMOUSSI, Professeur, CNRSM, Tunisia
5:15pm - 5:35pm	CO4: «Quantification of impurities, including carbonates speciation for Phosphates beneficiation by flotation», Eric JORDA, Ingénieur Chercheur, Responsable application flottation CECA, France
5:35pm - 5:55pm	CO5: «Valorization of phosphate waste rocks and sludge from Moroccan phosphate mines: Challenges and perspectives», Rachid HAKKOU, Professor, University Cadi Ayyad, Morocco

5:55pm - 6:15pm	CO6: «Flotation contrast of Ca-minerals using a mixture of carboxylic acids and nonionic additifs», L. O. FILIPPOV, Université de Lorraine, France
6:15pm - 6:35pm	CO7: «Phosphate Beneficiation Development for Customers Satisfaction in Sustainable Development Way, OCP North Axis Case Khouribga-jorf Lasfar», Abdelkader ALOUANI, Responsable Hygiène Sécurité Environnement, Direction Exécutive Axe Nord, OCP, Morocco
6:35pm - 6:55pm	CO8: «Natural rock phosphate: a sustainable solution for phosphorous removal from wastewater», Stéphane TROESCH, Research and Development manager, Epur Nature, France

FEZ 01 ROOM

Chairpersons:
Mr Mohammed ZAIN, Secretary General of Arab Fertilizer Association (AFA)
Mr Fabrice RENARD, Directeur Innovation, Prayon S.A, Belgium

FERTILIZERS

4:15pm - 4:35pm	CO1: «Ammonia production for use in phosphate fertilizers», Nikolaj KNUDSEN, Sales Manager, Haldor Topsoe A/S, Denmark
4:35pm - 4:55pm	CO2: «Quality of input Materials in Manufacture of Customized Fertilizers», G M PATEL, Technical Director CIFC (India)P Ltd, Rahimtula Group of companies, New Delhi, India
4:55pm - 5:15pm	CO3: «Application of the FLSmidth Deep Cone technology to the Fertilizer plants in OCP», Jean Claude SERBON, General Manager, FLSmidth SAS, France
5:15pm - 5:35pm	CO4: «Importance of Green Technology in Fertilizer Quality Improvement», Avdhesh MATHUR, Fernanda DIAS, Prakash MATHUR, NAQ Global Companies, India
5:35pm - 5:55pm	CO5: «Managem products potentially used in fertilizers industry», Houda AZZOUZI, Researcher at Reminex Research Centre, Morocco
5:55pm - 6:15pm	CO6: «Water-based Emulsion Anti-caking Technology for Phosphate Containing Fertilizers», J.A GONZALEZ-LEON, Ingénieur R&D, Centre de Recherche Rhône-Alpes ARKEMA (CRRA), France
6:15pm - 6:35pm	CO7: «Biodegradable Polyurethane Materials from lignin and vegetable polyol as coating Material for the controlled-release fertilizer (CRF)», Younes ESSAMLALI, presented by Mohamed ZAHOUILY, Professor, MAScIR Foundation, Morocco

FEZ MY DRISS 1ER ROOM

Chairpersons:
Mr Sébastien RAOUX, President & CEO, Transcarbon International, Argentina
Mr Paul LEVER, Professor, University of Queensland, Australia

ENVIRONMENT

4:15pm - 4:35pm	CO1: «Environmental Protection: An Imperative of Sustainable Development in Phosphate Industry», Abdelhak KABBABI, Environment Manager, Sustainability Department, OCP, Morocco

4:35pm - 4:55pm	CO2: «Recycling of carbon dioxide», Chakib BOUALLOU, Responsable Scientifique, MINES ParisTech, France
4:55pm - 5:15pm	CO3: «Calcium phosphates for odour treatment», Nathalie LYCZKO, Ingénieur de recherche, Université de Toulouse, Mines Albi, France
5:15pm - 5:35pm	CO4: «An integrated tool to survey and forecast impact of an industrial plant on its atmospheric environment», Fabien BROCHETON, Deputy General Manager, NUMTECH, France
5:35pm - 5:55pm	CO5: «Determination of Kinetical Data for the Reaction of SO2 with CAO Using a Thermobalance», Khoudir M. ALLAL, Responsable Développement Maghreb, SERVITHEN, France
5:55pm - 6:15pm	CO6: «Trends in Minimizing and Treating Industrial Wastes for Sustainable Environment», Dr. Muthanna AL-DAHHAN, Professor and Chair Chairman, Missouri University of science and Technology Missouri, USA
6:15pm - 6:35pm	CO7: «Case Study: Acid mine drainage in Chile», Hervé GORISSE, Expert Process Industrie, DEGREMONT Industry International, France
6:35pm - 6:55pm	CO8: «Gas Scrubber Efficacy via Uniform Distribution Injector Sprays», Kathleen BROWN, Research Engineer, Spraying Systems Co. ®, USA

FEZ MÉRINIDES ROOM

Chairpersons:
Mr Mohamed SMANI, Director of R&D Association, Morocco
Mr Ahmed EL BAHAR, Responsible of Global Performance - Central Axis, OCP S.A., Morocco

CORROSION & PROTECTION SYSTEM

4:15pm - 4:35pm	CO1: «Recent experience with metallic heaters For Phosphoric acid evaporation», B. SIZA VIEIRA, V. PERROT, Sandvik Materials Technology, Oporto, Portugal
4:35pm - 4:55pm	CO2: «Installation of Rubber Lining in Phosphoric Acid Vessels», David P. JENTZSECH Jr, presented by Mike PARSONS, R&D Manager, Blair Rubber Company, USA
4:55pm - 5:15pm	CO3: «Basis for calculation and design of FRP piping and vessels», A. Adriano URENA, Directeur technique, Ollearis, S.A., Spain
5:15pm - 5:35pm	CO4: «Sulzer's experience of the resistance of cast materials in pumps and agitators in phosphoric acid applications», Merja PÄRSSINEN, Sulzer Pompes Process, Pumps Equipment, Finland
5:35pm - 5:55pm	CO5: «A material challenge – Pumps in sulphuric acid application», Dr. Gerhard PRACHT, Material Specialist - Senior Manager, Friatec-Rheinhütte, Germany
5:55pm - 6:15pm	CO6: «Tubes Failure of Ammonium Nitrate Falling Film Evaporator», Saqib RAZA, Process Engineer-Nitro phosphate Plant, Fatima Fertilizer Company Limited, Pakistan
6:15pm - 6:35pm	CO7: «Newest Product Portfolio of ThyssenKrupp for the Phosphate Industry», Achim SCHÖNFELDER, ThyssenKrupp Industrial Solutions AG, Germany

6:35pm - 6:55pm	CO8: «How the Rapid Development Of Duplex Grades Influence Material Selection», Hachemi LOUCIF, Head Of Desalination, QPE Degerfors Outokumpu Stainless AB, Sweden

KARAM 1 ROOM

Workshop 5

Chair: Mr El Hassane CHELLAI, Professor University Cadi Ayyad Marrakech, Morocco

Co-Chair: Mr Youssef DAAFI, responsible of R&D geology center, OCP, Morocco

PHOSPHATE GEOLOGY

4:15pm - 4:35pm	WS6: «Chemostratigraphic constrains on the phosphate series of the Ouled Abdoun Basin in Morocco based on stable isotope and trace element compositions of fossil remains», László KOCSIS, Professor, Universiti Brunei Darussalam, Brunei
4:35pm - 4:55pm	WS7: «Geology and Mineralogy of Phosphorite Concretions in the Ma'an area, south Jordan», Khalid TARAWNEH, Faculty of Engineering, Al Hussein Bin Talal University, Jordan
4:55pm - 5:15pm	WS8: «Preliminary data of REE in Algerian phosphorites: a comparative study and paleo-redox insights», Rabah KECHICHED, Professeur, Université Kasdi Merbah, Ouargla, Algeria
5:15pm - 5:35pm	WS9: «The Geological Society of Africa, more than 40 years of Geoscience services in Africa: Future challenges», Hassan M HELMY, GSAf Vice President for Northern Africa, Egypt, Youssef DRIOUCH, GSAf Councillor for northern Africa, Morocco
5:35pm - 5:55pm	Discussions / Recommendations

KARAM 2 ROOM

Workshop 6

Chair: Mrs Fatiha CHARRADI, Responsible OCP Innovation fund for agriculture, OCP, Morocco

Co-Chair: Mr Abdelmonim EL KANIT, Agronomical marketing Analyst, OCP, Morocco

AGRICULTURE IN AFRICA

4:15pm - 4:35pm	WS1: «Diagnosis of phosphorus requirements for cocoa soils in Côte d'Ivoire», Louis KOKO, Soil fertility scientist, CNRA Divo, Cocoa Program, Côte d'Ivoire
4:35pm - 4:55pm	WS2: «IPNI North Africa Challenges in nutrient management under rainfed agriculture of Morocco», Mohamed El GHAROUS, Consulting Director, IPNI North Africa, Morocco
4:55pm - 5:15pm	WS3: «Ethiopia Transforming Small Farm Holders livelihood through the application of custom made fertilizer», Hezekiel TASSE, Ethiopian Agricultural Transformation Agency and Ministry of Agriculture of Ethiopia, Addis Ababa, Ethiopia
5:15pm - 5:35pm	WS4: «Carte de fertilité des sols du Maroc et ses relations avec les pays africains», Riad BALAGHI, INRA, Morocco

5:35pm - 5:55pm	WS5: «Efficacy Evaluation of two NPKS Fertilizer Formulations of OCP on Three Important Food Crops in Smallholder Farming in Kenya», Esther GIKONYO, Kenya Agricultural Research Institute KARLO, Kenya
5:55pm - 6:15pm	WS6: Jacob MWALE, Zambia
6:15pm - 6:55pm	Discussions / Recommendations

8pm	**Gala Dinner**

WEDNESDAY, MAY 20TH 2015

PLENARY: MINISTERS' ROOM

8:30am - 9:15am	PL5: «Phosphates and Derivatives for Lithium Ion Battery Application», Mr Rachid YAZAMI, Ph.D, Professor, Nanyang Technological University, Energy Research Institute (ERIAN), Singapore
9:15am - 9:45am	KN7: «Value-add, Critical Materials and the Waste Hierarchy: Policy Drivers in the Phosphate Fertiliser Market», Julian HILTON, Chairman at Aleff Group, United Kingdom
9:45am - 10:15am	KN8: «Bringing Big Data to the Mine Face: Using Mobile Apps and Integrated Data at all Levels of the Mine», Dr. Sean DESSUREAULT, President, MISOM Technologies Inc., and Associate Professor, University of Arizona, USA
10:15am - 10:45am	Coffee break

MINISTERS' ROOM

Chairpersons:
Mr Maoulainine MAOULAINE Site Phosboucraa Director, OCP, Morocco
Mr Barthélémy NYASSE, Vice-Chancellor and Professor, University of Bamenda, Cameroon

MINING BENEFICIATION

10:45am - 11:05am	CO9: «State of the art of processes and technology of sludge thickening», Zouhair HAFID, My Brahim JOUTI, Abderahman ETAHIRI, OCP, Morocco
11:05am - 11:25am	CO10: «Developments in flotation collectors for phosphate beneficiation», Jan-Olof GUSTAFSSON, Scientist Mining Chemicals, Akzo Nobel Surface Chemistry AB, Sweden
11:25am - 11:45am	CO11: «Dry Pre-concentration of Phosphate Ore», Jens-Michael BERGMANN, Dr. Christopher ROBBEN, Sales and Project Manager, TOMRA Sorting GmbH, Germany
11:45am - 12:05pm	CO12: «Flotation C-Plant; an optimum modular approach», Luis RUDOLPHY, Outotec Oy, Finland
12:05pm - 12:25pm	CO13: «Beneficiation of phosphate solid coarse waste from Redayef (Gafsa mining Basin) by grinding and flotation techniques», Wissem GALLALA, Assistant Professor, Science University of Gabès, Tunisia

FEZ 01 ROOM

Chaipersons:
Mr Iliass ELFALI, Safi Site Director, OCP, Morocco
Mr Thierry MARIN, Clean Technologies Director for EMEA and South Asia, DuPont Sustainable Solutions, Belgium

SULFURIC ACID

10:45am - 11:05am	CO1:»New sulfur melting technology installed in KAZAKHSTAN and USA», Mark GILBREATH, Devco, USA

11:05am - 11:25am	CO2: «Revamp and Upgrade Possibilities in Sulphuric Acid Plants», Jan ALBRECHT, OUTOTEC GmbH & CoKG, Germany
11:25am - 11:45am	CO3: «Latest developments on DuPont™ MECS® sulphuric acid catalyst», Tom BROUWERS, EMEA Product Manager, Sulphuric Acid Plants and Catalysts, MECS, Belgium
11:45am - 12:05pm	CO4: «Effect of inferior and ageing catalyst», Casper VITTRUP FRANDSEN, Haldor Topsoe A/S, Denmark
12:05pm - 12:25pm	CO5: «Convertible Lump Sum EPS Contracting Model – How to get the plant you need now and still enjoy in 20 years?», Michael FENTON, Senior Business Development Manager, Chemetics Inc., Canada
12:25pm - 12:45pm	CO6: «Process Heat Recovery and Digitalisation in Sulphuric Acid Plants», Michael KEMMERICH, Outotec GmbH & Co.KG,Germany
12:45pm - 1:05pm	CO7: «Commercialisation of MECS® SolvR™ regenerative SO2 recovery technology», Garret PALMQUIST, Business Development Manager, MECS, Belgium
1:05pm - 1:25pm	CO8: «Increasing production capacity through sustainable cleaning», Henning URCH, BASF SE, Formulation Technologies, Germany

FEZ MY DRISS 1ER ROOM

Chairpersons:
Mr Garth KIRKHAM, President Elect, Canadian Institute of Mining (CIM), Canada
Mr Khalid TARAWNEH, Professor, Al Hussein Bin Talal University, Jordan

GEOLOGICAL MODELLING

10:45am - 11:05am	CO1: «Three challenges in maximising phosphate resource value and how Maptek confronts them», Joseph SYKES, Gary BUCHANAN, Maptek, UK
11:05am - 11:25am	CO2: «Modeling and reserve estimation of Sra Ouertane phosphate deposit (Centre-West of Tunisia)», Wissem GALLALA, Assistant Professor, Science University of Gabès, Tunisia
11:25am - 11:45am	CO3: «Geological Modeling, a key step into Mining Operations Optimization», Rafal WALECKI, Saadi BENTOUMI, Mine Modeling and Extraction Planning Managing Consultant – EMEIA with VENTYX ABB, Poland
11:45am - 12:05pm	CO4: «OCP's geological information system», Youssef DAAFI, Es-Said JOURANI, Kamal TIDDARINE, Oussama KHADIRI YAZAMI, OCP, Morocco
12:05pm - 12:25pm	CO5: «Geological modeling and reserves of phosphate calculation in the Oum Elkhecheb deposit using Geographic Information System (GIS) (Métlaoui Basin - Southwestern Tunisia)», Habib SMIDA, Assistant Professor, Science University of Gabès, Tunisia

FEZ MÉRINIDES ROOM

Chairpersons:
Mr Hicham BENKIRANE MTITOU, Business Development Responsible, OCP S.A., Morocco
Mr José Roberto NUNHEZ, Professor of Chemical Engineering, UNICAMP – State University of Campinas, Brazil

HIGH VALUE ELEMENTS

10:45am - 11:05am	CO1: «How Would You Recover 1 Million Kilograms U3O8 per Annum?», Vaughn ASTLEY, Regis STANA, Dr Phosphate, USA
11:05am - 11:25am	CO2: «Production of HF from H2SiF6», Olivier RUFFINER, Sales Manager Fluorine, Buss ChemTech AG, Switzerland
11:25am - 11:45am	CO3: «Overview of the fluorochemicals industrial sectors», Alain DREVETON, AD Process Strategies Sarl, Switzerland
11:45am - 12:05pm	CO4: «The Benefits of Isolating & Utilizing Fluorine from Phosphate Operations», Ray WILL, IHS, USA
12:05pm - 12:25pm	CO5: «Recovery of Rare Earths from Wet Process Phosphoric Acid, the Solvay experience», Alain ROLLAT, SOLVAY Rare Earth Systems, France
12:25pm - 12:45pm	CO6: «Process online to follow the production by LIBS Laser Impulse Plasma for fertilizer», Dr ALBERT SOTTO, PhD, TAL INSTRUMENTS, France
12:45pm - 1:05pm	CO7: «In-Situ Recovery of Critical Technology Elements», Michael HASCHKE, Head of Mineral Resources, G.U.B. Ingenieur AG, Germany
1:05pm - 1:25pm	CO8: «Carbamoylalkylphosphonates for dramatic enhancement of uranium extraction from phosphates ores», Dr. Stéphane PELLET-ROSTAING, Senior Researcher CNRS, France

KARAM 1 ROOM

Workshop 7
Chair: Mr Hicham GUELLAF, Responsible Central Axis Support, OCP, Morocco
Co-Chair: Mr Abdellah MAHSOUN, Project Manager of Mines Performances, OCP, Morocco

DIGITAL MINING

10:45am - 11:05am	WS2: «CODELCO DIGITAL: history advances and challenges» Marco ORELLANA, CIO Corporate, Codelco, Chile
11:05am - 11:25am	WS1: «Transforming Workplace Culture and Clearing Bottlenecks through Mobile Technology, Integrated Business Intelligence, and Process Change», Dr. Sean DESSUREAULT, President, MISOM Technologies Inc. & Associate Professor, University of Arizona, USA
11:25am - 11:45am	WS3: «Cisco Experience on Digitalizing the Mine», Dean SMITH, Vertical Manager in Mining & Industrial Plants Digitalizing covering Europe, Middle, CISCO, United Kingdom

11:45am - 12:05pm	WS4: «Intelligent Mine - Optimization, guidance, robotics.», Mikhail MAKEEV, Project director, VIST Group, Russia
12:05pm - 12:25pm	WS5: «Evolving Dragline Fleet Application: Techniques To Reduce Cost», Randy GOVIER, Caterpillar Global Mining, South Milwaukee, USA
12:25pm - 12:45pm	WS6: «Disruptive Innovation in Digital Mining», Alexander CONTI, Technology Strategy, Accenture Plant and Commercial Services, Brazil
12:45pm - 1:05pm	WS7: «Mobile weighing systems and data transmission: Save time and money - optimize processes - reduce costs», Mustapha KOUMIH, Area Sales Manager PFREUNDT GmbH, Germany
1:05pm - 1:25pm	Discussions / Recommendations

KARAM 2 ROOM

CONFERENCES

Chair: Dr Habiba CHAKIR, Director, International Partnerships and Government Relations, Canada

CONFERENCES

10:45am - 11:05am	Conference 1: «Exploration of sulfur and potash in Morocco: state of play», Addi AZZA, Ingénieur Général, Ex-Chef du « Projet Soufre », Minister of Energy, Mines, Water and Environment, Morocco
11:05am - 11:25am	Conference 2: «Innovation in the Phosphate Industry: A review and analysis of patents relating to the Phosphate Industry», Bob STEMBRIDGE, Senior Patent analyst, Thomson Reuters, United Kingdom
11:25am - 11:45am	Conference 3: «Competitive drivers in the phosphates business», Oliver HATFIELD, Director of Fertilizer Research, Integer Research, Invicta House, United Kingdom
12:45pm - 2pm	Lunch

PLENARY: MINISTERS' ROOM

2:30pm - 3:15pm	PL 6: «Africa and AIMS: Bridging the Skills Gap in Science, Technology, Engineering and Mathematics (STEM)», Thierry ZOMAHOUN, President and CEO, The African Institute of Mathematical Sciences – Next Einstein Initiative (AIMS), Canada
3:15pm - 3:45pm	KN9: «The Computerized Maintenance Management System (CMMS) – an essential tool for World Class Maintenance», Michael WIENKER, ThyssenKrupp Industrial Solutions AG, Morocco
3:45pm - 4:15pm	KN10: « What kind of Modern "green" Chemical Engineering is required in the Framework of Global Trade, Sustainability and Industry Technical Innovation Demand?», Jean-Claude CHARPENTIER, Former President European Federation of Chemical Engineering, CNRS/ENSIC/University of Lorraine, France
4:15pm - 4:45pm	CLOSING CEREMONY

B TO B MEETINGS

Monday, May 18th 2015 / **2pm - 6:55pm**
Tuesday, May 19th 2015 / **9:15am - 6:55pm**
Wednesday, May 20th 2015 / **8:30am - 1:25pm**

EXHIBITION VISITS

Monday, May 18th 2015 / **8am** → Wednesday, May 20th 2015 / **3:45pm**

SOCIAL PROGRAM

Monday, May 18th 2015 / **8am** → Wednesday, May 20th 2015 / **4:30pm**

SYMPHOS 2015

PLENARY LECTURES

THE MANUFACTURING PLANT OF FHE FUTURE: NEW APPROACHES TO THE PROCESS INDUSTRIES

JEAN-PIERRE DAL PONT
President SFGP, Paris, France

Most of the products and the relevant services needed by all societies find their origin in manufacturing plants. Manufacturing and operations have too often been neglected in many countries. This has been the case for the Chemical Process Industries (CPI) active in the field of chemistry, oil and gas, pharmacy, metallurgy ….

CPI are major economical players worldwide. Chemistry serves a lot of downstream industries.

CPI are characterized by heavy capital expenditure (CAPEX) and operation costs (OPEX) with most of the time a long ROI (Return on Investment). They are by definition capitalistic; they are currently faced with a very changing and uncertain world, a fierce global competition. At the same time they have to abide more and more stringent regulations in terms of Environment protection. Plant design has inherited a century of Chemistry and Chemical Engineering development. The industrialization process defined as methods and techniques to go from research to an operating plant have reach a good level of maturity. Industrialization, project management are mature. Systems analysis, project scope definition, safety analysis, capital investment evaluation, robustness, risk analysis are among the tools available to Process and Project engineers to design plant of good quality and reliability.

However new approaches for plant design are much needed to cope with the modern world situation; the concept of sustainability cannot be ignored any longer. Profitability by essence is a prerequisite; there must be a return on the invested capital. Process Industries have to comply with the concept of corporate social responsibility (CSR), circular economy, HSE matters, human factors, stakeholders satisfaction.

To be first in the market, Customers satisfaction, Value Chain approach imply to revisit Engineering.

Equipment design and integration in the facility has to be given more attention. Innovation, flexibility, agility, continuous improvement, operations control concepts have to considered as part of the project scope, upfront.

As of to day Industry 4.0, Digital Manufacturing, Connected Objects, Digital Business, Embedded Computing Devices may bring a major breakthrough in the way we define, manufacture products.

Chemical Engineers cannot ignore it and have to be prepared for a major change.

EXTRACTING VALUE THROUGH OPERATIONS EXCELLENCE

ANDRÉ P. KOTLAREVSKY
DuPont OCP Operations Consulting, Casablanca, Morocco

The context in which companies operate is becoming ever more complex: market volatility has become the "new normal"; shareholder and stakeholder expectations for reliability, efficiency and profitability are increasing; and competitive pressures require ever more agility. Against this backdrop, companies are investing in productivity improvements and operations excellence efforts seeking to gain an edge over competition, and increase their ability to adapt to shifting market conditions.

While many companies are investing in productivity improvements, success rates for achieving and sustaining operational improvements are quite low. Narrow approaches that focus solely on improvement tools and methodologies or are overly dependent on elaborate standards, procedures and technologies often lead to an inability to attain, or sustain, results.

In order to extract maximum value from productivity improvements, our DuPont OCP Operations Consulting experts help to apply integrated approaches that combine both organizational and technical solutions to accelerate results and deliver lasting improvements. The approach allows companies across multiple sectors to develop the organizational capability required to optimize asset performance and eliminate inefficiencies.

The expertise behind Operations Excellence implementations is not a core competency for most companies, nor should it be. It makes good business sense for most companies to use consultants for implementation of these systems, and there are many consulting companies that offer these services. Most of these consultant-delivered programs deliver quick productivity improvements. Unfortunately, however, most of these programs are not sustainable for long after the consultant leaves.

It is possible to operationalize customized strategies and build capabilities within different organization to sustain improvements going forward. Experts can bring the unique perspective and experience of DuPont as an integrated manufacturing company for more than 200 years, as well as our experience enabling operations excellence efforts at a number of leading global companies.

CLIMATE CHANGE: AN UPDATE ON THE ROAD TO PARIS AND IMPLICATIONS FOR THE PHOSPHATE INDUSTRY AND THE AGRICULTURE SECTOR

SÉBASTIEN RAOUX
Specialist in Climate Change and Sustainable Development
Ph.D. in Physics, Juris Doctor
President & CEO, Transcarbon International
President, Transcarbon Africa Middle East, Argentina

Climate change has become more than an inconvenient truth: it is an undeniable reality. The period between 1971 and 2000 has been the warmest in the last 14 centuries. 2014 was the warmest year on record since 1880, and the 10 warmest years have now occurred since 2000 (with the exception of 1998). The Intergovernmental Panel on Climate Change (IPCC) has concluded with greater than 95% certainty that the observed increase in global temperature is caused by anthropogenic (man-made) GHG emissions. Should we continue on our current course, extreme climate events will become more intense, heat waves will become more frequent and longer, sea level rise can be expected to reach 1 meter by the end of the century, and the rate of species extinction will continue unabated. Due to increased pressure on natural resources, water scarcity, migrating pests and diseases, and lower agricultural yields, the health and livelihood of hundreds of millions is at risk, especially in low-lying and developing countries.

A technological, economic, social and political revolution is necessary to transition to a low-carbon economy. If we are to meet the objective of the Copenhagen Accord to limit to 2°C the increase in global temperature before the end of the century, we must act now and deploy policies incommensurate with the scale of initiatives to date. Unfortunately there is a disconnect between political ambition and practical reality: While the world should devote US$ 100 billion per year to mitigate and adapt to climate change - including investing in renewable energy, we continue locking - in to carbon intensive infrastructure such as coal power plants. We are running out of time, and the longer we wait the more expensive and harder it will become to address the issue. In this context, we will review the emission reduction goals that must be achieved, what technologies exist today and what solutions may become available in the near term to meet the 2°C goal, what critical barriers must be overcome to transition to a low-carbon economy, and what policy and carbon pricing mechanisms should be implemented to avoid the worst consequences of climate change.

An effective global climate agreement must be adopted in Paris. The 21st Conference Of the Parties (COP21) to the United Nations' Framework Convention on Climate Change (UNFCCC) will be held in December 2015 in Paris to arrive at a comprehensive international treaty to succeed to the Kyoto Protocol by 2020. The purpose of the Paris conference is to agree on a set of principles, rules, and measures to be taken by all developed and developing countries to achieve the 2°C target. While the principle of "common but differentiated responsibilities" towards climate change will remain central to the Paris agreement, one of the key objectives of the treaty should be to include standardized criteria to monitor, report and verify contributions by all countries. The agreement should also provide a framework to balance climate policies and international trade to ensure competitiveness, and offer suitable emission reduction commitments and adequate financing mechanisms to ensure

the transition to a low-carbon and climate-resilient economy. Some of the pressing questions that we will attempt to answer are: How can we achieve an effective and credible international climate treaty in Paris? What should its architecture be? Can it be legally binding under international law? And how can we reconcile international and domestic factors among developed and developing countries?

International climate policy will impact the phosphate industry and the agriculture sector. Like all other sectors of the economy, the phosphate industry will need to continue implementing sustainable development practices. Economic, social, and environmental considerations must be integral to the decision-making process, at all levels of the value chain: encouraging the adoption of sustainable mining, designing sustainable production and consumption patterns, radically advancing the efficiency of manufacturing processes, promoting the transfer of low-carbon technologies, moving towards environmentally- and socially-sound pricing systems, and reducing, reusing, and recycling waste are among the measures that must be implemented. In addition, sustainable intensification in agriculture will impact the manner in which fertilizers are used: agricultural yields must be increased while negative environmental impacts must be reduced. To this effect, and pursuant to the Bali Action Plan concluded in Doha in 2012 (COP18 of the UNFCCC), a number of States have already designed Nationally Appropriate Mitigation Actions (NAMAs) to reduce GHG emissions from the agriculture sector. This presentation will conclude with a review of the various actions that are currently being implemented or considered to reduce GHG emissions from agriculture, including using biological processes to increase yields, introducing combined irrigation and fertilization techniques to increase efficiency, and using better agronomic practices to optimize the use of chemical fertilizers.

PHOSPHATES AND DERIVATIVES FOR LITHIUM ION BATTERY APPLICATION

RACHID YAZAMI
Nanyang Technological University, Energy Research Institute (ERIAN), Singapore

In the last two decades lithium-ion batteries (LIB) have gained tremendous popularity among end-users, particularly in the mobile electronics consumer market owing to their outstanding performances as compared to other batteries, such as higher energy density -both in weight and in volume-, higher power density, longer life and cost-effectiveness.

Phosphorous is present in almost all commercial LIB as LiPF6 a key component solute of the electrolyte. LiPF6 provides high ionic conductivity, good thermal and high interfacial stability.

Lithium metal phosphates (LMP) are the second most important cathode materials in practical LIB, behind lithium metal oxides. LMP (M=Fe, Mn, Ni, Co, V,...) feature high thermal stability, high power density and relatively low costs. Therefore, LMP have been considered for electro-mobility applications, particularly in 2-wheel vehicles and in hybrid electric vehicles and in stationary clean energy storage systems.

Other phosphorous-based materials are currently actively investigated for their potential application in LIB such as metal phosphides (MPx) anode materials and lithium-metal polyanionionic cathode materials such as fluoro-, sulfato- and vanadato-phosphates.

In this presentation we will review and discuss the ongoing research activity on phosphorous chemistry and materials for LIB.

AFRICA AND AIMS: BRIDGING THE SKILLS GAP IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM)

THIERRY ZOMAHOUN

President and CEO, The African Institute of Mathematical Sciences – Next Einstein Initiative (AIMS), Canada

As the African economy continues to grow and transform, the agriculture and resource extraction sectors remain primary drivers for Africa's future prosperity. Just as important to ensure Africa remains at the forefront of technology and innovation in agribusiness and phosphate development is to confirm it has the scientific leadership and human capital to drive change. The African Institute of Mathematical Sciences (AIMS), under the leadership of President and CEO Thierry Zomahoun, is bridging the skills gap.

Thierry will present how the search for the next Einstein in Africa is supporting domestic research and development with concrete examples of talent that are tackling challenges in the agribusiness and resource extraction sectors. Encouraging young scientists to return to the continent to apply practical solutions is setting Africa on a solid footing for the future. AIMS is Africa's first and largest network of centres of excellence for scientific training, research and outreach in mathematical sciences. The AIMS mission is to enable Africa's brightest students to flourish as independent thinkers, problem solvers and innovators capable of propelling Africa's future scientific, educational and economic self-sufficiency. AIMS was founded in 2003 and has produced 748 graduates. It will graduate its 1000th scholar in the next year.

The goal is to build 15 centres of excellence across Africa by 2023. AIMS believes that human capital coupled with a unique and measurable educational model will drive Africa's key sectors, such as agriculture, forward to reach scalable and sustainable economic growth.

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KEYNOTES

A VISION FOR THE FUTURE OF MINING: THE ROLE OF TECHNOLOGY

PAUL LEVER
CRCMining School of Mechanical and Mining Engineering, University of Queensland, Australia

The mining industry is currently facing some of its most significant challenges, including an increasing rate in demand growth, reduced effective commodity prices, declining productivity (labor and capital), increasing need to change its skills base, and declining availability of mineral deposits that are increasingly difficult to locate and extract. We must find new and smarter ways to mine current and future deposits with the appropriate environmental, social and cost frameworks that can support profitable mining businesses. Economies of scale (bigger trucks, shovels, etc.) that drove improving productivities of the past may not be effective anymore.

For over tow decades CRCMining has engaged with its members (mining companies, Original Equipment Manufacturers OEMs and researchers) to develop a strong industry voice with a clear common vision and strategy to tackle these industry-wide challenges. This industry-supported strategic research agenda works collaboratively to develop and implement the needed innovations in mining technology and processes that are crucial to meeting these challenges.

This presentation will provide details of this vision for the future of mining, discuss the role of technology in meeting the challenges and outline some projects currently underway.

MANAGING INNOVATION & TECHNOLOGY IN THE PROCESS INDUSTRIES: CURRENT PRACTICES AND FUTURE PERSPECTIVES

THOMAS LAGER
EMINES – School of Industrial Management, Université Mohammed VI Polytechnique, Morocco

The "family" of process industries spans multiple industrial sectors and thus constitutes a substantial part of all manufacturing industries, including petrochemicals and chemicals, food and beverage, mining and metal, mineral and material, pharmaceuticals, pulp and paper, steel, and utilities. One key difference between companies in the process industries and those in other manufacturing industries is that the products supplied to them, and often also delivered from them, are materials or ingredients rather than components or assembled products. Moreover, development activities for these materials are conducted in a laboratory or pilot/production plant environment rather than at a design office, and product prototypes are replaced by test runs in pilot plants or full-scale production. Additionally, raw material properties will not only influence production costs and the complexity of appropriate production process technology but also often determine the quality and performance of final products.

It cannot be said that existing best practices in Management of Innovation & Technology in general do not apply to the process industries. However, the idiosyncrasies of process companies should presumably influence the conduct of R&D and innovation; as a result, there is also a need for more specific or adapted tools and best practices in order to develop an actionable and improved knowledge base. This article begins by reviewing currently used methods and tools for effectiveness improvements, such as technology road-mapping, R&D strategy development, open innovation and portfolio balancing. Next, more efficiency-related areas – for example, technology transfer, R&D organizational structures, work-process delineation, and methodologies like design for six sigma, quality function deployment, and so forth – are presented. Both areas relate to product and process innovation from idea generation to implementation. Starting from this platform of knowledge, perspectives on the need for new approaches and tools for improved Management of Innovation & Technology in the Process Industries are presented and discussed.

CIM DEFINITIONS, STANDARDS, BEST PRACTICES AND NI43-101

GARTH KIRKHAM
President Elect, Canadian Institute of Mining (CIM) and Chair, CIM Best Practices Committee
CIM Distinguished Lecturer 2013-2014
Director, Geoscientists Canada and Chair, Securities Committee
Principal Consultant, Kirkham Geosystems Ltd., Canada

NI43-101, introduced in the 1990's, is a prescribed format and detailed set of rules to guide the reporting of resources. In addition, the basic principles of "best practices" have been created to guide the practitioner in all aspects of mineral resource evaluation from data management, data analysis, geological modeling, domaining, estimation and classification. As professionals and practitioners we must defend and uphold standards to insure public protection. This presentation is a discussion of NI43-101, CIM Definitions, Standards and Best Practices along with the role of the "Professional".

ENERGY AND CHEMICALS FROM BIOMASS & WASTE: THE STATE OF THE ART

JAMAL CHAOUKI
Ecole Polytechnique, Montréal, Canada

According to the World Bank report (2012), the global amount of Municipal Solid Waste (MSW) is expected to grow from 1.3 billion tonnes per year in 2012 to 2.2 billion tonnes/year in 2025 and to 4.2 billion tonnes/year by 2050.

Today, North America and the European Union are recognized as major producers of MSW, but the MSW production rates are also rapidly increasing in developing economies. Due to global environmental concerns, more research have been actively focused on the efficient use of energy resources and the effective utilization of renewable biomass resources as well as non-recycle waste material.

As it will be examine in this article, incineration is currently the most dominating waste-to-energy (WtE) technology for MSW and biomass processing resulting in energy recovery of different types of waste into heat and electricity. Other advanced disposal technologies, which also will be discussed, need to be implemented, to provide higher energy efficiency, to produce chemicals and to meet increasingly stringent environmental regulations. Among these technologies, pyrolysis, gasification and combustion are attractive approaches to develop an environmentally, economically and sustainable solid waste and biomass management process.

PRECISION PHOSPHORUS FERTILIZATION

FABRICE RENARD
PRAYON S.A., Engis, Belgium

After a short introduction of some latest technologies developed to serve precision farming, the presentation will focus on potential future developments to enhance precision phosphorus fertilization process which is the poor relation in comparison with nitrogen.

In addition, based on Prayon strong academic partnerships, an urban farming initiative to restructure industrial brownfield as well as specific know-how on the biosystem (Water-Soil-Plant) will be exchanged.

DÉVELOPPEMENT DES ECOSYSTÈMES INDUSTRIELS INNOVANTS OCP

HASNA BOUTZIL, SAAD MIKOU
OCP Group, Morocco

Le développement des écosystèmes industriels innovants OCP (EII OCP) s'inscrit dans le cadre de la stratégie de développement du Groupe OCP, et a pour objectif de soutenir le développement des filières industrielles stratégiques autour des bassins d'implantation de l'OCP. Les EII OCP constituent à terme, un levier pérenne de compétitivité et de création de valeur au niveau local et national.

Aussi les EII OCP participent directement au Plan d'Accélération Industriel initié par l'Etat, qui vise principalement à augmenter la valeur ajoutée industrielle et à renforcer l'intégration industrielle grâce à la mise en place d'outils de soutien.

C'est dans cette perspective que l'Etat et OCP œuvrent pour doter les EII OCP d'un statut incitatif avancé, leur conférant une forte attractivité. Ce dispositif est composé de plusieurs volets, incluant particulièrement:

- La formation professionnelle et d'excellence
- L'innovation et la R&D
- Le foncier et les infrastructures
- Le fonds de soutien et d'investissement

L'innovation et la R&D, et plus globalement « les actifs du savoir » à travers les universités, notamment l'UM6P, les Centres de compétences Industrielles OCP, les Living Labs, et les centres de R&D, sont au cœur de la stratégie de développement des EII OCP, afin d'en assurer la pérennité.

Les acteurs ciblés par les EII OCP sont principalement les entreprises leaders mondiales dans leurs secteurs d'activité, les entreprises TPME industrielles nationales et aussi les start-ups innovantes.

VALUE-ADD, CRITICAL MATERIALS AND THE WASTE HIERARCHY: POLICY DRIVERS IN THE PHOSPHATE FERTILISER MARKET

JULIAN HILTON, MALIKA MOUSSAID
Aleff Group, London, UK

This paper will explore the potential impact on the phosphate fertiliser industry of three major policy drivers, value-add uses of primary resources, critical materials and the waste hierarchy. Some phosphate producing countries are in the process of changing their policy on the export of phosphate rock, placing a new emphasis on value-add in the supply chain. To maximise the value-add will require significant investments in both human and financial capital.

Where should these investments focus?

Since May 2014 phosphate rock has been on the European Union's list of critical minerals, together with a range of rare earths, which are closely associated with phosphate rock. This focus on critical minerals adds pressure on the pursuit of fertiliser use efficiency while at the same time the recovery and reuse of secondary nutrient resources and will reposition the fertiliser sector much closer to the energy sector at a time when the energy sector itself is in a state of uncertainty.

What consequences may this have both on business models and operations?

The increasing attention given worldwide to compliance with the waste hierarchy is causing many leaders in the fertiliser industry to restructure their business models to optimise their use of all resources in the production/ consumption life-cycle while achieving a zero waste outcome.

What are the opportunities for the producers to enhance their business resilience while promoting innovation and investing in the Research & Development required to reuse and recycle resources that have hitherto been discarded or overlooked?

The changing nature and role of phosphogypsum as a secondary resource will be used to illustrate the wider change of strategic policy and regulatory framework within which NORM industries such as phosphates will operate in the future.

BRINGING BIG DATA TO THE MINE FACE: USING MOBILE APPS AND INTEGRATED DATA AT ALL LEVELS OF THE MINE

DR. SEAN DESSUREAULT
President, MISOM Technologies Inc., Tucson AZ, USA
Associate Professor, Mining Engineering Department, University of Arizona, Tucson AZ, USA

Big data and mobile applications are changing our personal lives and entire economic sectors, for example, Uber and AirBnB have grown, in just a few years from start-ups to Billion-dollar companies, fundamentally transforming the global taxi and hotel industries. Access to information, ubiquitous smart devices, and inexpensive wearables and nearables are opening new innovative ways of monitoring ourselves, workers, and processes. The adaption of these new technologies in the mining industry has been slow thus far, where many mines are stuck, having invested in expensive legacy systems that might focus on machine health and productivity, generating data, but rarely create the information, knowledge, or action that drives real value.

This presentation will be an unvarnished exposition of the underlying key new technologies and required change management that these transformative technologies will bring to mining, and real examples of where this has started in mines throughout North America in applications that range from improving productivity in mines, plants, to improving stakeholder listening for improved sustainability performance.

These key technologies include big-data, cloud computing, mobile computing, the internet-of-things, and motivational business intelligence.

THE COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM (CMMS) – AN ESSENTIAL TOOL FOR WORLD CLASS MAINTENANCE

MICHAEL WIENKER, KEN HENDERSON
ThyssenKrupp Industrial Solutions AG, Essen, Germany
ThyssenKrupp Industiral Solutions SARL Maroc, Mohammedia, Morocco

The management of maintenance in a large industrial operation is complex and has a significant impact on the profitability of the business. Managing this process effectively without modern computer-based support is almost impossible, but achieving successful implementation of these systems requires a major change-management program over many years. It is not surprising then that there is a low success rate among even large organisations worldwide in implementing an effective Computerised Maintenance Management System (CMMS) to support improved reliability and performance.

This paper focuses on understanding the reasons behind the low success rate achieved and outlines the essential elements that must be included to ensure a disciplined and well-resourced program that can deliver success. Emphasis is put on the need to gain and retain the support of top management to overcome the barriers to change by convincing them that such support makes good business sense.

WHAT KIND OF MODERN "GREEN" CHEMICAL ENGINEERING IS REQUIRED IN THE FRAMEWORK OF GLOBAL TRADE, SUSTAINABILITY AND INDUSTRY TECHNICAL INNOVATION DEMAND?

JEAN-CLAUDE CHARPENTIER
Former President European Federation of Chemical Engineering
Laboratoire Réactions et Génie des Procédés
CNRS / ENSIC / University of Lorraine, France

Confronted with the globalization of the markets, acceleration of partnerships and innovation, and to offer a contribution to the fight against environmental destruction and non sustainable behaviour of the today world production, the chemical and related industries militate for the evolution of chemical engineering in favour of a modern process engineering voluntarily concerned by sustainability (the green process engineering) that will face new challenges and stakes bearing on complex systems at the molecular scale, at the product scale and at the process scale.

Indeed the existing and the future processes will be progressively adapted to the principles of the « green chemistry » which involves a modern approach of chemical engineering that satisfies both the market requirements for specific nano and microscale end-use properties of competitive targeted green (sustainable) products, and the social and environmental constraints of sustainable industrial meso and macroscale production processes at the scales of the units and sites of production.

These last constraints require an integrated system approach of complex multidisciplinary, non-linear, non equilibrium processes and transport phenomena occurring on the different time and length scales of the chemical supply chain, which means a good understanding of how phenomena at a smaller length-scale relates to properties and behaviour at a longer length-scale, from the molecular and active aggregates-scales up to the production-scales (i.e. the design of a refinery or of a cement or phosphate production complex from the Schrödinger's equations...).

The success of this integrated multiscale approach for process innovation (the 3rd paradigm of chemical engineering) is mainly due to the considerable developments in the analytical scientific techniques coupled with image processing, in the powerful computational tools and capabilities (clusters, supercomputers, cloud computers, graphic processing units, numerical codes parallelization etc.) and in the development and application of descriptive models of steady state and dynamic behaviour of the objects at the scale of interest.

It will be shown in the conference that this modern scientific multiscale approach of chemical engineering « the green approach of process engineering » that combines both market pull and technology push is led with four main objectives strongly oriented on process intensification and on the couple green products/green processes "to produce much more and better in using much less", and to sustainably produce molecules and products responding to environmental and economic challenges, with the help of technical innovation and sustainable technologies for efficient mass and energy utilization and for a better quality of life.

This modern green approach of chemical and process engineering will concern the eco-efficient "Factory of Future".

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THEMATIC SESSIONS

ELECTROSTATIC BENEFICIATION OF PHOSPHATE ORES: REVIEW OF PAST WORK AND DISCUSSION OF AN IMPROVED SEPARATION SYSTEM

DR JIM BITTNER, DR STEVE GASORIOWSKI, FRANK HRACH, HERVE GUICHERD
ST Equipment & Technology LLC, Needham, USA

Beneficiation of phosphate ores by dry electrostatic processes has been attempted by various researchers since the 1940's. While work continues to further refine these methods, fundamental limitations on the conventional electrostatic systems include capacity, the needed for multiple stages for adequate upgrading of ore, and operational problems caused by fines.

A complete review of past work using conventional electrostatic separators as well as the parameters identified as influencing the separation performances will be presented and specific advantageous aspects of the STET separator to phosphate processsing will be highlighted.

In contrast to other electrostatic separation processes that are typically limited to particles greater than 75µm in size, the STET belt separator is ideally suited for separation of very fine (←1µm) to moderately coarse (300µm) particles with very high throughput. The high efficiency multi-stage separation through internal charging/recharging and recycle results in far superior separations that can be achieved with a conventional single-stage free-fall tribo-electrostatic separator. The STET separator technology has been used to separate a wide range of materials including mixtures of glassy aluminosilicates/carbon, calcite/quartz, talc/magnesite, and barite/quartz.

EVALUATION OF ALTERNATIVE MINING METHODS AT OCP

DANIEL M. GAGNON
Directeur Général Mines, Met-Chem Canada Inc, Montréal, Canada
ABDELLAH MAHSOUN
Directeur Projets, Groupe OCP, Casablanca, Morocco

Met-Chem Canada Inc. (Met-Chem) is an engineering consulting firm serving the mining industry since 1969 and based in Montreal Canada. Met-Chem is a wholly owned subsidiary of UEC Technologies LLC which is part of United States Steel Corporation. Met-Chem's mining engineers have been involved in many mine planning and mine development round the world, including Northern Africa and the Maghreb.

OCP is integrated phosphate producer, extracting, marketing and selling phosphate and its derivatives, phosphoric acid and fertilizers. OCP is the world's largest exporter of phosphate rock and phosphoric acid, as well as one of the world's largest producers of fertilizer.

Since 2012, Met-Chem and OCP have been studying alternative mining methods and equipment to enable Groupe OCP to increase production and reduce operating costs at its phosphate mines. This technical presentation will review the different mining methods and equipment studied at OCP as alternatives to its current methods and discusses the results.

GRADE CONTROL AND STOCKPILE MANAGEMENT AT BENGUERIR PHOSPHATE MINE: A NEW APPROACH TO RESOURCES OPTIMIZATION

MANSOUR ASRI
OCP Group, Benguérir, Morocco

Moroccan phosphate mining, especially at Benguérir phosphate mine site, raises some questions concerning grade and stockpile management as to the determination of the optimal parameters for the whole system at design, development and production levels.

This issue is a direct consequence of the nature of the mineral deposit as there are large discrepancies in terms of grades between the different geological layers as well as between zones. Accordingly, the final product is obtained by blending these different individual sources and the target qualities must fit the customers' requirements.

In a time basis, an optimal balance between the "rich" and the "poor" parts of a mine is a key requirement. The gap between these two "natural sources" for the making of the final blend raises an issue with regard to the management of the stockpiling capacities as the seams should be stored individually in most cases prior to reclaiming and blending.

To address these issues, a research has been conducted to develop a mathematical model that provides the best combination of resources quantities to blend while taking into account the different grade and stockpile constraints.

The present paper is an overview of the aforementioned model and its applications. It will also highlight potential improvements.

OUTOTEC HIGMILL™ – OPTIMIZATION OF STIRRED MILLING TECHNOLOGY

MATTIAS ÅSTHOLM
Sweden
HARRI LEHTO
Finland

OUTOTEC HIGmill™: The demand for finer grind in minerals processing has set new challenges for comminution technology. In addition to just performing the grinding duty itself the other challenge is to perform the grinding with lower energy utilization.

Outotec introduced two years ago a unique but well proven milling technology for fine grinding applications.

The HIGmill™ technology has been developed in the industrial minerals, where there are already nine 5 MW units installed, making them by far the world's largest fine grinding mills.

The Outotec HIGmill™ provides the operators with excellent flexibility to maintain the target product size during variations in the upstream process. This gives downstream process the best possible preconditions to maintain high and consistent recovery.

The HIGmill™ provides several unique advantages, such as a low specific grinding energy (SGE) value combined with high power intensity; simple flow sheet with no recirculating loads, true flexibility in process variables and long maintenance intervals. Since its introduction, the market has shown great interest in Outotec's HIGmill™ technology. Within the first two years Outotec has established projects in the base metal and PGM industry. The first mill for a copper concentrate regrind project was delivered earlier this year.

SUSTAINABLE DRY GRINDING OF PHOSPHATE ROCK WITH LOESCHE VERTICAL ROLLER MILLS

FRANK DARDEMANN
LOESCHE GmbH, Duesseldorf, Germany

Since more than 100 years the Loesche Vertical Roller Mills operate in the wide field of grinding cement raw materials, clinker, slags, minerals and solid fuels. Grinding of phosphate rock is from the beginning of the success story of LOESCHE mills a permanent requested application. In recent years the demand increases for dry, highly energy saving grinding technologies along with requests formaximum performance flexibility of the mill system.

In competition with conventional milling, the Vertical Roller Mill is in many topics a step ahead. Lower specific wear rate and lower specific energy consumption are some of the advantages not only in phosphate hard rock grinding. Optimized OPEX combined with convincing availability of the LOESCHE mills are only some arguments for plant operators. The flexibility in capacity and in product fineness ensures a sustainable performance of the LOESCHE mill during long periods of mining operation. Changes of mineral characteristics in the deposit will be covered at least by online controls along with adjustments of the grinding circuit. This ensures constant throughput of the mill into down stream processes.

High abrasive deposits, like Pyroxene deposits, request serious but manageable wear protection efforts in the complete grinding system. Along with high wear resistant grinding elements, the availability of the plant stays high. The adjustable grinding pressure, by a hydraulic system in the LOESCHE mill, overcomes the hardness of valuable rock or gang material. The amount of fines in the product stays low.

This paper will give an overview about the LOESCHE mill in hard rock applications respectively phosphate rock grinding and the advantages compared to conventional grinding systems.

3D TECHNOLOGIES FOR SURVEYING, MONITORING & MINING

FAÏZ OUMGHAR
Leica GEOSYSTEMS, Paris, France

Population growth will be for the next few years a major challenge all over the world and particularly in emergent countries and as a consequence, Human needs will naturally increase to satisfy.
Surveying in its entirety will have a major role in the future for extraction, transportation, ports logistics. The single aim behind this will be to develop a sustainable policy and management.

Productivity, security, accuracy, speed are most of the time what is needed in order to manage an industrial site as clear and as clever as possible.
Indeed to optimize accuracy when surveying, it is important to see what could be the benefice to use new technologies for calculating volumes of extraction or positioning in 3D a new engine, monitoring mines and designing pipelines.
For that, Leica Geosystems - as a major leader in the manufacture and development of 3D Solutions- has developed many products, softwares and workflows to find solutions for better management of industrial sites and connect all the knowledge that could be found on site.

Static laser Scanner,dynamic laser scanning, UAV (drone), combined with softwares have improved the way of managing industrial sites while providing with accuracy simulations on site, calculation.
As a result, many companies all over the industrial world, will be involved in using these technologies to get earnings.
Leica Geosystems is providing a new way to develop and manage industrial sites with a new way that save time and money.

1D 2D 3D RADAR TECHNOLOGY FOR SAFETY, OPERATOR ASSISTANCE AND AUTOMATION

DR. REIK WINKEL, CHRISTIAN AUGUSTIN, DAVID HAUMANN, MATTHIAS SCHÖNHOFER
indurad GmbH, Aachen, Germany
MANUEL DANGELA
Collège des Ingeniéurs, Paris, France

Laser technology has been successfully used for more than a decade in the manufacturing industry. However, due to restrictions found in challenging heavy industry environments, such as dust, fog, rain or snow, laser technology can only rarely be found in mining applications. At the same time, technology-supported geometrical environmental scanning is essential for the control of mining machines and mineral processes, as human eyes are not suited for range measurements. Because of this technology gap, many machines are frequently operated beyond their original design boundaries, which may result in significant safety impacts and collisions.

Recent breakthroughs in radar technology have allowed to go from simple 1D level measurement to full 2D profiling and 3D stockpile imaging, which is bound to trigger a revolution in mining. In close collaboration with major universities, radar technology has been developed to mature and ruggedized industrial sensors by indurad. A fundamental base was the availability of High Frequency 78GHz and 122GHz Radar Chips.

A case study performed by the Collège des Ingénieurs in Paris could identify for example production increases by radar solutions in Stacker/Reclaimer Operations by 5%-10%. Besides Operators from Shiploaders can now be substantially assisted with guidance systems, as they are already state of the art since years as parking assistance in cars. Five of the 10 major mining companies like RioTinto, BHPbilliton, Vale and Codelco have recently been adopting the technology successfully in their operations. Based on the success indurad could convince ThyssenKrupp Industrial Solution to include the complete indurad solutions spectrum within their service offer, making the technology and local support fully available in countries like Morocco where indurad is not yet present. Apart from the proper technology behind this revolution, the authors will focus on best practice applications in the global mining industry on their paper.

Keywords: Radar, Sensors, Automation, Safety, Innovation.

ADVANTAGES OF USING SURFACE MINERS COMPARED TO CONVENTIONAL EXCAVATION METHODS

FLAVIO VILLAA
Chief Engineer - Trencher Division, Tesmec S.p.A., Italy

Conventional Drill and Blast methods are still the most widely used excavation methods in quarrying and open pits mining; in many cases they remain the most productive and cost effective techniques.
Tesmec Rock Hawg technology allows excavating in a cost-effective way even strong and unfractured rock completely substituting and avoiding the use of explosive.
This aspect can be of primary importance and make the Rock Hawg a viable alternative to drill and blast methods, considering that:

- the use of explosives is being subject to restrictive regulations
- often environmental constraint can make blasting uneconomical

Compared to other mechanical excavation methods the Tesmec Rock Hawg is always the more cost effective solution. The productivity of a single Rock Hawg can be more than 3 times the one of an excavator of the same weight, equipped with hydraulic rock breaker, and a few Rock Hawg units can replace an entire fleet of excavators.
Rock Hawg produces small and quite uniform material with a tight particle size. This allows avoiding primary crushing, more efficient settings on secondary and tertiary crushing systems.
There are many other advantages in using the Tesmec Rock Hawg technology:

- Rock Hawg machines can excavate vertical side walls, thanks to the drum wider than the tracks and supported in the centre. The rear-mounted drum also allows the excavation of square corners. The excavated pit in many cases will not need any further finishing by other excavation means,
- Rock Hawg machine, using a laser system to control digging depth can produce a very smooth and gently inclined surface. The inclination can be easily controlled directly on-site.
- Tesmec Rock Hawg have the 3D GPS technology that gives the input to develop an integrated system that automatically controls machine alignment and digging depth, with relevant benefits in jobsite management.

MINING TECHNOLOGIES

WIRTGEN DRIVES THE DEVELOPMENT OF SURFACE MINING

HERMANN-JOSEF VOLK
Wirtgen GmbH, Windhagen, Germany

Why not to apply know-how gained in asphalt milling to the mining of hard rock? In the mid 70s, this idea triggered the development of a new, economically efficient opencast mining method known as Surface Miner Technology. What followed was an unparalleled success story, and it was headed by Wirtgen as the driving force behind it right from the start.

1980 marked the birth of the new and innovative surface mining process – Wirtgen developed a prototype based on road milling machines, the 3000 SM surface miner. Market entry was accomplished in 1983 when the first machine, a 1900 SM surface miner, was sold. In keeping with market requirements, Wirtgen continued to develop different machines for different application and performance rates.

Economically opencast mining of useful minerals is becoming increasingly difficult, because in many existing and also newly developed deposits the amount of useful minerals is decreasing as a result of complex geology. In rock operations, machines are needed for highly precise levelling work under restricted space conditions. Our patent remedy in both cases is mechanical exploitation by means of surface mining. This innovative technology takes account of an increasing demand for economically efficient and environmentally gentle solutions. As technology and market leader, Wirtgen is pressing ahead passionately with this method. Our know-how will enable us to successfully master all of the even more demanding challenges lying ahead.

Cutting, crushing and loading the mining material in a single operational step is much more efficient than conventional mining methods.

SOLUTION À TRIPLE BARRIÈRE POUR CONVOYEURS

AMINE GHALI BENNA
SKF France Bureau de Liaison Maroc, Casablanca, Morocco

Écologique et économique, la solution pour convoyeurs peut prolonger la durée de service des roulements sans lubrifiants solides, joints Taconite ou larges quantités de graisse. Lubrifiée à vie dans la plupart des applications, la solution SKF pour convoyeurs est constituée de quatre composants:

- Roulements à rotule sur rouleaux SKF Explorer étanches et roulements CARB étanches
- Paliers à semelle SKF
- Joints de type L ou S SKF standard
- Graisse biodégradable SKF LGGB2

Conception et performances éprouvées

Les roulements à rotule sur rouleaux SKF Explorer peuvent supporter des charges axiales importantes et des charges radiales très importantes dans des applications où un désalignement ou une flexion de l'arbre sont susceptibles de se produire. Grâce à l'efficacité des joints à frottement et à un graissage effectué en usine avec une graisse haute qualité, ces unités sont prêtes à monter.

Les roulements à rotule sur rouleaux SKF Explorer permettent d'améliorer considérablement les paramètres opérationnels clés et ont fait la preuve de leur durée de service plusieurs fois supérieure aux roulements concurrents lors de tests dans des conditions d'utilisation lourde types. Ceci vaut particulièrement pour les roulements à rotule sur rouleaux étanches SKF, dont les performances d'étanchéité extraordinaires laissent la concurrence loin derrière.

Bénéfices pour les équipementiers:

- Augmentation de la durée de disponibilité
- Fiabilité accrue
- Résistance à la contamination
- Augmentation des niveaux de productivité
- Réduction du niveau sonore et vibratoire
- Excellente résistance à l'usure

MINING TECHNOLOGIES

PRECISION SURFACE MINING, THE NEXT STEPS

JIM HUTCHINS,
Senior Application Engineer, Vermeer, USA
STEPHAN OPPELAAR
Regional Manager, Vermeer EMEA, Netherlands

Precision surface mining is gaining traction in the phosphate, iron ore, copper, iodine, limestone, bauxite, coal and gypsum markets. Precision surface mining allows following an ore body in three dimensions to maximize ore quality over that possible from drill and blast techniques by keeping the ore separate from the waste. In addition to eliminating the need for a primary crusher, precision surface mining allows for production of a uniform material with a tight particle size distribution.

Top-down cutting allows variation in product size, with fewer fines being generated that that obtained in the same material using drill and blast techniques. In this study, we present case studies in Chile (iodine) and South Africa (coal) to illustrate these results.

Vermeer is committed to developing the capabilities of our surface mining machines to make them more efficient and environmentally friendly. Asection of the paper is focused on a new dust suppression capability not involved with using water. The remainder of the paper describes step-by-step developments on Vermeer's "road to autonomy". While true autonomous operations are sometime in the future, there are several necessary steps along the way which must be operational. These include a remote control capability to allow mining next to walls, an operating system (Tec® Plus) which teaches the operator how to more efficiently run the machine – along with presenting operational data for management purposes. In addition this section includes a description of automatic steering using GPS techniques – both in a straight line and turning.

EVOLUTION OF TECHNOLOGY ON THE BLASTHOLE DRILL

TYLER J BERENS
USA

Over the last decade, automation has continually taken on an increased role in blasthole drills. Automation began making an impact with the advent of the PLC in the early 70's. The early 1980's saw the arrival of a PC and later the CAN bus which has continually grown into the sophisticated automation machines of today. Automation is able to extend its reach across many stakeholders in a mine's value chain. From operators, to maintenance teams, to blasting teams and management, automated blasthole drills offer many subjective and objective advantages. Automation's strengths lie in being a flexible, modular and predictable system. As a flexible tool, automation is safely able to integrate into data flows and operational processes. Being modular in nature allows a mine to implement parts to immediately and directly address its Continual Improvement initiatives while planning for the future.

As the mine evolves, new automation items are placed into the operational processes as plug and play. Predictability through repeatable and reliable processes is another attribute automation supplies. Computer processes controlling the drill provides manually operated drills with smooth and safe operations while more sophisticated autonomous operations ensure sequences are followed each and every time to completion. Automation is now commonly becoming the enabler of solutions to a mine's tactical challenges and strategic opportunities. Pit Viper automation has developed many unique solutions guarding safety, ensuring precise drilling, providing faster drilling cycles, and producing sophisticated reporting tools while integrating into mine wide data flows. So, where's the limit for automation? We haven't found it yet. While the existing uses of automation are impressive, the continuing work in this field is pushing into exciting territory including full autonomy, exemplifying safety, productivity, and precision.

APPLICATION OF CAST BLASTING IN MOROCCAN PHOSPHATE MINES

MANSOUR ASRI, YOUSSEF DAAFI
OCP Group, Benguérir, Morocco

Very few cases of Cast Blasting use in phosphate mining have been reported. However, in open-cast coal mining, Cast Blasting is a common practice. And yet, the geological structure of both types of deposits is similar. Accordingly, advantages for phosphate strip mines are manifest, especially as future conditions of Moroccan phosphate deposits fit quite well with the approach.

The perspectives in terms of increasing capacity and reducing cost of stripping are quite positive. The dragline market (backbone of strip mining) is currently dominated by few suppliers. Avoiding investment in these mining equipments would limit the risk of dependency and therefore provide a strategic advantage.

Moreover, coping with the improvement of efficiency issues, transforming fixed costs into variable costs are a key measure. And this is something that could be achieved through Cast Blasting.

Prior to the implementation of this method, a study was achieved to demonstrate profitability while specifying the conditions of optimal use. The study was based both on the use of numerical simulation and field trials.

The presentation provides a summary of the geology, the blasting method and the findings of this study and highlights the side effects that should be fixed (mainly back break) in order to ensure the best result from the Cast Blasting method.

THE FEATURES AND BENEFITS OF CATERPILLAR LARGE MINING TRUCKS

STEVE JACKSON
Marketing Manager des Larges Mining Trucks, Caterpillar, USA

Caterpillar will provide a presentation on the features and benefits of Caterpillar Large Mining Trucks. This will involve an overview of haulage equipment from 130 metric tons to 360 metric tons. We will also show the differences between mechanical and electric drive systems, and a close examination of the applications where mechanical drive and electric drive systems are best applied. Lastly, there will be an in-depth study of the benefits of evaluating the cost per ton and cost per hour methodology.

PLANT PROFITABILITY IMPROVEMENT THANKS TO PRODUCTION TEAM AND ENGINEERING OFFICES SYNERGY: A CASE STUDY IN PRAYON PRODUCTION SITE

NICOLAS VAN LIERDE
Prayon Technologies S.A., Engis, Belgium
LAURENT BECKERS
Prayon S.A. (Phosphoric Acid Plant), Engis, Belgium

Phosphoric acid production is a well-known and mature technology but still has room for improvement and innovation. In that respect, the permanent exchanges between process engineers of plant and design offices are of great value. In the Prayon production site of Engis, we have both and achieve permanent plant improvement due to communication between the divisions.

The production plant operates under the CPP process in operation for more than 40 years. It is a dihydrate-hemihydrate process producing an acid of 32-36% P_2O_5 with efficiency higher than 98% and a high quality calcium sulfate valorized in the plaster industry.

Considering our client requirements, the quality of the calcium sulfate needs to be followed with great care and cannot suffer any deviation. The Prayon tilting pan hemihydrate filter needs to be permanently at his best. The P_2O_5 content in the calcium sulfate (with a maximum limit at 0.6%) must be carefully controlled during all operation time. Therefore, cleanness of the clothes has to be constantly kept as best as possible to ensure the plant capacity and a maximum P_2O_5 yield recovery. Moreover, cell cleaning operation must be reduced in order to limit the maintenance and the shut-down costs.

To tackle these challenges, a joint team of Prayon production plant, Profile and Prayon Technologies has been established. The cake wash water flow has been optimized in order to improve the cake washing efficiency and minimize the P_2O_5 losses.

Furthermore, a new high pressure oscillating ramp has been designed to greatly improve the cloth wash.

Finally, a new cell bottom made up of two parts has been implemented for easy removal and cleaning of the filter cell bottom.

Overall it allows the Engis plant to save 400 hours of maintenance per year, to lower the shut-down time for cells and clothes cleaning of 2 days per year and to recover 8500 tons of P_2O_5 per year by efficiency improvement.

JACOBS NEW PROCESS FOR REMOVING IRON FROM PHOPHORIC ACID

STEPHEN HILAKOS
Jacobs Engineering Inc., Lakeland FL, USA

Jacobs has developed a new technique for removing iron from phosphoric acid. Although the process cannot be disclosed prior to the patent filing, details and results are expected to be available for presentation at the conference. With the new process, Jacobs has successfully treated high iron acids and reduced minor element ratios (MERs) by over 50% with only a minor loss of P_2O_5 content. The new process should be attractive in regions with phosphate deposits that contain high concentrations of iron, such as those located in Australia, Canada, Northern Africa and areas of the Middle East.

AMÉLIORATION DE LA FILTRABILITÉ DE LA BOUILLIE PHOSPHORIQUE PAR AJOUTS DES ADDITIFS MINÉRAUX

SLIMANE MANAR, JAOUHAR JEBRIL, MAROC

L'ajout des additifs minéraux naturels au cours de l'étape de l'attaque sulfurique du phosphate Lavé flotté de Youssoufia s'est avéré très efficace pour l'amélioration de la filtrabilité de la bouillie phosphorique produite par voie humide. En effet la morphologie des cristaux de phosphogypse est améliorée. Ainsi leur diamètre médian est amélioré et leur forme tabulaire rhombique est favorable à l'augmentation du taux de filtration.

L'ajout de la silice réactive (ALUFLUOR) pour la complexations de l'élément F qui est défavorable à une bonne cristallisation est montré limité en terme d'efficacité en l'absence de l'alumine; les cristaux sont effectivement développés, mais selon un seul sens et prennent la forme de barreaux minces. Par ailleurs la présence de l'alumine permet d'améliorer davantage la morphologie des cristaux avec un développement régulier suivant les trois axes.

Dans cette étude nous présentons les résultats d'ajouts de plusieurs additifs contentant des taux variés en SiO2 et en Al2O3.

Les résultats obtenus pour ces différents additifs par diverses méthodes justifient et prouvent l'efficacité de l'ajout de ces additifs ainsi que le rôle complémentaire de la silice et l'alumine.

THICKENING, FILTRATION AND CLARIFYING IN PHOSPHORIC ACID INDUSTRY

PHILIP LAKE
WesTech Inc. Salt Lake City, UT, USA
RALPH CUTLER
WesTech Inc. Salt Lake City, UT, USA
ABILIO GASPAR
WesTech Mena. Casablanca, Morocco
ROGER SUMMERHAYS

Whenever it is thickened, filtered and clarify concentrates or residues, the question is: What equipment to choose without falling into the temptation to go cheaper and thus sacrifice quality over quality over price. This presentation gives you some tips to avoid the trap.

Some topics: When it comes to concentrate and Tailings Thickening, Filtration equipment – which filter to choose?

Thickening, Filtration and Clarification equipment – Specificities, advantages of Westech solutions.

Thickener and clarifier technology advancements in the phosphates Industry.

IMPACTS OF Al_2O_3/P_2O_5 RATIO ON GYPSUM CRYSTAL GROWTH AND PHOSPHORIC ACID PLANT OPERATION

CURTIS GRIFFIN
PegasusTSI, Tampa Fl, USA

One of the most critical operating parameters in a phosphoric acid plant is gypsum crystal formation. The size and the shape of the gypsum crystals alter the performance of the phosphoric acid plant by impacting filtration rates and P_2O_5 recovery. Phosphate rock impurities, specifically Aluminum, have a significant effect on the gypsum crystal shape and size that is produced.

The purpose of the research was to show the effect that various Al_2O_3/P_2O_5 ratios have on gypsum crystal growth characteristics and filtration rates, this was done by performing two separate pilot plant tests. The first test used phosphate rock with a low Al_2O_3/P_2O_5 ratio, the Al_2O_3/P_2O_5 ratio was increased by adding laboratory grade Kaolin (Al_2O_3 $(SiO_2)_2$*$2H_2O$). The second test used phosphate rock with a high Al_2O_3/P_2O_5 ratio, the Al_2O_3/P_2O_5 ratio was decreased by blending low Aluminum concentration phosphate rock. During both tests, gypsum crystal formation, filtration rates and P_2O_5 losses were evaluated.

The results from the first test showed that when starting with an Al_2O_3/P_2O_5 feed ratio of 0.004 the average filtration rate was 2 t P_2O_5/m^2/day. When the Al_2O_3/P_2O_5 feed ratio was increased to 0.016 the average filtration rate increased to 6 t P_2O_5/m^2/day. The filtration rates continued to improve until the Al_2O_3/P_2O_5 feed ratio reached 0.047 where the average filtration rate then decreased to 5 t P_2O_5/m^2/day. The decrease in filtration rate was after the full effect of the increase inAl_2O_3 appeared in the liquid phase of the reactor and indicates that too much Aluminum can have an adverse impact on filtration rates. The only impurity that was adjusted in this evaluation was the Aluminum verifying that the Al_2O_3/P_2O_5 ratio has a direct impact on filtration.

The results from the second test showed that when starting with an Al_2O_3/P_2O_5 feed ratio of 0.029 the average filtration rate was 5 t P_2O_5/m^2/day. When the Al_2O_3/P_2O_5 feed ratio was decreased to 0.0174 the average filtration rate increased to 6 t P_2O_5/m^2/day. When the Al_2O_3/P_2O_5 feed ratio was decreased to 0.009 the average filtration rate increased to 7 t P_2O_5/m^2/day. In this test, the Al_2O_3/P_2O_5 ratio was decreased by blending low Aluminum concentration phosphate rock, this method also impacted the levels of other impurities which could also have an impact on the gypsum crystal growth and filtration rates.

In conclusion, the tests produced a variety of crystal shapes, sizes and a range of filtration rates confirming the Al_2O_3/P_2O_5 ratio has a direct impact on crystal formation and filtration rates.

WATER MANAGEMENT; TOWARDS MINIMUM IMPACT CONCENTRATORS

KAJ JANSSON
Outotec, Espoo, Finland

Today, minerals processing concentrators are facing challenges with the fresh water availability and quality, as well as new environmental limitations towards the old traditional tailings management facilities and the volume and quality of the seepage from these. The trend of lower grades in mineral deposits is also enlarging water and energy consumption, as well as the tailings management facilities size. For future successful operations, water usage issues should not only be looked as own separate entity, but as a part of whole site operation including the mine, mineral process and dewatering processes.

As a key element to reach minimum water usage and maximum water reuse is the understanding of the effects of selected tailing methods, and the present qualities and quantities of waters in the existing phosphate processes. This understanding will open up new possibilities to reuse water inside the process, thus saving further on fresh water and effluent volumes and treatments. It should be noticed that not all process steps do need desal quality waters - more an understanding on what elements are harmful and which are not for the process.

For example, using conventional wet tailings system will lead to high water usage due to the high seepage, lock-in and evaporation at the tailings pond. As a result the seepage streams from North African phosphogypsym wastes including many times uranium and other toxic elements a result of the AMD waters generated from the acid producing tailings. These waters will need to be treated with technologies and units capable to handle these flows and removal efficiencies. However, using more water preserving tailings methods these ones can be minimize at the same time as the reuse potential is maximized.

Different water treatment, such as desalination, process waters and effluent treatment technologies will be discussed from the point of where they are needed to reach specific qualities and how to optimized water volumes for the process. Also Outotec HSC simulation tool potential in full water, energy and mineral balance calculation and estimation will be discussed.

The future minimum impact concentrators do have go towards new tailings methods to reach more closed and smaller water volumes in order to save the water need for the operation and reduced operational risks.

DEVELOPMENT OF CALS-TECHNOLOGY FOR THE PHOSPHORIC ACID OF HIGH PURITY

GLUSHKO ANDREY, FILATOVA LYUDMILA
Federal State Unitary Enterprise "State Scientific-Research Institute of Chemical Reagents and High Purity Chemical Substances" (IREA), Moscow, Russian Federation
BESSARABOV ARKADIY, KVASYUK ALEKSEY
R&D Centre "Fine Chemicals", Moscow, Russian Federation

We have developed an industrial production of phosphoric acid of high purity for high-performance liquid chromatography. The design was carried out under the most modern and advanced system of computer support – CALS-technologies (Continuous Acquisition and Life cycle Support). The principle technological scheme of the operating unit includes: fluoroplast reactor for oxidative degradation of impurities, dipsticks, absorptive capacities, rotary filter, pressure vessel, rotating fluoroplast crystallizer, receivers of mother liquors and wash water, receivers of the finished product – purified crystals. In addition, the technology of production of phosphoric acid does not require protection from gas emissions and waste water, i.e. it is environmentally safe. At the present time the requirements for purity significantly were tightened and the number of parameters characterizing the quality of the product were increased. At the same time requirements to the methods of analytical control of high pure phosphoric acid were increased.

The solution of these problems is possible only on the basis of the modern computer quality management system (CQM-system). The CQM-system developed on the basis of CALS-technologies has a hierarchical structure of databases. Three major information categories are: an analyte; analytical methods and technical means; output and normative-technical documentation. All analytical methods used for analysis of the basic substance and impurities were included in the CQM-system. Also the CALS-project contains information about devices corresponding to each method: schematic diagram of the device; operational documentation; schedule of checking and the testimony of its performance; calibration or calibration graphs. Ultimately, the selected information CALS-technology allows you to create an effective systems of design and quality control of products conforming to international standards.

COMPARISON OF DIFFERENT WAYS OF DESULFATATION USED IN OCP PHOSPHORIC ACID PLANTS

HANANE MOURCHID

Responsible of Phosphorique Production, Maroc Phosphore Safi, OCP S.A., Morocco

Within the reaction of phosphoric acid production by sulfuric acid attack of the phosphate rock, the presence of an excess of sulfate ions is required in the formation of calcium sulfate in both hydrated forms. In this way, for different process, with simple or double crystallization, and following diverse stages of each process, the free sulfates concentration in the slurry differs according to crystalline form desired. However, this excess can reach high values and affects negatively the phosphoric acid quality expected by the client. In fact, it needs to be removed. This explains the importance of desulfatation

Desulfatation has been done in many ways in the history of OCP: in the reaction tanks, post filtration or in the final product storage. Each different method has its own advantages and weaknesses. In this way, the present work has the main aim to present all these methods.

CHEMICAL AND PROCESS SYSTEM ENGINEERING CONTRIBUTION TO SUSTAINABILITY

JEAN-PIERRE DAL PONT
Président SFGP, Paris, France

Sustainability and Sustainable Development (SD); its origin from the "Brundtland report" (Our Common Future) to nowadays concepts. The SD is well represented by the 3 P's: people, profit, planet. It is a development which is socially acceptable with the minimum impact on the environment and is economically viable. It has become a priority due to planet challenges: climate change, water shortage, pollution,energy and raw materials depletion, population growth, health and food issue to name only a few. Chemical Engineering (CE) and Process System Engineering (PSE) have developed a set of tools to contribute to a SD. CE is by definition an integration of different disciplines and sciences: chemistry, biology, biotechnology, physics...

It has been instrumental in developing the Unit Operations concept, flowsheeting with energy and material balances, equipment specifications and engineering methods in general.

Process System Engineering has introduced new tools; complex systems analysis, modeling, exergy analysis, water conservation, CO2 and green house gases (GHG) reduction, impact analysis, safety management, waste management, eco-design and LCA (Life Cycle Analysis) of products. PSE has adopted the principles of Green chemistry and Green engineering to better design, operate and control Process facilities. Circular Economy, Industrial Ecology, Corporate Social Responsibility of the Enterprises, dedicated Metrics are among the new concepts Chemical engineers have to consider for SD. They are the key players of Sustainability at the intersection of Research and Engineering. They make things happen.

PHOSPHATE ENTERPRISE OPTIMIZATION

DONAL S. TUNKS
Phosphatics LLC, Tampa, Florida, USA

Enterprise Optimization is a methodology that combines Operations with the science of Chemical Engineering in an effort to achieve a fully streamlined production process. This includes combining all the steps in manufacturing as a single controlled process and also incorporating this process into the logistics of distribution. The benefits of approaching the production of Phosphate based products as an Enterprise Optimization problem include reduced raw material cost, increased capacity, enhanced yield, and improved phosphate project lifetime.

Along with the general introduction of the application of Enterprise Optimization in the Phosphate Industry, this paper presents several optimization challenges which are necessary components in developing an entire enterprise wide optimization strategy. These strategies include the following:

- Phosphate Resource Optimization – This will focus on developing a strategic mining plan to maximize the life of a commercial grade phosphate deposit.
- Fully Incorporated Supply Chain – This will focus on integrating the entire Phosphate Fertilizer Production Process into a supply chain management program. The type of facilities incorporated into this analysis include Phosphate Beneficiation, Sulfuric Acid, Phosphoric Acid, and Granular Phosphate Based Fertilizers.
- Process Optimization – The use of Process Optimization is essential in developing a full Enterprise Optimization Strategy. These techniques will be applied to the reduction of raw materials and utilities, improved product recovery, and enhanced energy efficiency.

DES MÉCANISMES DE TRANSFERT DE TECHNOLOGIE ET DES ATOUTS POUR RÉUSSIR CE TRANSFERT

BARTHÉLÉMY NYASSE
University of Bamenda, Bamenda, Cameroon
University of Yaoundé I, Fac.Science, Yaoundé, Cameroon

Le transfert de technologie étant le processus par lequel le concepteur d'une technologie la met à la disposition d'un partenaire afin que celui-ci l'exploite. Un tel processus s'effectue en établissant des relations juridiques en vertu desquelles: le propriétaire de la technologie ou le titulaire des droits concédés sous licence pour exploiter la technologie accorde de nouveaux droits d'exploitation au partenaire du transfert de technologie.

Il s'agit ici, d'une part, d'examiner les mécanismes de transferts entre les réservoirs de connaissance situés dans les universités et les centres de recherche, vers l'industrie et les services et, d'autre part, de voir ceux des transferts de l'extérieur vers l'intérieur. Par la suite, les raisons de la mise à disposition d'une technologie par le concepteur (constitution d'alliances pouvant faire progresser la conception de la technologie pour réussir à la placer sur le marché; permettant une capacité de fabrication, de commercialisation et de distribution; assurant l'exploitation dans un domaine d'application différent, etc.) sont exposés.

De plus, l'exposé présente une classification et une analyse des processus de transferts de technologie (les IDE (Investissement Direct Etranger), la franchise, les sociétés conjointes, les réseaux internationaux de commercialisation, les stratégies de cluster, etc.) portant sur une catégorie des secteurs et des sous secteurs. La méthode suivie permet de déterminer des mécanismes permettant de faciliter les transferts de technologie à partir d'une sélection d'indicateurs applicables à certain nombre de structures ou des prérequis à l'absorption de technologies.

STOCKYARD OPERATION AND AUTOMATION THE ROLE OF ADVANCED AUTOMATION TECHNOLOGIES IN SUPPLY CHAIN MANAGEMENT FOR BULK MATERIALS

TINA KNUDSEN
General Manager, FLSmidth Material Handling Automation, Wadgassen, Germany
OLE KNUDSEN
Global Manager, FLSmidth Automation, Valby, Denmark

The use of advanced automation for stockyard operations has become a key success factor in order to establish an efficient, high-quality, stable and competitive supply chain. Depending on various factors such as type of application, geographical location, infrastructure etc., there are several reasons to consider an advanced level of automation for stockyardoperations. Among those are:

- Lack of skilled man-power (especially in remote locations) and/or high labour cost
- Low utilization of the stockyard and machinery
- Complex planning and coordination of the stockyard operations
- High wear and tear of the equipment
- No accurate material tracking and inventory management
- Health and safety aspects

It is today possible to minimise or completely eliminate these factors by implementing advanced automation to the material handling machinery and system management. Advanced automation allows one single operator, placed in a central control room, to handle the operations of a complete stockyard, consisting of a various number of stacker/reclaimers, ship unloader/loaders and train loader/unloaders. The mobile machines will be operating autonomous and "intelligent"-without ahuman operator on-board.

FLSmidth offers a range of advanced automation products tailored to the bulk material industries. The key-technology is a 3D terrain model, enabling the centralized operator to have exact information of where different materials are located in the stockyard. The machines will be equipped with 3D or 2D laser-scanners or radars, providing an accurate feedback to the terrain model and to the machine control.

By adding advanced automation to bulk material operations, FLSmidth's track record shows; 15-20% higher reclaiming efficiency (stockyard throughput), more homogeneous flow rates, increased quality prediction and control, as well as maximum machine reliability and safety.

DÉPLOIEMENT DE L'OPS (OCP PRODUCTION SYSTEM), LA VOIE VERS L'EXCELLENCE OPÉRATIONNELLE: CAS PRATIQUES ET RÉSULTATS TERRAIN DU SITE DE GANTOUR

ABDELGHANI GASMI, HICHAM BAHA, MOHAMED AIMAD BOUGDIF
OCP Group, Site de Gantour, Morocco

Après le succès de la transformation opérationnelle initiée aux différents sites de l'OCP, en particulier au site de Gantour, les premiers pas vers l'Excellence Opérationnelle sont déjà ancrés. Par ailleurs, et pour continuer dans l'approche de changement par rupture initiée avec IQLAA, l'intégration de toutes les dimensions de l'Excellence Opérationnelle dans un système de production cohérent et complet permettant une pérennisation des acquis et une accélération de la mise en œuvre de la stratégie industrielle du groupe, s'avérait nécessaire. L'OPS; OCP Production System; est ainsi né et a été mis en place depuis 2011.

Ce système, bâti sur six blocs essentiels (Management de terrain, Qualité et maitrises des processus et des procédés, pilotage de la performance, maitrise des flux, maitrise de l'outil de production, et développement durable et capital humain), vise essentiellement l'excellence opérationnelle.

Conscient des grands défis à relever et des challenges de par notre groupe pour atteindre un niveau WORD CLASS, le site de Gantour s'est inscrit dans une démarche d'excellence opérationnelle en s'appuyant sur les opportunités offertes par le système OPS. En effet; étant un système global, basé sur des principes et structuré sous forme d'outils et piliers facilement appropriables par le personnel, le Site de Gantour en a fait son système pour la réalisation de ses objectifs.

Ainsi et après trois ans de déploiement, L'OPS est devenu un système intégré et approprié par tout le personnel et toutes les entités de site de Gantour. Ainsi les résultats sur le terrain et sur les performances sont spectaculaires:

- Performances exceptionnelles en matière de HSE, traduites par le déploiement à 100% des standards de gouvernance et opérationnelles
- Des performances record en termes de production et de coût
- Des records en termes de consommations spécifiques
- Professionnalisation de la maintenance à travers la redynamisation de la GMAO et le déploiement à 100% des bureaux des méthodes au niveau de tous les départements de maintenance.

SYSTEM RESEARCHES OF THE DEVELOPMENT OF PHOSPHORIC INDUSTRY OF RUSSIA

BESSARABOV ARKADIY, KVASYUK ALEKSEY, ZAKOLODINA TATIANA, ZAREMBA GALINA, VENDILO ANDREY

R&D Centre "Fine Chemicals", Moscow, Russian Federation

Analysis was carried out for all of 15 enterprises of phosphoric industry of Russia. It was shown that the main volume of production (82%) is focused at the next 4 enterprises: "Ammophos" (Cherepovets), "Balakovskie mineral fertilizers", "Voskresenskie mineral fertilizers", "Phosphorite" (Kingisepp). At the first stage system analysis of main indicators of innovative development of phosphoric industry leading enterprises was carried out. For solution of this task innovative work of enterprises was parsed for 1995-2013. The main results of innovative activity were represented as 4-point scale: 3 – the highest degree of indicator influence, 2 – average, 1 – less essential, 0 – no influence. It is shown, that introducing of innovations made the most significant influence on the "output quality improvement" and "assortment expansion" (rating is 2.86 points and more). Compliance with standards and improvement of labor conditions influenced the development of phosphoric enterprises in a lesser degree (1.05-2.18 points).

However, influence of innovations on reduction of environmental pollution was estimated by the companies' CEOs as inessential (0.25-0.80 points). This neglect of the environmental problems resulted in large volumes of accumulated waste of the phosphoric industry. Factor analysis of the influence of the main results of innovative activity on the reduction of material costs" showed that most closely with this option relate to "improvement of product quality" (correlation coefficient R = 0,98) and "growth of productive capacities" (0,65). Somewhat less was the relationship of analyzed parameter "compliance with current standards" (0,62) and a lot less "increasing of production flexibility" (0,02). The closest connection with the third result parameter ("reduced energy costs") was recorded for such influencing factors as "increasing of production flexibility" (0,78). Correlation coefficients for the other three factors had lower values: "improvement of product quality" (0,52), "compliance with current standards" (0,48), and "growth of productive capacities" (0,10).

THE MANAGEMENT OF THE ENVIRONMENT DURING THE REALIZATION OF INDUSTRIAL PROJECTS: CASE OF ODI'S PROJECT OCP GROUP –JORF LASFAR SITE

AMAL BELLARBI, RACHID M'HAMDI, CHAFIK JARID, ABDELLATIF CHEIKH
Jacobs Engineering S.A., OCP Group

OCP S.A. Group has undertaken an extensive program to develop its capabilities in the mining and industrial axis Khouribga - Jorf Lasfar.

In the context of this program which includes:The project Jorf Phosphate Hub (JPH) located in the chemical complex of Jorf Lasfar consists in building several plants: Downstream, extension and modification of the existing plants in Morocco Phosphorus MPIII & MP IV, JPH infrastructure to serve all the new facilities and 10 new fertilizer plants namely ODI (Own Development Investment) with a capacity of 1 million tons of fertilizers for each.

Acting in responsible industry, the Group OCP and JESA aims to work towards exemplary on environment, safety and preserving the health of its employees and its stakeholders.

The ODI Projects contributed generating skills, jobs and good living conditions for the resident in Eljadida city, Jorf lasfar and theirs regions.

During our intervention, and through examples from OCP projects, we would like to show you an overview of the steps to follow by a teamfrom: JESA / OCP, contractors and sub-contractors to ensure that the ODI projects will be designed, built and operating with respect of the parameters and conditions stated in the environmental impact study.

Key words: OCP Project, JESA, ODI, Environmental Impact Study, skills, contractors and subcontractors.

WATER MANAGEMENT IN PHOSPHORIC ACID: A PROCESSES COMPARISON

TIBAUT THEYS, NICOLAS VAN LIERDE, ALEXANDRE WAVREILLE
Prayon Technologies, Engis, Belgium

Due to many factors such as the global warming and the population growth, sustainable production of fertilizer is an important subject. In that respect, water management has a strong impact when phosphoric acid production is considered.

Water consumption greatly varies according to the process chosen and the quality of water available.

Water consumption comparison between hemihydrate, dihydrate and the new dihydrate hemihydrate DA-HF process will be presented considering a plant location inland and nearby the sea.

From the results shown, some possible paths are presented to reduce the water consumption.

2020 CATHODE MATERIALS COST COMPETITION: LITHIUM IRON PHOSPHATE, THE PROMISING BEST CANDIDATE FOR ENERGY STORAGE SYSTEM

FABRICE RENARD
PRAYON S.A., ENGIS, BELGIUM

The goal of this paper is to compare the cost structure of the Lithium Iron Phosphate cathode material in its position in terms of price/cost performance for mass industrialization in regard with other current cathode materials used for Electrical Vehicle or Energy Storage System: Lithium Manganese Oxide, Lithium Nickel Cobalt Aluminum and Lithium Nickel Manganese Cobalt.

The study integrates also Lithium Cobalt Oxide although this material is not used for large storage system. However, due to its massive usage in portable electronics, this material is still a reference cathode material for Lithium-Ion Batteries (LIB) to make a comparative study.

By 2020, Lithium Iron Phosphate and its further evolutions will be competitive with all the cathode materials and in particular with the future generation of Lithium Nickel Manganese Cobalt specifically designed for full electrical vehicle. It will probably become the best-in-class in terms of $/kWh but - linked with its lower specific energy capacity and voltage - it will be more dedicated to large storage application.

ELECTRODE MATERIALS BASED ON PHOSPHATES AS A SUITABLE WAY FOR CLEAN ENERGY STORAGE

ISMAEL SAADOUNE
Laboratoire de Chimie des Matériaux et de l'Environnement, Université Cadi Ayyad, Marrakech, Morocco

Lithium-ion batteries (Li-ion) are interesting devices for electrochemical energy storage for most emerging green technologies such as wind and solar technologies or hybrid and plug-in electric vehicles. Compared with conventional aqueous rechargeable cells, such as nickel–cadmium and nickel–metal hydrid, Li-ion cells have higher energy densities, higher operating voltages, lower self-discharge and lower maintenance requirements.

Present commercial lithium-ion batteries use mainly LiCoO2 and its derivative as cathode materials, and graphite or carbonaceous materials as anode materials. Nevertheless, the oxygen release at high potentials leads to high thermal instability of these oxides and thus to many safety problems. This safety problem is more pronounced for stationary applications for which large size batteries were needed.

Phosphates were renowned by their high structural stability which are essential to overcome the above mentioned safety issue. Furthermore, their high ionic conductivity and their benign impact on the environment make this kind of materials as convenient one for active electrode not only for lithium-ion batteries (LIB), but also for the recently reinvestigated sodium-ion batteries (NIB).

Here, we present our recent studies on three phosphates: $Fe_{0.5}TiOPO_4$ and $LiFe_{0.4}Mn_{0.6}PO_4$ (as electrode materials for LIB) and $Na_{1.5}Fe_{0.5}Ti_{1.5}(PO_4)_3$ (as active material for NIB). The low electronic conductivity of these phosphates was overwhelmed by carbon coating, leading to batteries with high discharge capacities and a coulombic efficiency approaching 96% after cycling for more that 50 charge/discharge cycles. The mechanisms of the insertion/extraction reactions were characterized by using many specific technics such as in-situ XRD, Mossbauer, Raman and XPS,....

Acknowledgements: Thanks to IRESEN and CNRST for the financial support. The presented research works are the recent results of the fruitful collaboration with Uppsala University (Sweden), University Montpellier II (France) and Karlsruhe Institute of Technology (Germany)

PHOSPHATES: VERSATILE PRODUCTS FOR ENVIRONMENTAL AND ENERGY APPLICATIONS

NATHALIE LYCZKO, DOAN PHAM MINH, BRUNA REGODEVASCONCELOS, ANGE NZIHOU
Université de Toulouse, Mines Albi, CNRS, Centre RAPSODEE, France
PATRICK SHARROCK
Université de Toulouse, SIMAD, IUT de Castres, France

Phosphates are known for their numerous applications including food additives, metal coatings, potable water treatment, and ceramic formulation or flame retardants. Phosphates can be used in liquid or solid forms.

This paper summarizes on some of the applications of phosphates performed in our laboratory. It shows that phosphates based materials have important potentials for applications in environment and energy domains.

A study on municipal and industrial wastewater treatment showed that calcium phosphate synthesized from waste carbonate and potassium phosphate allows significant reductions contents of about 50 to 60% of main metals such as lead, aluminium and iron in the liquid phase. Organic molecules were also reduced during the treatment. The use of this reagent could improve biological wastewater treatment processes by reducing significantly the pollution load and enable the microbiological process to digest the remaining contents.

Another study was focused on phosphates for gas treatment. The results showed the efficiency for the removal of heavy metals from smoke stacks and passive capture and identification of toxic emissions. For example, in an incinerator flue gas treatment, 99.7% of cadmium emissions have been removed due to phosphate sorbents. The used of phosphates to create porous composites with controlled properties as porosity, mechanical resistance or functional surface groups. These composites could be used for gas filtration, retention of pollutants in the atmosphere and pollutants detectors and sensors. Phosphates research has been also carried out for energy application. $LiFePO_4/C$ composites used as a cathode for lithium ion batteries were studied. The results showed that particle size distribution and calcination temperature control the performance (energy and power) of the cathode.

Phosphate based composites for syngas (used for production of biofuels) production and reforming are also investigated. This study showed a high catalytic activity, high selectivity in H_2/CO and catalytic stability.

The examples provided highlight the wide range and promising applications for phosphate materials in environment and energy fields.

CATALYSIS BY PHOSPHATES: A SUSTAINABLE ROUTE

ABDERRAHIM SOLHY
Université Mohammed VI Polytechnique, Benguérir, Morocco

Industrial chemistry in the new millennium is widely adopting the concept of "Green Chemistry" to meet the fundamental scientific challenges of protecting human health and the environment while simultaneously achieving commercial profitability[1]. The development of solid catalysts for the production of fine chemicals is nowadays a subject of increasing interest[2].Indeed, phosphates have attracted wide attention due to its use as macroligand for bi-functional catalysts.

Our group demonstrated the utility of these materials as solid catalysts for many organic transformations[3]. Herein, we present a short history of the applications of phosphates in organic synthesis which we have achieved for the development of "Clean Organic Synthesis".

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PRODUCTION OF SODIUM DIHYDROGENO-PHOSPHATE (NAH_2PO_4) AND SODIUM TRIMETAPHOSPHATE ($NA_3P_3O_9$) USING SODIUM CHLORIDE (NACL) AND ORTHOPHOSPHORIC ACID (H_3PO_4)

DOAN PHAM MINH, ANGE NZIHOU, PATRICK SHARROCK
Université de Toulouse, Mines Albi, CNRS, Centre RAPSODEE, France

Up-to-date, sodium phosphates are synthesized by the neutralization of sodium hydroxide (NaOH) withorthophosphoric acid (H_3PO_4). For the best of our knowledge, the reaction between NaCland H_3PO_4 has not been yet reported in the litterature. In this work, we demonstrated that in selected experimental conditions, this reaction could take place. The main solid products could either be Sodium dihydrogeno-phosphate,NaH_2PO_4, or sodium trimetaphosphate (STM, $Na_3P_3O_9$). During the reaction, hydrochloric acid (HCl) gas was produced andevacuated with nitrogen or air. The reaction temperature, the presence of water in the reaction mixture, and the evacuation of gas product were identified as the key parameters for the yield and for the selectivity of the reaction. The best results for the formation of NaH_2PO_4 reached 91% of conversion and nearly 100% of selectivity at moderate conditions (110°C). For $Na_3P_3O_9$, both the yield and the selectivity in the desired product reached more than 99% at 600°C.

Using NaCl instead of NaOH for the production of sodium phosphate salts such as NaH_2PO_4 and $Na_3P_3O_9$) seems to be an interesting route.

COMMERCIAL ORGANOPHOSPHORUS CHEMICALS: STATUS AND NEW DEVELOPMENTS

NORBERT WEFERLING
WefConsult GmbH, Huerth, Germany
SHUAN MING ZHANG, CHO HSIEN CHIANG
Changzhou Hongfu Hightech Organophos R&D Center Co, Ltd., Liyang, China

By definition, organophosphorus chemicals are those with at least one P-C-bond. They all are downstream-products of elemental phosphorus – mostly of the P_4-allotrope – though with very few exceptions they cannot be synthesized directly from phosphorus element; instead, use has to be made of P_4-derivatives, such as PCl_3, PH_3 or sodium hypophosphite (SHP).

By the end of the 90th and the early 2000 novel processes for the production of organophosphorus chemicals and their transformation, resp., were developed and partly commercialized.

Examples are the BASIL® process (BASF), and olefin addition reactions to SHP, leading to novel flame retardants (EXOLIT® OP-types, Clariant), or to a new way of making a well-known extraction agent for the separation of Cobalt and Nickel (IONQUEST® 290, Rhodia, now Solvay). Various methods to produce organophosphorus chemicals in commercial scale are described. Using the example of methylphosphonous acid, existing and new routes are shown to synthesize that key intermediate for herbicide BASTA® (BASF) and flame retardants like EXOLIT® OP (Clariant).

CHEMICALS MODELISATION

AN OVERVIEW OF STATE OF THE ART CONSEQUENCE AND RISK MODELLING APPROACHES FOR THE PROCESS INDUSTRIES

HICKEY COLIN, TORRENS STÉPHANE
DNVGL, France

Consequence and risk analyses have proven themselves over many decades as critical tools for managing loss prevention in the process industries. Since the first evolution in the 1970s of classical quantitative risk assessment for land use planning, developments have seen consequence and risk analysis techniques steered towards the risk based engineering design tools they are today. Driven by learnings from accidents, advancements in science, regulatory demands and business drivers, this paper gives an overview of the latest capabilities of consequence and risk modelling techniques and showcases their broad applicability in today's demanding process industry.

The paper outlines the latest ground breaking scientific research into droplet formation during loss of containment, multi-component vapourisation from pools of flammable and toxic materials and CO2 discharge and dispersion. In parallel the safety analysis domain is supported by computer technology evolution whereby ALARP principles can be demonstrated using sensitivity analysis supported by sophisticated IT database systems. This paper outlines the state of the art of process safety modelling and points to a bright future for operational risk management.

THE USE OF COMPUTATIONAL FLUID DYNAMICS FOR HEAT TRANSFER AND IMPELLER DESIGN IN MIXING APPLICATIONS

JOSÉ ROBERTO NUNHEZ, RONALD JAIMES PRADA
UNICAMP – State University of Campinas, School of Chemical Engineering, Brazil
NICOLAS SPOGIS
ESSS, Engineering Simulation and Scientific Software, São Paulo, Brazil

It is well known that Computational Fluid Dynamics (CFD) is a powerful tool for process design and optimization. However, few are the contributions that explore real optimization models to arrive at better equipment design and/or better processes operation. In fact, to date only one contribution using both approaches for stirred tanks are presented in the literature Spogis and Nunhez (2009). It will be shown the development of an impeller for solid suspension based on a model mixing CFD (the commercial ANSYS CFX software was used for the CFD results) with an Optimization method (the commercial software modeFRONTIER was used as the multiobjective design optimization tool) (Spogis and Nunhez, 2009). The combined approach used seven design variables that were used with a view to meet two objectives: (1) to increase the impeller effectiveness, defined as the ratio of pumping number to power number (in other words, the ratio of the pumping capacity to power consumed, normalized to be dimensionless), and (2) to improve the homogeneity of the liquid-solid mixture (by increasing the cloud height). The model arrived at several possible mathematical solutions at the end of the procedure, but experience clearly showed the best virtual prototype.

The optimization process was divided into two main steps:

1 - A real optimization step, in which the objective functions and constraints were evaluated by the CFD approach.

2 - A virtual optimization step, in which well-behaved response surfaces were used to extrapolate the initial results, saving computational time.

A further improvement on the first prototype of the impeller was obtained by imposing a minimum value for the Impeller Power Number NP, since very low values for the Power Number restrict the use of an impeller for several industrial applications.

In another work a tank for heat transfer applications that require the use of helical coils is optimized using a three-dimensional CFD model (in this case no commercial optimization software was used). The use of helical coils in stirred tanks is suggested when external heat transfer surfaces are not enough to remove the heat Paul et al. (2004). The main objective to use these internals is to achieve uniform heat transfer inside the tank. In the case of heat removal, when highly exothermical reactions are involved, the internal coils can work as an extra heat transfer surface to guarantee the demand of heat removal is met. Prada and Nunhez presented a CFD model to predict the heat removal of an arrangement proposed by Oldshue and Gretton (1954) in the 2014 Mixing Conference in Lake George, USA.

They proposed a methodology to obtain a Nusselt Equation for this arrangement using CFD numerical data. The results were within a 15% maximum difference in relation to the experimental results of Oldshue and Gretton (1954). Currrent work compares the arrangement proposed by Pedrosa and Nunhez (2003) in terms of heat removal. The process side heat transfer coefficients of the helical coil arrangements will be compared and the geometry that presents the higher average heat transfer coefficient will be considered to be the best arrangement.

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DYNAMIC SIMULATION OF PHOSPHORIC ACID FILTRATION

DONAL S. TUNKS
Phosphatics LLC, USA

In the production of wet process phosphoric acid, the primary method used in the filtration step is the tilting pan filter. Although there are other technologies that are available, most of the phosphoric acid plants worldwide have utilized this type of technology. Tilting pan filters offer the advantage of being very robust, yet the application of a tilting pan filter presents a number of challenges in terms of operability. If careful attention is not paid to the operation, a sudden degradation of the filtration operation can occur which will result in reduced phosphoric acid recovery.
This degradation is due to an intermingling of filter washes.

By use of a dynamic simulation, data will be presented of how a phosphoric acid filtration operation should be performing and what could result if the filtration operation is allowed to degrade. A simulation will also be presented of how to return to normal operation once a degraded mode of operation is achieved. The ultimate aim of producing these simulations will be to determine the optimal configuration of the tilting pan filter, how to achieve optimal control of the operation, and to add greater stability to the operation.

CRYSTALLIZATION OF CALCIUM SULPHATE DURING PHOSPHORIC ACIDPRODUCTION: MODELING PARTICLE SHAPE AND SIZE DISTRIBUTION

ZHILONG ZHU, YOU PENG, T. ALAN HATTON, ALLAN S. MYERSON, RICHARD D. BRAATZ, KAMAL SAMRANE

The OCP-MIT Program in Phosphate Processing, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, USA

A key unit operation in the production of phosphoric acid is the filtration needed to separate calcium sulphate dihydrate ($CaSO_4 \cdot 2H_2O$, gypsum) crystals from an acid slurry. The filtration efficiency depends on the shape and size distribution (SSD) of the gypsum crystals produced from the upstream reactive crystallization. This presentation describes the construction of a first-principles model and computationally efficient numerical solver for the prediction of SSD during the reactive crystallization of gypsum while taking non-ideal phase equilibria and the effects of impurities (i.e., metal ions) into account.

A population balance model couples the impurity compositions in the feed streams to the SSD for given process conditions, with the independent length scales of the crystals being their length and width. Such a population balance model with two independent length scales is able to represent rod-like crystals with varying aspect ratios (length/width). The compositions of all species in solution and the supersaturation driving force for crystal nucleation and growth are described using a mixed solvent electrolyte model that accounts for long range, short range, and ionic interactions. OLI software for computing the compositions is integrated with a Matlab implementation of the population balance model that is solved using the method of characteristics, which transforms the partial differential equations of the population balance model into a system of ordinary differential equations. This numerical method does not exhibit the numerical diffusion or dispersion common in other numerical solvers while being more computationally efficient.

The crystal nucleation and growth rates are measured in a series of mixed-suspension mixed-product-removal experiments of various acid concentration, temperature, and impurity levels. A variety of models for the effects of impurities on the growth rates along the width and length dimensions are compared in terms of their ability to describe experimental observations.

PLANT OPERABILITY OPTIMIZATION THROUGH DYNAMIC SIMULATION, A CASE STUDY FOCUSED ON PHOSPHORIC ACID CONCENTRATION UNIT

SERGIO JOAO,
SNC-Lavalin, Canada
ALEXANDRE DURAND, OLIVIER SCHREVENS
Prayon S.A., Belgium

All phosphoric acid concentration units suffer from fouling requiring frequent shutdowns, cleaning and start-up cycles. These cycles are time consuming. Any improvement facilitating the operations and reducing start-up time can lead to significant increase on strong acid production.

This study shows how the operability of a phosphoric acid concentration unit can be optimized thanks to dynamic simulation.

In order to perform this optimization, a first principle model predicting how process and associated control will respond as a function of time was created based on all plant's engineering information. The model was then combined to DCS graphics and field operated devices schematics to create a dynamic simulator.

Finally, several start-up scenarios were tested in the simulator in order to estimate which procedure minimizes time to concentrate acid from 25% to 50% P2O5. Energy consumption for each scenario is also compared.

Furthermore, the simulator allowed testing and optimizing any other operational procedures, verifying equipment design, interlocks, control logic and identifying new control enhancements opportunities.

In addition, many tools available with the dynamic simulator can be used for operator training purposes leading to potential operability gains.

ETUDE ET DIAGNOSTIC DE L'AGITATION ET DE L'HYDRODYNAMIQUE D'ÉCOULEMENT AU SEIN D'UN DIGESTEUR EXPLOITÉ DANS LES PROCÉDÉS DE FABRICATION D'ACIDE PHOSPHORIQUE PAR VOIE HUMIDE

LHACHMI KHAMAR, KAMAL SAMRANE
R&D OCP Group, Morocco

L'agitation est l'une des opérations les plus universelles intégrées dans les procédés de valorisation des phosphates minéraux par voie humide. Bien qu'elle soit une opération très énergivore, elle est très essentielle pour le conditionnement et le déroulement de plusieurs processus physico-chimique. Par ailleurs, son optimisation, l'étude de fonctionnement des agitateurs et l'analyse locale du comportement des cuves agitées présentent plusieurs intérêts, notamment pour les procédés de fabrication d'acide phosphorique par voie humide. Bien que les approches et les techniques expérimentales qui permettent de réaliser ce type d'études existent, elles nécessitent un appareillage, un savoir-faire et un temps assez long pour leurs mises en œuvre. Ce sont en effet des méthodes très coûteuses et qui demandent des conditions opératoires difficiles et souvent impossibles à réaliser. En revanche, la simulation numérique par l'approche de calcul de la dynamique des fluides (CFD) constitue un moyen très efficace et moins coûteux pour réaliser ce type d'étude.

C'est dans ce contexte que ce travail vient de s'inscrire. Il a en effet comme objectifs l'étude et le diagnostic, moyennant l'approche CFD, de l'écoulement hydrodynamique au seIn de l'un des digesteurs exploité au niveau des installations de production d'acide phosphorique en vue de maîtriser le fonctionnement de l'opération de traitement du phosphate non broyé et de déterminer des leviers d'amélioration de l'agitation au sein de tels réacteurs.

PHOSPHATE-BASED MATERIALS FOR ENERGY STORAGE

DOAN PHAM MINH, ABDOUL RAZAC SANE, ANGE NZIHOU, PATRICK SHARROCK
Université de Toulouse, Mines Albi, France
NAWAL SEMLAL, RACHID BOULIF
Groupe OCP, El Jadida, Morocco
CLAUDIA TOUSSAINT, ALAIN GERMEAUC
PRAYON S.A., Engis, Bélgique

During the last decades, energy consumption rapidly increases worldwide, linked with the expansion of world population and the consumption of new emerging countries, while the classical fossil sources such as coal, natural gas, petroleum... are limited. Also, the use of fossil-origin products increases the risk of global climate change. In this context, the renewable energies such as: wind, solar, biomass etc... are of increasing interest.

Heat takes important place in the global energy consumption. The valorization of solar energy, the recovery of fatal energy from industrial sites, the improvement of energy efficiency for industrial sites appear to be strategic actions for the future. As for other energies, such as electricity, heat storage is one of the key issues and challenges to deal with. Nowadays, the development on thermal energy storage (TES) can be divided in three main groups: sensible heat storage; latent heat storage; and thermochemical heat storage. Up-to-date, TES technology that uses molten salts (alkali nitrates and alkali nitrites) is the only major application at industrial scale for exploiting concentrated solar energy. However, molten salts have several disadvantages including low thermal conductivity, low operating temperature range, and corrosive property. In addition, their use may cause problem with agricultural activity because their limited sources. Thus, the development of new materials for TES application is a promising challenge at international level.

In this work, we investigated new phosphate-based materials being potentially used for TES application. The highlight is put on phosphates because of the following arguments:

- High thermal stability.
- Possibility for composition control.
- Possibility for property control.
- Possibility for the formulation.
- Availability of the natural phosphates and industrial phosphate based products.

Preliminary characterizations and results with some selected phosphates will be presented in this paper.

ETUDE D'UN PROCÉDÉ THERMIQUE DE DESSALEMENT D'EAU DE MER PAR L'ENERGIE SOLAIRE,THERMOSOLAIRE ET EOLIENNE

D. SAIFAOUI, W. DRISSI
Laboratoire Physique appliquée et Energies Renouvelables
Université Hassan II Casablanca – Faculté des Sciences Ain Chock, Morocco

Le problème de l'eau potable se posant de façon aiguë sur notre planète, et particulièrement dans notre pays, a engendré le développement des techniques de dessalement d'eau de mer qui soient économiques, plus fiables et protectrice de l'environnement. D'ailleurs, 1.4 milliard d'habitants ne disposent pas d'eau potable alors que les océans représentent 97% de l'eau de la planète. Plusieurs procédés de dessalement de l'eau de mer ont été utilisés, le plus simple étant la distillation de l'eau de mer, les sels étant non volatils.

Dans notre cas, nous avons effectué une simulation numérique du procédé thermique de dessalement de l'eau de mer, l'alternateur étant alimenté en énergie électrique par aérogénérateur rapide tripale et de 25 mètres de hauteur. L'installation comprend un compresseur, une pompe et un échangeur de chaleur dans lequel l'eau de mer est préchauffée et un évaporateur. La vapeur d'eau produite est comprimée parle compresseur entraîné par l'alternateur et ce, après élimination des gouttelettes d'eau. La pression étant très grande, la vapeur d'eau se condense à une température supérieure à celle régnant dans l'évaporateur, ceci étant dû à la chaleur latente de condensation. D'autre part, ce procédé permet l'alimentation en eau potable tout en préservant l'environnement car l'énergie électrique nécessaire est d'origine éolienne, solaire PV et thermosolaire en plus d'une consommation plus faible.

Dans notre intervention, nous analysons les résultats de l'expérience sur le prototype de dessalement qui est basé sur l'évaporation, la condensation et la compression. Le système sera alimenté en énergies par les énergies renouvelables (photovoltaïque, éolienne et le concentrateur de Fresnel). Le rendement et le dimensionnement du système sera définis à partir des tests. Ce prototype est développé en collaboration avec une entreprise. Les tests vont être effectué sur le site OCP de Safi.

ENERGY RECOVERY AND VALORIZATION IN THE PHOSPHATE INDUSTRY BY ABSORPTION MACHINES

MARIO BERNARDINI
Head of Sales and Marketing, Heat recovery systems, CNIM Group, France

Converting low-temperature waste heat into useful energy reduces fossil fuel consumption and allows equipment to operate at maximum performance.

Can we reduce green-house gases emissions and increase energy efficiency and productivity at the same time ? How can we limit the fossil fuel requirements, be in compliance with the most severe environmental norms and be even more profitable? How the energy transition can be implemented in the Phosphate Industry?

The absorption machines engineered and manufactured by CNIM and their integration into the process can make it possible.

We will show some potential applications and case-study.

GAS TURBINE: OPTIMIZATION OF ENERGY PRODUCTION AND HIGHEFFICIENCY BY USING POWER ELECTRONICS

AZIZA BENABOUD
Royal Navy School, Sour Jdid, Casablanca, Morocco

The use of gas turbines in the electric industry has been increasing. Their demand represents more than 50% of the world market of thermal power plants. Electric power generators using gas turbines as power sources are connected to the turbines through a mechanical gearbox, in order to adapt their synchronous speed to the optimal rotation speed of the turbine, which is very often much higher than the synchronous speed. However, due to direct network connection, the generator speed cannot be variable: it is imposed by the network and constant.

To overcome this problem, we propose to replace the mechanical gearbox by a flexible electronic solution which offers a high efficiency. Using this approach, the turbine is directly connected to the synchronous generator, which is connected to the grid through an indirect static frequency converter. However, this type of converter is not common in this application because of very high switching losses due to the high frequency of the PWM technique used for its control. In this paper, a new control strategy is proposed for the three level converter, characterized by its high efficiency due to the use of square-wave modulation. The main advantage of this mode is the quasi absence of switching losses. In this mode, only the frequency can be varied between the input and the output voltage, but their magnitudes are not freely controllable. A voltage magnitude adaptation can be done by the generator's excitation. The produced active and reactive power can be controlled by the generator excitation as well as both the angle shift between the generator and rectifier voltages and between the inverter and network voltages. Simulation and experimental results for different operating points highlight the capabilities of the proposed control strategy. These include the ability to operate with unity power factor and better current quality.

ETUDE D'UN PROCÉDÉ THERMIQUE DE DESSALEMENT D'EAU DE MER PAR L'ENERGIE SOLAIRE, THERMOSOLAIRE ET EOLIENNE

M. KADDARI[1,3], M. EL MOUDEN[2,3], A. HAJJAJI[2,3]
[1] OCP, Centralethermoélectrique, MarocPhosphore Jorf Lasfar, Morocco
[2] University Chouaib Doukkali, ENSA El Jadida, Morocco
[3] Laboratoire des Sciences de l'Ingénieur pour l'Energie (LabSIPE)

Industry contributes to substantial energy consumption, it accounts for almost 1/4 of the total final energy consumption of Morocco. This consumption causes significant emissions of greenhouse gases, energy dependence and the electrical energy bills more expensive and difficult for manufacturers. Improving energy efficiency in industry therefore represent major challenges, both on environmental issues as aspects of competitiveness of our industry.

An effective way to face these challenges is to improve electric motors efficiency as one of the greatest energy consumption apparatuses in the world. In addition, 96% of the cost of using electric motors is generally related to the cost of the electricity consumed. Therefore, there is a real interest in acting.

This paper explores the field of energy efficiency in the chemical industry and presents potential energy savings by installing high-efficiency motors (HEM) instead of rewound and standard efficiency motors. The analysis of the data provided an overview of energy losses often generated by the degradation and aging electric motors. The cost–benefit analysis showed that motor substitution (from standard to high efficiency) is advantageous. In this scenario, energy savings can be achieved and the simple payback is less of three years.

In the end of this analysis, we were able to recommend a variety of solutions and improvement actions to limit over consumption.

Key words: Chemical industry, energy efficiency, electric motor.

CONSTRUCTION OF SLURRY PIPELINES

JUAN PABLO BELTRAN
Construction Manager, Techint Engineering & Construction, Buenos Aires, Argentina

The aim of this paper is to provide a description of construction activities and strategies performed by Techint Engineering and Construction for different aqueous slurry pipelines and facilities. Construction methodologies are discussed for slurry pipelines up to 36 inches in pipe diameter, more than 300 km in length and considering internal linings or just internal bare pipelines. Employed construction equipment is described for each executed project. At the end, this paper presents the current state of strategies and methodologies for slurry pipelines construction.

MODELLING AND SIMULATION OF SLURRY PHOSPHATE THICKENING

CHAIMAA BENSKOURA, SOUKAINA ETTOUIMI, ZINEB LARGATE, FAIÇAL GUENNOUN, SALAHEDDINE ALBUSTAMI
Jacobs Engineering S.A., Casablanca, Morocco

This paper proposes a simulation model established according to sedimentation process basis of high rate slurry thickener using modified Kynch flux theory and empirical formulas. A numerical simulation of the model has been developed using LABVIEW software in order to evaluate and predict the performance of sedimentation process in thickeners.

Numerical solution of partial differential equations (PDE), which describe the model, is the result of resolving a selected numerical scheme using space-time discretization analysis, where the inputs are design/operation parameters, and ore settling characteristics.

This study offers a convenient simulation system platform for both batch and continuous thickening, which can be used as a forecasting tool to identify thickener output operating conditions.

THE DESIGN AND ENGINEERING OF THE 187 KM KHOURIBGA TO JORF LASFAR PHOSPHATE SLURRY PIPELINE

JULIAN RUSCONI
Paterson & Cooke, Cape Town, South Africa
ANIS LAKHOUAJA
Jacobs, Casablanca, Morocco
MUSTAFA KOPUZ
Tekfen Construction, Istanbul, Turkey

The Jorf Lasfar phosphate slurry pipeline, commissioned in April 2014, is one of the world's largest slurry pipelines. The pipeline receives phosphate ore from the El Halassa, MEA and Daoui wash plants situated up to 22 km away. The product from these plants varies in grade and quality and is stored in separate agitated slurry tanks at the Khouribga head station. From the head station the slurry is pumped 187 km in batches separated by water to the terminal station at Jorf Lasfar. As these batches of phosphate slurry arrive at the terminal station they are diverted to dedicated storage tanks that feed separate process streams in the refinery. This means that the pipeline design needs to accommodate the pipeline transport requirements of the different batches and to be able identify where these batches are during transport so as to ensure they are allocated to the appropriate tanks.

As the batches are intermittent and have variable flow properties the pipeline design needs to accommodate a wide range of operating conditions. This is achieved by controlling the pipeline operation by varying the pumping head and through a series of pressure monitoring stations and a choke station at the terminal. Due to the scale of the project the system comprises some of the largest slurry handling equipment yet produced and this presented many unique challenges for the engineering team that required an innovative approach to solving such unique problems. This paper presents a few of the design and engineering challenges faced by the engineering team responsible for successfully delivering this project.

MAROC PHOSPHORE III-IV: PAP ADAPTATION TO PHOSPHATE SLURRY WITH PROCESS IMPROVEMENT

BENOIT VAN MASSENHOVE
Prayon Technologies, Engis, Belgium

In the frame of the MPIII-IV PAP adaptation to phosphate slurry project, technical audits, achieved during Maroc Phosphore III-IV PAP operation and shut down, were also dedicated to the screening of any malfunction zone and, as appropriate, to proposing relevant recommendations with a view of optimizing plant performances.

The major modification is the pairing of the 8 Rhône-Poulenc phosphoric acid lines into 4 Prayon Mk4 phosphoric acid lines of 1350 TP_2O_5 PD each. Modifications are currently ongoing.

Adaptation philosophy and process improvement solutions are presented.

HIGH PERFORMANCE ELASTOMER PIPE COATINGS IN PHOSPHATE, OIL SANDS, AND DREDGING SLURRY LINES: FIELD EXPERIENCE

LOUIS L. RENEVEY, MICHAEL MAGERSTAEDT
ROSEN Intelligent Plastic Solutions, ROSEN Swiss AG, Stans, Switzerland
THORSTEN RAETH, LARRY K. LAI, DAN PLOURDE
ROSEN Intelligent Plastic Solutions Canada, Calgary, Canada
HOLGER ROSENBLECK-SCHMIDT
ROSEN Intelligent Plastic Solutions, ROSEN Technology and Research Center GmbH, Lingen, Germany

Analysis of multi-year erosion and corrosion protection field experience with high performance polyurethane elastomer internal coatings of steel pipes in slurry and tailings applications will be presented.

Useful life of steel pipes in coarse tailings of oil sands operations in Canada was extended by a factor of 10 by using these coatings. Similar results were obtained from phosphate slurry transport and from sea water / sand mixtures in enhanced oil recovery and dredging applications.

Evidence was found that such liners even outlast expensive chromium carbide overlays (CCO) in situation where erosion-corrosion is likely to occur. This finding was confirmed in the long term, data will be presented here.

An excursion into field experience with exterior pipe coatings made from related high performance elastomers will be given. Not only long-term corrosion protection, but also protection from external pipe damage in thrust boring situations can be achieved with these materials. Field examples will be presented.

ON-LINE LIGHT ELEMENT ANALYZER FOR PHOSPHATE BENEFICIATION

L. KÖRESAAR
Application Specialist, Outotec (Finland) Oy, Espoo, Finland
J. TIMPERI
Commercial Product Manager, Analyzers, Outotec (Finland) Oy, Espoo, Finland
A. RANTALA
Manager, Advanced Process Control, Outotec (Finland) Oy, Espoo, Finland

Measurement of light elements such as CaO, MgO and P_2O_5 are essential for phosphate flotation control. Traditionally these measurements have been analyzed manually in on-site laboratory because there has not been a robust on-line analyzer for phosphate applications available. In this paper a commercial light element analyzer based on Laser-Induced Breakdown Spectroscopy (LIBS) is demonstrated by several feasibility studies from different sedimentary and volcanogenic phosphate ore sources.

Automatic light element analyzer enables potential for improved process control compared to traditional use of manual laboratory. The high cost per manual assay and associated manpower requirements often limit the frequency of shift composite samples and laboratory assays. Furthermore, the shift composite assays represent past performance of a plant due to long delay between sample collection and retrieval of the measurement result from the laboratory. Automatic analyzer on the other hand is able to provide immediate measurements from all essential process streams to enable efficient process control.

This paper discusses about design requirements of an industrial light element analyzer in phosphate applications. Also selection of the most suitable analysis method based on intended use of the measurement is discussed.

PRODUCTION DE GRANULATS LÉGERS À PARTIR DES REJETS DES BOUES DE LAVAGE DE PHOSPHATE DU BASSIN PHOSPHATÉ DE GAFSA (TUNISIE)

EMNA FAKHFAKH, IMEN KHIARI, WALID HAJJAJI, FAKHER JAMOUSSI
Laboratoire de valorisation des matériaux utiles, CNRSM, Soliman, Tunisia
FERNANDO ROCHA
Geobiotec & Dep. Geociencias, Universidade de Aveiro, Aveiro, Portugal
ALBERTO LÓPEZ-GALINDO
Andalusian Institute of Earth Sciences (IACT), CSIC-University of Granada, Granada, Spain

Dans cette étude, nous avons évalué les potentialités d'utilisation des boues sous-produit de lavage des phosphates comme matière première pour la production d'agrégats légers. Plusieurs échantillons des boues provenant des différentes installations de lavage dans le bassin phosphaté de Gafsa, ont été caractérisés physico-chimiquement. Les boues sont séchées, broyées et façonnées en boulettes sphériques. Ces agrégats ont été frittés pendant 5 minutes dans le four de laboratoire à différentes températures comprises entre 1120°C et 1180°C. Le potentiel d'expansion des agrégats légers ainsi que l'effet des températures de cuisson sur leurs propriétés (expansion, la densité apparente, absorption d'eau et de résistance à la compression) ont été évalués.

Les données minéralogiques montrent que les échantillons de boues recueillies sont essentiellement composés de carbonates, de francolite, de clinoptilolite, de quartz et de feldspath, la fraction argileuse est formée de smectite, de palygorskite et de sépiolite. De point de vue chimique, les échantillons présentaient des quantités importantes en SiO2, CaO et P2O5. Lorsqu'ils sont frittés, les agrégats vont gonfler; cette expansion résulte de la réaction concomitante de la libération de gaz et de la formation de la phase visqueuse. Les granulats légers ont révélé des propriétés technologiques acceptables avec des valeurs de densité apparente souvent inférieure à 0,9 g / cm3. En outre, une bonne expansion (60% en volume) et l'absorption de l'eau (près de 10%) ont été obtenus. Ces résultats sont encourageants et permettent d'envisager l'utilisation de ces boues rejets des laveries de phosphate comme matériaux prometteur pour la production de granulats légers.

Mots-clés: Agrégat léger, Phosphate, Bassin phosphaté de Gafsa, Boues, Expansion, Tunisie.

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QUANTIFICATION OF IMPURITIES, INCLUDING CARBONATES SPECIATION FOR PHOSPHATES BENEFICIATION BY FLOTATION

ERIC JORDA, MICHEL BERTUCCI
CECA, La Garenne Colombes, France
ISABELLE BIRKEN
ARKEMA, Centre de Recherche Rhône-Alpes, Pierre-Bénite, France

The purpose of this work is to contribute to the improvement of Phosphate ore characterization in order to optimize P_2O_5 recovery. This paper depicts how, by strategically combining different analytical techniques like X-ray Diffraction, X-Ray Fluorescence powder/beads, Infra Red Spectroscopy, and Thermogravimetric Analysis, it is possible to obtain a very accurate picture of the ore, leading to a better control of the beneficiation process. As this method furthermore allows the speciation of carbonates (Calcite, Dolomite, Francolite), it is also valuable fordownstream management where Calcite and Dolomite behave differently.

Most of the phosphates resources in the world are from marine origin (sedimentary deposits), and one of the main mineralogical species is Francolite, also called carbonated Apatite. Depending on the mine, gangue minerals can contain more or less Quartz, clays and carbonates (Calcite and Dolomite).

Among flotation processes, reverse flotation of the impurities appeared to be one of the most efficient technique to separate Francolite from carbonates. Adaptation of the collector to the impurities is critical for the beneficiation of the ore. Efficacy of the process is generally assessed by titrating P_2O_5, SiO_2 and CO_2 equivalences in froth and purified phosphate samples. Decrease of the CO_2 content in the phosphate mineral is generally indicating an increase in valuable species but this single parameter does not give any indication concerning the partition between Calcite and Dolomite. The completeness of the analysis method depicted in this article makes it a valuable tool to help chemists to develop always more performing collectors.

VALORIZATION OF PHOSPHATE WASTE ROCKS AND SLUDGE FROM MOROCCAN PHOSPHATE MINES: CHALLENGES AND PERSPECTIVES

RACHID HAKKOU
Laboratoire de Chimie des matériaux et de l'Environnement, FSTG, Université Cadi Ayyad, Marrakech, Morocco
MOSTAFA BENZAAZOUA, BRUNO BUSSIÈRE
Université du Québec en Abitibi Témiscamingue, IRME, Rouyn-Noranda, QC, Canada

Sedimentary phosphate mines produce large quantities of waste rock during open-pit mining. In addition, during ore phosphate beneficiation, fluorapatite is separated from associated gangue minerals by a combination of successive mineral processing steps involving crushing and screening, washing, and flotation. These operations generate large volume of tailings (called phosphate sludge), stockpiled in ponds. The reuse potential of these phosphate mine by-products have been investigated in the last 10 years.

As a first option consist in using alkaline phosphate waste (APW) rock to control the acid mine drainage (AMD) was investigated. Indeed, these alkaline mine wastes contain significant quantities of calcite (46 wt%) and dolomite (16 wt%) that help in neutralizing the acidity generated by the closed Kettara mine waste disposal areas, located near Marrakech, Morocco. The addition of 15 wt% APW to the coarse Kettara tailings produced leachates with significantly lower acidity and metal loads than the un-amended control sample.

Secondly, the efficiency of APW was assessed in the laboratory as an alternative alkaline material for passive AMD water treatment. Experiments were done in both anoxic and oxic conditions. In semi-arid climate, the oxic passive treatment has been proven to be the most suitable.

As a third option, the hydrogeological characterization of APW (original and screened phosphate limestone waste rocks and phosphate sludge) showed their suitability for being a component of store-and-release (SR) covers for industrial site reclamation. Lab tests (columns) and field tests (instrumented columns and experimental cells) showed that water infiltration can be controlled, even for extreme rainfall events (150 mm/day), by a 1 m SR cover made with APW.

Presently, further research studies on recycling and valorization of waste rock and phosphate sludges from phosphate mines as ceramics, mortars and concrete are under investigations. Preliminary promising results will be presented.

Key words: Phosphate by-products, waste rock, phosphate sludge, recycling, valorization.

FLOTATION CONTRAST OF CA-MINERALS USING A MIXTURE OF CARBOXYLIC ACIDS AND NONIONIC ADDITIFS

L.O. FILIPPOV, Z.LAFHAJ, I. V. FILIPPOVA, V.V. SEVEROV
Université de Lorraine, Laboratoire GeoRessources UMR 7359 CNRS-Cregu
ENSG, Vandœuvre-lès-Nancy, France

Calcium minerals constitute the gangue of main phosphate ores. The separation of apatite from calcite is recognized to be difficult using carboxylic acids because of their similar surface properties. This paper discuss the effect of pur and mixing anionic collectors such as oleic and linoleic acid to different ratio (2:1, 1:1, 1:2) as well as the role of nonionic collectors on the selective separation of Ca minerals.

As a contribution towards the understanding of the flotation system, many pure minerals were selected for this study: four calcite samples from Mexico and China,, fluorite from Mexico and China, and two apatite samples from Madagascar and Brazil. All flotation tests were carried out in a modified Hallimond tube, using differents concentrations of pure fatty acids (oleic acid and linoleic acid) and their blends as collectors. Adsorption of collectors on calcium minerals is dependent, among other factors, on the surface properties (charge, speciation,...) of the minerals. Thus, adsorption is usually expressed in relation to pH as the main variable. The pH of mineral suspensions as one of the most important parameters for achieving effective and selective separation during the flotation process was studied and discussed in this paper.

The results obtained with the blend of anionic collectors with the molar ratio of 1:1 show a separation between apatite and calcite at pH 5 and pH 9. Additionally, this paper discusses the enhancing of the selective separation of Ca minerals when anionic collectors (oleic acid and linoleic acid) were blended with nonionic reagents. The effect of sodium silicate as a depressant for calcite and apatite is also examined with the same collector systems. Finally, the influence of oleate/ linoléate concentration, pH and the concentration of sodium silicate on the flotation behavior are discussed in detail.

PHOSPHATE BENEFICIATION DEVELOPMENT FOR CUSTOMERS SATISFACTION IN SUSTAINABLE DEVELOPMENT WAY, OCP NORTH AXIS CASE KHOURIBGA-JORF LASFAR

ABDELKADER ALOUANI
Réponsable Hygiène Sécurités Environnement, Direction Exécutive Axe Nord, OCP S.A.

L'exploitation des phosphates dans la zone minière de l'axe Nord se fait à ciel ouvert, les modes d'extraction et de traitement utilisés ont été adaptés pour préserver la qualité des différents niveaux phosphatés, éviter le salissement des qualités extraites, séparer les rejets le plus tôt possible dans la chaine de production et utiliser les techniques les plus adaptées pour l'enrichissement des phosphates dans le cadre de développement durable.

Pour améliorer davantage la qualité des produits, OCP a mis au point des nouveaux procédés de lavage et flottation des phosphates sédimentaires à gangue carbonatée ou silico-carbonatée. Leur enrichissement connaît un grand développement et suscite un intérêt particulier, motivé d'une part par la demande croissante et d'autre part par le besoin de traiter des niveaux phosphatés non enrichissables par les procédés de traitement conventionnels.

L'utilisation de ces procédés à l'échelle industrielle et son intégration dans les installations et usines réalisés dans le cadre du programme industriel d'OCP lancé depuis 2007 a permis de rationaliser l'exploitation des gisements de phosphates et augmenter leurs durées, valoriser toutes les couches de la série phosphatée, améliorer la productivité des sols, prolonger la durée de vie des gisements en exploitation, produire des qualités marchandes de phosphate et dérivés à haute valeur ajoutée et assurer l'intégration de l'exploitation des différentes couches des gisements de phosphate dans les projets de développement stratégique d'OCP dans un cadre de développement durable.

La valorisation des phosphates, durant toute la chaine de valeur se réalise selon un processus industriel intégré depuis l'extraction de la roche jusqu'à la valorisation industrielle.

La nouvelle stratégie OCP mise en place a visé l'augmentation des capacités de production, l'optimisation des coûts et la flexibilité de l'outil de la chaine globale de valeur, dans un cadre de développement durable avec des soucis permanents à savoir:

- Une amélioration des procédés de valorisation des phosphates à KHOURIBGA et de fabrication des acides et engrais à Jorf Lasfar adaptés aux besoins des clients,
- Rationalisation de l'utilisation de l'eau selon trois leviers, visant l'optimisation de la consommation de l'eau, la mobilisation des ressources non conventionnelles et la réduction soutenue du recours aux eaux souterraines,
- Exploration de nouvelles ressources énergétiques, par la récupération maximale de la chaleur émise lors de la production de l'acide sulfurique et rationalisation de la consommation électrique des procédés,
- Réduction des rejets en CO2, et essentiellement par la mise en service d'un pipeline pour le transport du phosphate.

Une coordination permanente entre les sites le long de la chaine globale de valeur et une gestion efficace des interfaces pour la satisfaction continue des clients.

Le contrôle qualité des produits est assuré par la surveillance et la mesure des éléments de pilotage le long des circuits de production. Les processus de manutention, d'enrichissement et de fabrication des qualités marchandes et dérivés sont certifiées ISO 9001 et ISO 14001

Par ailleurs, les Entités de l'Axe Nord ont défini, élaboré et maitrisé tous les processus nécessaires pour assurer la satisfaction de ses clients et pour assurer une compréhension adéquate de leurs besoins, tout en respectant les exigences d'un développement durable.

NATURAL ROCK PHOSPHATE: A SUSTAINABLE SOLUTION FOR PHOSPHOROUS REMOVAL FROM WASTEWATER

STÉPHANE TROESCH
Epur Nature, Caumont-sur-Durance, France
PASCAL MOLLE
IRSTEA, Freshwater systems, Ecology and Pollutions Research unit, Vileurbanne, France
DIRK ESSER
SINT, La Chapelle du Mont du Chat, France

In application of the European Water Framework directive aiming to achieve a "good ecological status" for all waters, phosphorous removal from domestic wastewater is of importance before discharging into natural receiving bodies, especially for small communities localized upstream of catchment areas or in zones sensitive to eutrophication.

As rural communities in France often choose to treat their wastewater with extensive treatment systems such as constructed wetlands, because these natural processes are easy to operate, equivalent P-removal technologies have been asked for. Adsorption or precipitation mechanisms on specific reactive materials have therefore been researched. In this context, recent studies undertaken by Irstea (French public research center institute, formerly Cemagref) in collaboration with SINT and Epur Nature have shown the interest of natural rock phosphate (apatite) as an efficient and sustainable solution material for phosphorous removal from wastewater.

Epur Nature (Syntea group) has recently developed and patented a specific filter configuration filled with apatite pellets for high phosphorous removal efficiencies (P outflow concentrations ←2 mg P/L). The mechanisms and key factors for an optimal treatment (apatite quality, particle size, kinetics) are explained and synthetized in the paper. The results from lab scale columns and first results from full scale wastewater treatment plants in operation since several years are also presented.

Finally the possible reuse of the apatite enriched with P from wastewater after 10 to 20 years of operation will be discussed.

Key words: Constructed wetland, Phosphorus removal, apatite.

ETAT DE L'ART DES PROCÉDÉS ET TECHNOLOGIES D'ÉPAISSISSEMENT DES BOUES

HAFID ZOUHAIR
Assistant chercheur, Centre de recherche OCP, Khouribga, Morocco
JOUTI MY BRAHIM
Maitre de recherche, Centre de recherche OCP, Khouribga, Morocco
ETAHIRI ABDERAHMAN
Maitre de recherche, Centre de recherche OCP, Khouribga, Morocco

Bien que la séparation solide liquide fût utilisée de tout temps pour la clarification des eaux de consommation, ce n'est qu'au début du XX^{e} siècle que la concentration des minerais dans des laveries de grande capacité a rendu nécessaire la séparation de grands débits de solides et de liquides en opération continue. En 1906, Dorr a mis en œuvre, dans une mine d'or du Dakota du Sud, un décanteur liquide-solide continu.

Ce décanteur consistait en une grande cuve circulaire, dont le fond en pente était muni d'un mécanisme de raclage animé d'un mouvement rotatif lent, qui entraînait, vers la pointe centrale inférieure de l'appareil, les solides sédimentés. Ceux-ci étaient évacués par un orifice de décharge, sans créer de turbulence, de sorte qu'un liquide clair débordait à la périphérie de la cuve. Le procédé s'étendit à pratiquement toutes les usines de traitement de minerais et à un grand nombre d'industries tout au long du XX^{e} siècle.

Dans les années 70 est apparu, en série sur le marché, un nouvel appareil: il s'agit du décanteur lamellaire, qui comporte des cloisons inclinées, destiné à la clarification des suspensions diluées.

Toutefois, le principe est connu depuis fort longtemps puisque le premier brevet a été déposé aux États-Unis en 1886. Et vu l'impact considérable de l'épaississement sur les performances de toutes les opérations antérieures et sur l'aspect économique d'un procédé de traitement des boues en sa globalité, Des efforts considérables de recherche et développement ont été déployés pour perfectionner les procédés et technologies existantes ainsi que le développement de nouvelles technologies et procédés d'épaississement de boues.

Ces procédés et technologies d'épaississement peuvent être classés en deux grandes familles; les technologies et procédés d'épaississement des boues issues des stations d'épuration et les technologies et procédés d'épaississement des boues d'activités d'enrichissement minière. Le classement en question résulte de la différence des deux catégories des boues de point de vue physique (densité,...) et quantité de boues générées par les deux activités.

L'opération d'épaississement prend de plus en plus d'importance et d'ampleur dans la chaine de production de l'OCP; surtout avec le démarrage du pipeline (besoin de technologies et procédés compétitifs d'épaississement) et les défis posés par la problématique des boues de phosphate. Cette importance s'est traduite par le développement en interne à l'OCP de la technologie du convoyeur séparateur pour l'épaississement du phosphate pulpe profil pipeline et se traduit aujourd'hui par les efforts de la R&D OCP; en effet un important programme de recherche a été lancé pour mettre au point de nouveaux procédés d'épaississement des phosphates et des boues, ainsi que le développement de nouvelles formulations de floculant plus performants.

DEVELOPMENTS IN FLOTATION COLLECTORS FOR PHOSPHATE BENEFICIATION

JOSEFIN LANNEFORS, KERIM SASIOGLU, HENRIK NORDBERG
Akzo Nobel Surface Chemistry AB, Sweden

As ores have become more complex and fine-grained the need for specialized flotation solutions has increased. As each ore, available water quality andflotation process setup is unique, solutions need to be tailor-made for each flotation process in order to achieve optimal performance. On top of recovery and grade, froth issues and sustainability of the product are critical parameters that are increasing in importance.

This paper describes several cases where new flotation collectors have been developedto improve not only performance but also froth characteristics and sustainability of the product.

DRY PRE-CONCENTRATION OF PHOSPHATE ORE

JENS-MICHAEL BERGMANN, DR. CHRISTOPHER ROBBEN
TOMRA Sorting GmbH, Wedel, Germany

Selective mining of phosphate ores often is only possible to a certain degree. The ores have to be mined together with various contaminants, as in-seam and out-of-seam dilution (silica, carbonates). Also the mines very often are located in dry regions or even deserts, where water becomes a very precious commodity.

TOMRA Sorting GmbH, the most experienced provider of cutting edge sensor sorting solutions, developed a series of high-capacity sorters which can remove a very high percentage of these contaminants already before crushing or grinding; at coarse particle size and without adding water. Sorting can reduce the overall processing costs of the ore considerably. And this cost-saving potential is not limited to comminution. It's also there for transport, water and energy consumption, calcination or flotation. New installations can be designed much smaller and cost efficient with the same productivity.

Tomra sorters could be applied either directly at the mine site to reduce transport costs or in the crushing circuit, thus either as semi-mobile or stationary installations. The paper gives an introduction into the applicable technologies to remove chert and/or carbonates from phosphate ore, present results, experience, and installation possibilities. Finally indicative figures for feed capacity and operational expenditures are presented.

FLOTATION C-PLANT; AN OPTIMUM MODULAR APPROACH

PEKKA TÄHKIÖ, LUIS RUDOLPHY
Outotec (Finland) Oy, Espoo, Finland

Flotation plant design, construction and start-up can be challenging tasks, as multiple factors and disciplines have to be combined in an efficient manner, in order to execute a project that meets the technical, financial and timeframe expectations.

Key considerations that need to be addressed when designing a flotation plant are process requirements, equipment integrability, automation, upstream and downstream processes/ designs. Furthermore, several other lifecycle factors need to be considered, such as servicing & maintainability, operational costs, future expansions and decommissioning among others.

In order to address the above mentioned challenges, Outotec has developed a new approach for designing flotation plants that target to eliminate most of the inherent risks that can be found in these types of projects.

The new Outotec Flotation C-Plant is a fully modular approach in which the above mentioned challenges have been taken into consideration in the design phase. As a result the C-Plant concept can give several benefits for new and experienced companies involved in minerals processing business, such as lower risk investments, fast and cost efficient flotation plant delivery, faster ramp-up period, easy plant expansions, fully automated processes and operation & maintenance ease.

As well, dismantling and transportation of the c-plant to a new location is easy and fast, hence the new C-Plant Concept makes possible to exploit small, short lifespan ore deposits and also retreat old tailings ponds that might contain valuable minerals and where the ore quantities are limited.

VALORISATION DES PHOSPHATES DE REJETS GROS DE REDAYEF PAR L'OPTIMISATION DES TECHNIQUES DE BROYAGE ET DE FLOTTATION

WISSEM GALLALA, FATMA HERCHI, ILHEM BEN ALI,
Département des Sciences de la Terre, Faculté des Sciences de Gabès, Tunisia
LEILA ABBASSI
Campagnie des Phosphates Gafsa, Tunisia

Les phosphates exploités au niveau Jebel Alima (région de Redayef) font partie des gisements du bassin minier de Gafsa. Le traitement de ce minerai passe par plusieurs étapes pour devenir un concentré: fragmentation, débourbage, classification, attrition, déschlammage, flottation. Le rejet grossier qui découle de la première étape de traitement du minerai est néfaste pour la nature et la santé puisqu'il contient généralement des métaux lourds comme le Cd et occupe une grande surface près de l'usine de traitement. Les résultats de la caractérisation chimique montrent aussi que l'échantillon brut de départ titre 13,52% en P_2O_5, après 170 essais de débourbage de 1,4kg de rejet pour chaque, la fraction libérée a montré une teneur de 24,33% en P_2O_5.

Après le tamisage, la fraction inférieure à 315 µm est récupérée pour la flottation, alors que la fraction supérieure à 315 µm passe au broyage. 11 essais de broyage ont été réalisés en tenant compte de variations de paramètres (vitesse de rotation, temps de broyage, concentration solide et la charge) le résultat de l'optimal de broyage (charge: 7/1; vitesse: 60t/min; temps: 5,5min; Cs: 45%), la teneur de fraction libérée est de 20,24%. Avant d'appliquer la flottation inverse, on mélange le produit de sortie débourbage (fraction $\leftarrow$315 µm) et de sortie broyage de la fraction $\rightarrow$315 µm et le produit d'alimentation aura une teneur de 22,44% de P_2O_5. L'enrichissement de rejet par une flottation inverse en milieu acide, et en utilisant les amines et les esters avec les consommations suivantes:

- dosage 150ml ester 150ml amine
- dosage 100ml ester, 150ml amine
- dosage 100ml ester, 150ml amine, 10ml acide, 270ml ester
- dosage 10ml acide, 150ml ester.

La teneur atteint 28,16% de P_2O_5 et le taux de carbonatation 1,6. Cette teneur est très proche de celle de phosphate marchand qui ne dépasse pas le 29%. D'où l'importance de ces déchets qui doivent être considérés comme réserves potentiels pour l'avenir.

Mots-clés: Rejet de phosphate, Débourbage, Broyage, Flottation inverse

AMMONIA PRODUCTION FOR USE IN PHOSPHATE FERTILIZERS

NIKOLAJ KNUDSEN
Haldor Topsoe A/S, Denmark

Production of phosphate fertilizers is an obvious opportunity to expand the value chain for any exporter of phosphate rock or phosphoric acid. Ammonia is a key commodity in the production of phosphate fertilizers and a major contributor to its cost of production. The cost of ammonia is in turn largely determined by the price of natural gas, which is highly geographically dependent.

This paper will describe how to produce ammonia in the most effective way – whether the plant is located near the phosphate source or disconnected at a location where natural gas is available at a lower price. Various options in the process configuration are available to dramatically increase the valuable output from stand-alone ammonia plants through utilization of by-products and optimum integration of utilities in ammonia production complexes greatly improve the cost of production. These, along with measures to minimize environmental impacts from ammonia production facilities are among the topics discussed.

QUALITY OF INPUT MATERIALS IN MANUFACTURE OF CUSTOMIZED FERTILIZERS

G M PATEL
Technical Director CIFC (India)P Ltd, Rahimtula Group of companies, New Delhi, India

Customized fertilizer is more than simply a fertilizer – it is a concept around the plant nutrient. Such fertilizers are backed by sound scientific plant nutrient principles and research. Customized fertilizer blends provide the best nutritional package for premium quality plant growth.

- Optimum supply of all essential nutrients
- Efficient use of fertilizer
- Promote synergistic interactions and keep antagonistic interactions out of the crop production system
- Enhance crop yield, crop quality and farm profits
- Correct inherent soil nutrient deficiencies
- Maintain or improve lasting soil fertility
- Avoid damage to the environment
- Restore fertility and productivity of the land

The quality of fertilizer product is basically judged by two criteria: (1) chemical properties, and (2) physical properties.

The good chemical properties of a fertilizer are ultimately reflected in their agronomic response. In the contrast, the physical form of a fertilizer product and its ability to resist deterioration are important with respect to processing, handling, storage, field application and agronomic response.

The most frequently encountered problems resulting from deficiencies in physical properties are caking (agglomeration or lump formation), dustiness, poor flowability, excessive hygroscopicity (moisture absorption characteristics), and segregation (nonuniformity of composition throughout a fertilizer lot).

APPLICATION OF THE FLSMIDTH DEEP CONE TECHNOLOGY TO THE FERTILIZER PLANTS IN OCP

JEAN CLAUDE SERBON
General Manager, FLSmidth SAS, Torcy, France
LIAM MAC-NAMARA
Vice President EMEAI Sales, FLSmidth Ltd, Warwickshire,, United Kingdom
FRED SCHOENBRUNN
Director Sedimentation Technology, FLSmidth Inc, USA

FLSmidth pioneered Deep Cone Thickening technology in the global Minerals Industry, after early development by the UK Coal Board and adaptation by Alcan in the Alumina flowsheet. As one of the world's leading Mineral Processing equipment suppliers, with particular strengths in solid-liquid separation, FLSmidth were able to adapt the technology to a wide range of uses. FLS pioneered the use of Deep Cone Thickening for applications such as; Mine Backfill, Sub-aqueous Tailings Disposal, Cement Kiln Feed, Autoclave Feed, and In-Pit Tailings Disposal, as well as using the technology to gain global acceptance of the innovative "Thickened Tailings Discharge" (TTD), a "best practice" technology for the mining industry.

The paper will briefly cover the core principals of flocculation and thickening of mineral slurries, before detailing the unique aspects of the Eimco Deep Cone Thickener and the current and potential applications of the technology. Particular focus will be given to the recent installation at OCP's JFC V in Jorf Lasfar where one Deep Cone Thickener is used to thicken the feed to the acid attack tanks, reducing water and acid consumption.

IMPORTANCE OF GREEN TECHNOLOGY IN FERTILIZER QUALITY IMPROVEMENT

AVDHESH MATHUR, FERNANDA DIAS, PRAKASH MATHUR
NAQ Global Companies, Brazil & Morocco

The topic can be divided in 3 main points:
A) Fertilizer Quality Improvement
B) Conventional Technologies
C) Green Technology.

With the increased use of fertilizer, it is also required that a right quality of fertilizer is provided to the end user at affordable cost. Fertilizer Industry face problems of caking, dust generation, foaming, non homogenous distribution of micronutrients etc. Due to these problems, there are direct and indirect losses in terms of recycling, re-processing, rejections and penalties. Apart from these, such quality problems carry inferior brand image for fertilizer.
To overcome such problems, some additional products are used which are termed as Fertilizer Quality Improvement Products. These FQI products help fertilizer manufacturer to deliver right quality fertilizer to the end users.

There have been some conventional products which were/are in use. These products are more harmful than providing advantages to fertilizer and fertilizer users. Products like Fuel oil, Mineral Oil, Paraffin Wax are being used with fertilizer for it to remain free flowing and dust free. These coatings are not efficient, and also affect the soil in negative sense. The very purpose and cost of FQI, which was supposed to save the overall costs is lost.

To overcome such negative effects and provide right products, GREEN TECHNOLOGY was introduced in this field. Latest generation Green products are:
A. More effective, thus saves cost,
B. From vegetable origin, hence better adaptability with soil
C. Can be used in varied applications in fertilizer manufacturing processes
D. Easy in Handling & non hazardous
E. Last but not the least, Soil Friendly.

This paper will also illustrate some technical studies in lab & plant scale where the comparison of Conventional products and latest generation Green Technology products has been done.
It is proven that such green technology coatings reduce post production dust more than 80% as compared to about 45% by mineral oil based products. Such positive results have lead to convert more than 90% fertilizer manufacturer and blenders in South America to use vegetable origin coatings from conventional mineral oil & fuel oil based products.

Conclusion: Quality of fertilizer today is very important issue for the Manufacturer as well as end user. Quality loss may lead to financial losses during the production itself, loss of reputation and loss of required nutrition at the time of usage. Latest generation Green Technology FQI products take care of these fertilizer quality issues efficiently and economically. Proper application of such Fertilizer Quality Improvement products not only improve the quality of fertilizer and saves money, but also add value to the fertilizer product.

MANAGEM PRODUCTS POTENTIALLY USED IN FERTILIZERS INDUSTRY

H. AZZOUZI, K. OUZAOUIT, A. ABOULAICH, Y. DALI, A. KADDAMI, I. AKALAY
REMINEX centre de recherche, Marrakech, Morocco

In addition to the macronutrients (nitrogen, phosphate and potassium), micronutrients such as zinc, copper, cobalt and secondary elements for instance magnesium represent a major factors of crop growth and development. Beet, lettuce, onion, spinach, sunflower and tomato have relatively high copper requirements.

Zinc plays a significant role in the auxins metabolism witch is well known as plant growth substances. Copper is necessary for photosynthesis process, as demonstrated by several authors. Concerning cobalt, this element has positive effect on the production of secondary metabolites.

These elements can be produced under several chemical forms. Managem group (Morocco), in its mining activities, produce (Zn^{2+}, Cu^{2+}, Co^{2+}, Mg^{2+}) for fertilizers industry.

Nanosized zinc oxide (50-200 nm, ZnO (%) ↗ 95 %) with higher specific surface area. Its reactivity affect considerably zinc solubility, diffusion in soil and hence Zn availability to plants.

Magnesium, Copper and Cobalt in form of sulfates could be synthesized with high purity at the solid and liquid forms. The chemical and physical characteristics of Managem products give them a good competitiveness in the fertilizer market.

WATER-BASED EMULSION ANTI-CAKING TECHNOLOGY FOR PHOSPHATE CONTAINING FERTILIZERS

C. BARSACQ-METHIVIER, J.A GONZÁLEZ-LEÓN
Centre de Recherche Rhône-Alpes ARKEMA (CRRA), Pierre-Bénite, France
I. BIRKEN
CECA, La Garenne-Colombes, France

A major concern for many granular fertilizer producers is the storage and transport of their products. Most fertilizers granules tend to cake overtime under pressure and because of moisture variations. This is commonly solved by applying a small quantity of a suitable anti-caking coating to the granules before storage. These coatings are usually made out of mineral oil-based formulations that may additional contain other active components. These coatings have proved over many years to be very effective in avoiding caking of fertilizers.

In this work, a new kind of anti-caking coating is described. In this novel technology, the active ingredients, with a minimal amount of mineral oil, are emulsified in water. The emulsion can be applied like a standard anti-caking coating, at similar quantities. In addition, as the main component is water, it may be applied at lower temperatures than classic mineral oil-based coating. This technology is as effective to reduce caking in ammonium nitrate fertilizers as standard oil-based coatings. Its use in other more complex fertilizers, such as diammonium phosphate, is shown. The environmental advantages of this technology compared to classical coatings are also discussed.

BIODEGRADABLE POLYURETHANE MATERIALS FROM LIGNIN AND VEGETABLE POLYOL AS COATING MATERIAL FOR THE CONTROLLED-RELEASE FERTILIZER (CRF)

YOUNES ESSAMLALI, MOHAMED ZAHOUILY
MAScIR Foundation, INANOTECH, Rabat, Morocco
Laboratoire de Catalyse, Chimiométrie et Environnement, URAC 24, Faculté des Sciences et Techniques, Université Hassan II, Mohammedia, Morocco

Fertilizers are one of the most important products of the agrochemical industry. They are added to the soil to release nutrients necessary for plant growth. However, the use of huge quantity of conventional fertilizers in agriculture leads to some important environmental problems. One of these problems is the overconsumption of nutrients. About half of the applied fertilizers is lost to the environment, which results in the contamination of ground water by nitrates and other elements in addition to others sources of pollution (pesticides...).

One of methods to overcome this problem and reduce nutrient losses involves the use of controlled-release fertilizers (CRF) obtained via encapsulation of fertilizers by coating materials. Among these, polymer such as polyurethane (PU) and its derivatives appear very appealing due to their multicell structures and biodegradability.

In this study polyurethane prepared from a tree-component system consisting of diisocyanate, vegetable polyol and lignin biopolymer was pulverized on mono ammonium phosphate (MAP) fertilizer. The swelling rate and water retention properties of CRF were investigated. Moreover, the slow release behavior of N and P in the product was also controlled by carefully controlling the coating thickness.

The results showed that the product had high initial swelling rate, and not only had a good slow release property but also excellent water retention ability, which could effectively increase efficiency of the fertilizer.

ENVIRONMENTAL PROTECTION: AN IMPERATIVE OF SUSTAINABLE DEVELOPMENT IN PHOSPHATE INDUSTRY

ABDELHAK KABBABI
Environment Manager, Sustainability Department
OCP S.A., Casablanca, Morocco

The valuation cycle of phosphate rock called the industry to deal with several aspects of sustainable development and the environment. As regards the environment, such considerations come through the management of mining by-products, rationalization of water resources, the mastery of emissions and discharges, and extend to the interests of other stakeholders directly linked or indirectly with the manufacturer. Today, the sustainability of activities in the mining industry in general, and especially phosphate industry, must pass through an integrated approach to these issues in industrial and development strategies.

Based on the sustainable development vision at the OCP, our communication will deal with the variation of this vision in the development programs of our business, both environmental and social. On the environmental field, we present the innovations that allow our group to improve, in an innovative way, its environmental footprint with waste to produce energy, mastery of atmospheric and the establishment of innovative tools emissions monitoring and performance measurements, management of water resources and the reduction of greenhouse gas emissions. The valorization of phosphogypsum will be addressed through the main results of scientific experiments conducted in a road construction pilot project and the opportunities offered by the first results.

On the social section, we will present our program to stakeholders. The special case of programs for youth in mining areas, environmental education, associations or the farmer will be shared to consolidate this holistic approach to sustainable development adopted by OCP Group for a better valuation of the rock and in harmony with the preservation the environment and the development of its ecosystem and stakeholders.

Key words: Environment, water, phosphogypsum, waste, CSR.

RECYCLING OF CARBON DIOXIDE

CHAKIB BOUALLOU
MINES ParisTech, PSL Research University, CES – Centre for energy efficiency of systems, Paris, France

Direct or indirect CO_2 emissions are generated in the phosphate industry; they come from phosphate treatment, electricity and steam / heat used. In addition to reducing emissions by developing innovative processes, the use of captured CO_2 can become a profitable business. For the CO_2 chemical transformation pathways, the carbon dioxide reacts with other highly reactive components, in order to complete the synthesis of basic chemicals or products with high energetic value. Among these pathways: The hydrogenation of CO_2 which produces methane, methanol, or synthetic fuels. There are already pilot plants for the hydrogenation of CO_2, and is expected to become industrialized in few years. The recycling of CO_2 has the advantage of recycling large volumes of CO_2 with an average duration of CO_2 sequestration.

Many technological challenges, and very few of feedback are the main challenges of this pathway. It should be noted that these pathways differ with respect to their degree of maturity, their potential for emergence, duration of CO_2 sequestration, energy consumption, volume of CO_2 recovery and energy efficiency. An innovative process for producing fuel grade methanol from captured CO_2 is proposed in this work. The process is designed and simulated with Aspen Plus. The CO_2 is captured by chemical absorption. The hydrogen is produced by water electrolysis using carbon-free electricity. The methanol plant provides 36% of the thermal energy required for CO_2 capture, reducing considerably the costs of the capture. The CO_2 balance of the process showed that it is possible to abate 1.6 ton of CO_2 per ton of methanol produced if oxygen by-product is sold.

CALCIUM PHOSPHATES FOR ODOUR TREATMENT

NATHALIE LYCZKO[1], ANGE NZIHOU[1], PATRICK SHARROCK
Université de Toulouse, Mines Albi, CNRS, Centre RAPSODEE, Campus Jarlard, Albi, France.
Université de Toulouse, SIMAD, IUT de Castres, Castres, France

Sodium bicarbonate ($NaHCO_3$) is a product used in a wide range of applications such as food, cosmetic, pharmacy and industry. Sodium bicarbonate can also be used in flue gas epuration, incineration, organic farming and animal nutrition. The most important characteristics of sodium bicarbonate are that this component and its by products are not toxic for environment and health.

Sodium bicarbonate is namely produced using the Solvay process based on an ammonia loop. A CO_2 stream passes through an aqueous solution basic of sodium chloride. The base used in this process is ammonia. So, the crude produced solid, $NaHCO_3$, has a non-negligible content in ammonia that can generate an odour.

The objective of this study is to remove the odour while of ammonia keeping the characteristics of sodium bicarbonate and allowing its uses. For this purpose the sodium bicarbonate was mechanically mixed with a calcium phosphate gel. This gel was preliminary synthetized using calcium carbonate ($CaCO_3$) and phosphoric acid ($H3PO4$) at ambient temperature. The gel obtained is composed of brushite ($CaHPO_{4.2}H_2O$) and monetite ($CaHPO_4$). The mechanical mixing of the gel and sodium bicarbonate was carried out for different operating conditions such as the calcium phosphate gel and sodium bicarbonate ratio. The final product was characterized in terms of granulometry, flow behavior, crystalline phase to compare with raw sodium bicarbonate.

The results showed that the use of calcium phosphates allows to remove the ammonia odour while keeping a largely predominantly sodium bicarbonate product. When changing the calcium phosphates gel/ sodium bicarbonate ratio the formation of a new crystalline phase, an ammonium phosphate ($NH_4H_2PO_4$) was observed. So, the treatment with calcium phosphates has generated new phosphate products efficient for instance in heavy metals epuration frrom gas and liquid effluent. This represents an original and promising valorization of the calcium phosphates.

AN INTEGRATED TOOL TO SURVEY AND FORECAST IMPACT OF AN INDUSTRIAL PLANT ON ITS ATMOSPHERIC ENVIRONNEMENT

FABIEN BROCHETON, JAMAL YAHIA
NUMTECH, Aubière, France

For several years, environmental modeling has become a tool systematically used for regulatory purposes, prospective policies on air quality (including odors) and for impact assessment on air pollution in large emission situations too. For many industrial sites, the annual average impact is significantly lower than regulation limit. Nevertheless, in some critical meteorological conditions, pollution peaks may occur.

In this framework, NUMTECH has developed an operational modeling solution (Plum'Air ©) in order to help an industrial site to follow everyday its atmospheric impact and to anticipate situations of pollution peaks.

The principle of operation of this solution will be presented. A focus will be done on a practical case of implementation on TOTAL's refineries knowing that such tool is fully integrated in the decision scheme to manage the operation of the units. The objective achieved is a strong reduction of the SO2 peaks around refineries from the start of the project from now 10 years.

Similar system is currently deployed on two OCP's sites. The presentation will give a short overview of the main achievements obtained so far.

DETERMINATION OF KINETICAL DATA FOR THE REACTION OF SO2 WITH CAO USING A THERMOBALANCE

KHOUDIR M. ALLAL, ZOBER YAHIA CHERIF
SERVITHEN, Neauphle le Chateau -France

The content of volatile acid components in flue gases such as SO_2, SO_3, HCl, HF and H_2S can be reduced by reaction with dry alkaline sorbents like calcium oxide CaO, calcium hydroxide $Ca(OH)_2$ or calcium carbonate $CaCO_3$, prior to and during their filtration in a bag filter. Hence, the determination of the kinetical data necessary for the design of such equipment is carried out using a mathematical model in conjunction with results obtained from differential measurements of the conversion of CaO versus time for the system CaO/SO_2 by means of a thermobalance. The effects of the temperature of the reaction, the temperature of calcination, and the SO_2 concentration have been studied. A comparison between the experimental data and the theoretical results is done, showing a good agreement when one assumes that the effective diffusion coefficient is function of the CaO conversion.

TRENDS IN MINIMIZING AND TREATING INDUSTRIAL WASTES FOR SUSTAINABLE ENVIRONMENT

DR. MUTHANNA AL-DAHHAN
Professor and Chair Chairman, Department of Chemical and Biochemical Engineering
Missouri University of science and Technology, USA

One of the pillars of sustainable development is to sustain cleaner environment while producing the needed energy for the growth and development. Petroleum and natural gas will continue to be vital sources of energy and fuels. However, their industrial processes produce various types of pollutants in flue gases, waste water and solid wastes. Furthermore, chemical and mineral processing industries need large amount of water in upstream as well as in downstream. To maintain cleaner environment there have been various trends taken and advances made to treat the various wastes produced by industry and to treat the used water / wastewater for reuse. Two major trends have been implemented recently to minimize/eliminate and to treat the produced wastes. These are: i) minimizing or eliminating the pollutants at the source by developing new technologies and/or advancing the multiphase reactors and catalyst development employed, and ii) developing new processes or technologies to treat effectively the effluents from industrial processes which consists of 1) physical processes such as the development of advanced membrane technology, 2) chemical processes such as advancing processes related to catalytic wet oxidation and advanced oxidation by new/improving catalyst development and reactor engineering, 3) biological processes of both aerobic and anaerobic bioprocesses including microalgae culturing and 4) most recently the portable radiation technologies to treat both the flue gases, waste water and slugs.

In this keynote lecture these two trends will be reviewed and discussed with selected examples related to chemical and mineral processing industry that demonstrate I) the advances made and the approaches taken in the fundamental understanding of the multiphase reactors and catalyst development that enable minimizing or eliminating the pollutants at the source, and II) the recent advances in treating the generated wastes (flue gases, wastewater and slugs) using the physical, chemical, biological and radiation processes.

CASE STUDY: ACID MINE DRAINAGE IN CHILE

HERVÉ GORISSE
Expert Process Industrie, Degremont Industry International, France

Improving water efficiency in mining is a critical objective of the industry to keep sustainable operation and competitiveness while reducing water footprint. Water management in mines has its specific challenges, related to the nature of the water, the source of pollutant and the location, usually remote with limited resources and waterways.

The aim of this presentation is to focus on one case study, illustrating the processes and technologies used on a Chilean mine to manage Acid Mine Drainage, reduce the environmental impact and increase water recycling possibilities.

GAS SCRUBBER EFFICACY VIA UNIFORM DISTRIBUTION INJECTOR SPRAYS

K. J. BROWN, R. J. SCHICK
Spray Analysis and Research Services
Spraying System Company, Wheaton, USA

The reduction of environmental contaminants is a worldwide objective that has seen an increased focus in recent years. Historically, fluoride pollution has been a significant issue in the phosphate industry. This is due in large part to the fact that raw phosphate ore contains a relatively large concentration of fluoride. Fluoride varies based on the location of extraction, but often is 2-4% of the ore. In order to be used as a fertilizer, the ore must be processed into a water soluble phosphate with the addition of sulfuric acid. During this process, the fluoride content of the ore is vaporized into the process gas stream, forming highly toxic gaseous compounds. In the past these pollutants were emitted into the atmosphere resulting in damage to vegetation, destroyed crops, and crippled livestock.

Today these pollutants must be captured by scrubbing the gases prior to release. Wet scrubbers are employed to efficiently scrub the toxic compounds through the addition of water. The requirements for gas scrubbing and cooling applications are ever increasing, with energy reduction and cost reduction an ever-present concern. The fume gas scrubber is recognized as one of the most effective contaminant removal techniques offering low operating costs, but large capital cost for implementation; thus, accurate designs must be developed before deployment. Computational models provide an effective optimization method to reduce these capital costs and allow for a-priori assessment and optimization of the scrubber. Therefore, the efficient distribution of fluids or slurries in gas scrubbers offers an area for improvement through precision spray injectors and nozzles, as well as full-scale spray process modeling efforts.

This paper presents the results of a detailed spray injection study involving precision-engineered Uniform Distribution (UD) nozzles, which more evenly deliver scrubbing fluid. Experimental studies of the injectors are performed to characterize drop size and velocity distributions, as well as spray pattern coverage and shape. An accompanying spray modeling study demonstrates the improved effectiveness of the spray solution in the scrubber environment using the UD nozzles, and allows evaluation of the improved scrubbing at full-scale capacities.

RECENT EXPERIENCE WITH METALLIC HEATERS FOR PHOSPHORIC ACID EVAPORATION

BERNARDO SIZA VIEIRA
SANDVIK MATERIALS TECHNOLOGY, Oporto, Portugal
VINCENT PERROT
ACM, Lyon, France

The material used for phosphoric acid heaters is in many cases graphite, despite the many advantages of choosing a metallic material. The main reasons for selecting graphite is the materials good corrosion resistance and the tradition of using graphite. The corrosiveness of phosphoric acid during the wet-process concentration is complex and is dependent on several factors such as the presence of chlorine, fluorine, and diluted sulphuric acid. For this process there are metallic materials such as Sandvik SANICRO 28 that can be used with similar or even better results as graphite.

This paper refers to the advantage of using metallic heaters in phosphoric acid production. It also explains the important aspects of process design to fully take advantage of the benefits with a metallic material. It also includes a reference to a recent experience with process design, fabrication, and performance in Tunis of a metallic heat exchanger in Sandvik SANICRO 28 phosphoric acid heater.

INSTALLATION OF RUBBER LININGS IN PHOSPHORIC ACID VESSELS

DAVID P. JENTZSCH JR., MICHAEL PARSONS
Blair Rubber Company, Ohio, USA

Rubber linings have been used successfully in equipment for the manufacture, storage and transportation of corrosive chemicals, including phosphoric acid, for many years. It is the most cost effective material for preventing corrosion when the correct material is selected and the application is done properly. Due to current global market pressure, manufacturers have to maximize the use of their plant and equipment to remain competitive in the world economy. It is necessary to have a good understanding of the various service conditions, rubber linings suitable for these conditions, and proper procedure for application and curing to obtain a long trouble-free service life. The following steps for obtaining the best possible rubber lining are discussed in this presentation:

1- Assessment of service conditions

2- Material selection

3- Chemistry and physics of rubber

4- Lining application

5- Inspection, pre- and post-vulcanization

6- Vulcanization

7- Maintenance

8- Storage of rubber Lined Equipment.

BASIS FOR CALCULATION AND DESIGN OF FRP PIPING AND VESSELS

A.ADRIANO UREÑA
Ollearis S.A.,Spain

FRP and metallic materials have very different mechanical properties and behavior, so designing piping and vessels made of FRP or metallic materials will also require very different procedures. Calculation procedures and design codes for composites are not very well known among engineers, so preparing a calculation note of FRP elements, and verifying that the final design is correct becomes usually a major problem for the final users of this kind of material.

The aim of this paper is presenting a general overview of FRP design for piping and vessels, highlighting the basic questions that must be considered, giving also a guide that will help verifying that FRP calculation notes are covering the minimum aspects needed to guarantee the required safety and reliability.

After treating the influence of the manufacturing procedure and the type of resin in FRP mechanical properties, it will be given a list of the design codes available, comparing their main advantages and disadvantages. Next, a table summarize how the safety factor is obtained by these design codes and the minimum values required by each one.

It will also be shown how a first approach for obtaining the minimum wall thickness can be made considering the stress created by internal pressure. Next, it will be explained how many other efforts must be considered for calculating correctly piping and vessels (vacuum, wind and seismic loads, stress analysis according to support distribution, etc.).

Finally, a short explanation about how dynamic effects of wind in slim structures must be treated has been included, due to the high risk of collapse that exists in case of resonance.

SULZER'S EXPERIENCE OF THE RESISTANCE OF CAST MATERIALS IN PUMPS AND AGITATORS IN PHOSPHORIC ACID APPLICATIONS

MERJA PÄRSSINEN, MATTI RIKKA
Pumps Equipment, Kotka, Finland

In the manufacturing of phosphate fertilizers with the wet-process, there are various processes in which corrosive properties vary rather widely. Typically, the pumped liquid in the reactor stage is very difficult – it is both corrosive and abrasive. The process takes place at an elevated temperature, and some cavitation might also occur.

The solid particles are fine, but abrasive. The addition of chloride or fluoride ions makes the liquid aggressive. In the demanding process, the requirement of the reliability and lifetime of pumps and agitators is strict. Different cast materials have been delivered for various phosphate fertilizer processes, based on the material and process know-how. The corrosion rate has also been tested in laboratory. Avesta 654 SMO was proven to be the best material for phosphoric acid which contains a high amount of fluoride ions at 100 ° C. Duplex and super duplex steels have been used in processes where the temperature and the content of both fluoride and chloride ions is lower. The corrosion rate of austenitic stainless steel CF-8 has been tested as well.

A MATERIAL CHALLENGE – PUMPS IN SULPHURIC ACID APPLICATION

DR. GERHARD PRACHT
Friatec-Rheinhütte, Germany

Sulphuric acid is a highly corrosive liquid for metal alloys as well as for other materials. There are only a few metal alloys, which are recommended in the range of 0 – 99 % H2SO4. Beside these corrosion problems there are additionally corrosion issues found in pumps caused by the high rotational speed and the turbulences depending on the point of operation. Deviations in process may lead to unexpected corrosion phenomena, too.

An overview over materials as for example Duplex, higher austenitics as e.g. Alloy 20, ferritic alloys and high silicon alloys as SX and Siguss (ASTM A518) will be given. All these materials are classified for the optimal application in sulphuric acid service. Advantages and disadvantages of these materials in sulphuric acid are discussed. For example, the material Siguss shows the most universal corrosion resistance in sulphuric acid, especially for very hot and middle concentrated sulphuric acid.

Some typical corrosion examples will be shown, too. An important kind of corrosion called erosion-corrosion is explained.

TUBES FAILURE OF AMMONIUM NITRATE FALLING FILM EVAPORATOR

SAQIB RAZA

Process Engineer-Nitro phosphate Plant, Fatima Fertilizer Company Limited, Rahim Yar Khan, Pakistan

Fatima Group was established in 1936 with trading of commodities and gradually entered into the manufacturing of various products. The Group has a success story spread over seven decades, expanding its horizon from trading to manufacturing. Today, the Group is engaged in trading of commodities, manufacturing of fertilizers, textiles, sugar, mining and energy. Over 10,000 people are associated with Fatima Group, in various capacities.

Fatima Group owns and operates two mixed fertilizer manufacturing sites with annual capacity of 2.5 million tons producing Urea, Calcium Ammonium Nitrate and Nitro-phosphate.

The paper covers learning from the catastrophic failure of a Falling Film Evaporator tubes on Ammonium Nitrate service. Paper describes detailed investigation findings and root cause to avoid similar situation in other similar plants. Handling of damaged evaporator in such a way that plant could operate till arrival of new one (~9 months) was another challenging task, it is also described in detail.

It is expected that paper will be quite interesting for manufacturers where boiling acid attack on stainless steels is encountered.

NEWEST PRODUCT PORTFOLIO OF THYSSENKRUPP FOR THE PHOSPHATE INDUSTRY

ACHIM SCHÖNFELDER, MARC STARK, GUIDO GRUND, ULRICH MENTGES
ThyssenKrupp Industrial Solutions AG, Essen, Germany

ThyssenKrupp Industrial Solutions, the amalgamation of ThyssenKrupp Resource Technologies and ThyssenKrupp Uhde, combine our plant engineering and construction expertise in the business units Resource Technologies and Process Technologies, and offer our customers Engineering Excellence[3].

This presentation highlights certain sectors of the company's portfolio, such as the mine planning, the most recent of portal reclaimers and the thermal upgrading of phosphate rock.

Draglines or truck haulage are commonly used for strip mining. TKIS offers alternatively continuously working mining equipment such as mobile crushers, screens and large crawler-mounted cross-pit spreaders. These mobile systems feature typically low operational costs in overburden or waste removal.

The mine planning engineered by TKIS investigates specific solutions with regard to the operational mining method and optimized dimensioning of mobile crusher/cross-pit spreader systems.

Subsequent to the mechanical beneficiation, the thermal treatment offers additional processes for further upgrading of phosphate rock. Enriched concentrates at low levels of contaminants allow for more efficient downstream production of fertilizer component.

TKIS provides the Flash Technology for thermal beneficiation like drying, burning of organic/carbon matter and calcination while maintaining the high level of reactivity of the phosphate rock.

For reclaiming of bulk material, full portal scraper reclaimers are favourable thanks to the space saving design and the operational flexibility. Until recently, the field of application of these reclaimers was restricted due to the adopted design solutions which limit their maximum capacity.

As the demand of high capacity is constantly growing for large export terminals, TKIS offers a new technology for portal reclaimers which has been practically implemented, e.g. for the 8 scraper reclaimers installed as part of the Morocco Phosphorus III & IV Complex at Jorf.

HOW THE RAPID DEVELOPMENT OF DUPLEX GRADES INFLUENCE MATERIAL SELECTION

HACHEMI LOUCIF
Head Of Desalination, QPE Degerfors Outokumpu Stainless AB, Sweden.

New milestones in the development of duplex stainless steels are reached more and more frequently. As the variety of grades increases, new opportunities for cost optimization when designing and constructing new desalination plants appear more obviously.

Austenitic grades have for a long time been the stainless steel material that come to mind first when looking for stainless steel construction materials. This is much due to well-known grades, good availability and well documented experiences, and not necessarily motivated by economics; rather the contrary if duplex stainless steels are also considered.

With the recent rapid development in the field of duplex stainless steels, the reasons for not making these grades to the first choice belong to the past. Up-to-date information shows that new duplex grades have filled the previously existing wide gaps in corrosion resistance, that welding duplex grades is well established and that the availability is not an obstacle anymore.

This paper presents the most recent developments in the field of duplex stainless steels and how these leads to more cost efficient solutions when constructing MED and MSF desalination plants. Duplex grades' suitability in the brine handling process are also discussed and new corrosion testing results are presented.

The duplex grade LDX 2404® is a new product that has closed the gap in corrosion resistance that historically has existed between 2304 and 2205; and simultaneously, the new grade further improves the already superior mechanical properties of duplex stainless steel grades compared to the austenitic stainless steels. By utilizing the strength of the new grade LDX 2404®, savings in weight and material costs can be made. The lower molybdenum and nickel content of LDX 2404® compared to 2205 will decrease material costs if 2205 is slightly over-specified and can be changed to LDX 2404®. The new opportunities that this grade presents will be discussed in this presentation.

REVAMP AND UPGRADE POSSIBILITIES IN SULPHURIC ACID PLANTS

JAN ALBRECHT
OUTOTEC GmbH & CoKG, Oberursel, Germany

This paper will elaborate on the possibilities and influencing factors for revamp and upgrade projects for sulphuric acid plants and OUTOTECs possible contribution to a successful execution of such projects.

Main drivers to execute revamp project will be discussed: e.g. changing environmental requirements, increased demand for acid production, increased demand for energy production as byproduct or changes in production profile. Other aspects might target lower operating costs, better availability or longer operating periods between shutdowns. Finally, worn-out equipment must be replaced and decision must be taken either to go like-for-like or to use the chance to combine the replacement with an upgrade to more developed solutions.

The paper will also cover the various aspects and influencing factors which contribute to the decision making in a revamp project. Such aspects might be budget or schedule restrictions as well as restricted resources for labour and material at site during the execution of the project.

OUTOTEC will present its portfolio of possible services covering engineering, procurement, construction, commissioning as well as operating and maintenance support, spare parts business or operator training. Depending on the project setup the split of scope and responsibilities has to be carefully chosen and agreed between the involved parties to obtain the optimum result.

The presentation will provide examples of executed revamp and modernization projects of the recent past.

EFFECT OF INFERIOR AND AGEING CATALYST

CASPER VITTRUP FRANDSEN, ALLAN GODSK LARSEN
Haldor Topsoe A/S, Denmark

After deciding to invest in fresh catalyst, it is in everyone's interest that the installation is followed by a boost in performance of the plant. The magnitude of this boost is, however, very dependent on where the catalyst is installed, the quality of the catalyst that is being replaced and the possibility of optimizing inlet conditions to allow the fresh catalyst optimal working conditions.

The aim of this presentation is to highlight how trends in reliable operating data and spent catalyst samples can be used to optimize plant performance and catalyst replacement strategy and to pinpoint, where a limited volume of fresh catalyst will give the most performance for the investment.

We will present simulations of temperature profiles through catalyst beds composed of multiple layers of catalyst with various activities. Also, we will link results obtained through simulations to actual plant performances, where plants have seen a dramatic increase in overall plant performance after the installation of high activity catalyst in combination with optimal inlet conditions.

LATEST DEVELOPMENTS ON DUPONT™ MECS® SULPHURIC ACID CATALYST

TOM BROUWERS,
EMEA Product Manager, Sulphuric Acid Plants and Catalysts, MECS, Belgium

Major sulphuric acid plant producers worldwide have installed MECS® catalyst since the 1920s. Over the past 90 years, the dedicated Research and Development team at MECS, Inc. (MECS) has evolved catalyst from pellets to energy-saving rings to low-emission cesium-promoted catalyst. As energy savings and environmental concerns create new operational and design challenges for sulphuric acid plants, innovations in catalyst technology provide the solution. This paper will detail the MECS® catalyst portfolio of vanadium-based and cesium-promoted catalysts for sulphuric acid, including the latest innovations, GEAR®catalyst and improved formulation cesium catalyst.

The benefits of lower SO2 emissions, increased acid production, energy savings, and longer production cycles through utilisation of these contemporary catalyst products will be explored. The effective performance of MECS® catalysts will be highlighted through several case studies that demonstrate low SO2 emissions.

NEW SULFUR MELTING TECHNOLOGY INSTALLED IN KAZAKHSTAN AND USA

BEVAN HOUSTON, MARK GILBREATH
Devco, USA
ROY PICKREN
Crescent Technology, USA

Hi-Cap Sulphur Melting Technology was developed over the last ten years to improve operating and maintenance performance at large sulfur melting installations. Several innovations make this the preferred choice for new and replacement sulfur melting installations. An external heat exchanger eliminates traditional steam heating coils inside the melting area. The melter tank utilizes baffles and an agitator to provide a strong vortex mixing solid product with molten sulfur fed from the heat exchanger providing for immediate contact of sulfur product with heat medium.

The design of the melting tank prevents settling of non-meltable solids which instead flow into second pump tank heated only by external heat transfer, no internal steam coils. Maintenance is vastly improved by the elimination of steam coils and the related corrosion issues in the tubes' sulfur/air interface. Cleaning is aided by the lack of such submerged plumbing coils/tubes and is performed by mechanical equipment.

Hi-CAP melters are presently operating in Galveston, Texas and Kazakhstan and a unit is currently being installed in Florida, the latter having a capacity of 3,600 metric tons per day. The Florida project utilizes modular execution philosophy where the majority of process equipment is fabricated and trial erected 2000 km from the installation site. The shop fabrication of modules allow for less delays due to weather, concurrent work on fabricated modules and civil construction allowing for greater speed in execution with less potential delays.

CONVERTIBLE LUMP SUM EPS CONTRACTING MODEL – HOW TO GET THE PLANT YOU NEED NOW AND STILL ENJOY IN 20 YEARS?

MICHAEL FENTON[1], TYLER CAVIGLIA[2], HARB JOHAL[3]
[1] Chemetics Inc., Pickering, Canada
[2,3] Chemetics Inc., Vancouver, Canada

In most instances process plants are designed to meet performance objectives that are clearly defined by a detailed technical specification. The contractors and licensors designing and building such process plants are quite proficient at designing a plant to meet those performance values for an economically attractive cost. However the reality for the owner and operator of the plant is that over the 40+ year lifetime of the plant the inlet feeds, production rate and operationally desired set points for each piece of equipment will change. Often times this can result in a non-optimal plant and performance problems or poor reliability. This fact is particularly severe for plants which undergo significant corrosion or fouling like that commonly seen in sulphuric acid plants. Plants are built to make money for their owners.

The primary way to make the most money out of a facility is to have the plant operational at as high of a capacity as possible for the maximum number of days in the operational life of the plant. There are numerous ways that the plant designer and builder can place design allowances, safety factors, built in redundancy, optional operational configurations, bypasses and other tricks to allow the facility to operate well for all desired production rates and all desired feed types. The costs of such options are often quite small if dealt with in the initial design phase. Unfortunately, in nearly all instances this optimal facility is not the facility that is built for the client. The reason why is often the inflexibility in the client/designer contractual relationship prevents open discussions on optimization. The Convertible Lump Sum EPS model can be used to get the optimal plant design for the clients present and future needs as well as providing price surety of a lump sum execution.

This paper will detail the aspects of the Convertible Lump Sum EPS model. It will use an example sulphuric acid plant project to show how the client can be involved in the decision making process to get the best plant design for their site with appropriate design factors and options. Instances will be illustrated where plants have been built that do not have the flexibility required to operate effectively as the plant ages and/or the plant slightly changes operational modes. This lack of flexibility often causes damage to the plant and operational downtime or reduced capacity. Cost/Benefit analyses will be done on each of these cases. This paper will show that use of an effective, technically and commercially transparent contracting model like Convertible Lump Sum EPS with the appropriate partner can allow significant savings in TIC cost as well as for total return on investment.

PROCESS HEAT RECOVERY AND DIGITALISATION IN SULPHURIC ACID PLANTS

MICHAEL KEMMERICH, DR. HANNES STORCH
Outotec GmbH & Co.KG, Oberursel, Germany

Energy efficient processes with maximised heat recovery and efficient operation have moved more and more into focus in the sulphuric acid business. Even metallurgical plants are now expected to produce high pressure steam for power generation. With the help of proven processes, like the Outotec LURECTM, HEROSTM and HIPROSTM this demand can easily be satisfied. Heat recovery causes interconnections between different areas of a complex to become more common. Additionally, individual plants have increased in complexity, which both leads to higher requirements for operational personnel. The unfortunate combination of higher personnel mobility and fluctuation with remote locations of green or brown field sulphuric acid plant projects results in often less experienced personnel, who need support to operate today's state of the art sulphuric acid plant. By combining Outotec's process knowledge with actual operational data of the plant, a digitalisation system can greatly assist operation.

The combination of higher efficiency and assistance through digitalisation will be further detailed in the Outotec presentation.

COMMERCIALISATION OF MECS® SOLVR™ REGENERATIVE SO2 RECOVERY TECHNOLOGY

GARRET PALMQUIST
Business Development Manager, MECS, Belgium

Southern States Chemical in Savannah, GA installed the MECS® SolvR™ regenerative SO_2 recovery technology on their single absorption CP2 sulphuric acid plant to meet new lower SO_2 emissions for the plant site. Using SolvR™ technology, Southern States significantly reduced SO_2 emissions with a lower capital investment than double absorption. SolvR™ technology is capable of delivering 0.2lb/tonSO_2 (~20 ppm) while using a non-toxic, commercially available solvent and low steam usage.

This paper covers the operating data and history of the SolvR™ technology installation at Southern States Chemical and presents the process options available to use SolvR™ technology for sulphuric acid production expansion (up to 20% on a double absorption plant) while at the same time achieving emissions of 20 ppm SO_2.

INCREASING PRODUCTION CAPACITY THROUGH SUSTAINABLE CLEANING

HENNING URCH, MASSIMILIANO BORDIGNON
BASF SE, Formulation Technologies, Ludwigshafen, Germany

During all production steps of phosphoric acid, scale formation is a well-known problem. The nature of the scale is mostly based on gypsum, apatite or brushite and hexafluorosilicic acid. The solubility of each mineral is different, but all have in common that they dissolve hardly in sulfuric acid, which is commonly used for cleaning. Additionally the sulfuric acid is not very friendly to the different construction materials used in the production plant. During our studies we found that methane sulfonic acid is the best solution in dissolving all types of scales while it is very mild to the equipment. With achieving a better cleaning performance of pipelines, concentrators or similar equipment the total productivity of the plant can be significantly improved. Longer lifetime of the construction material leads to longer operation time and less investment costs. So higher productivity and less maintenance costs can be achieved with a ecofriendly and sustainably solution.

THREE CHALLENGES IN MAXIMISING PHOSPHATE RESOURCE VALUE AND HOW MAPTEK CONFRONTS THEM

JOSEPH SYKES, GARY BUCHANAN
Maptek, Edinburgh, UK

Maximising the value of a resource, especially while significantly increasing production, frequently presents technological challenges for potash operators. Complex mineralisation regimes, poorly integrated technology, and forecasting the optimal allocation of capital, are key challenges to any operator. Maptek has many years' experience working with all types of mining companies across the globe, including phosphate operators, and has developed versatile technologies that meet the technical requirements of every project. Here we introduce the latest solutions for three technological challenges common within the global potash industry.

Firstly, our clients have presented us with complex geological scenarios including: steeply dipping; folded; or, complexly faulted geology, all of which can add difficulty in determining the value and extent of the resource. Maptek has produced a range of powerful and innovative tools which integrate sophisticated geological modelling functionality along with unique resource modelling tools, providing the capability for an unparalleled level of resource model accuracy.

Secondly, once the resource model is defined the operator is required to design and then execute a mine plan. Potash miners, like other mining industries, are often faced with poorly integrated geology and mining procedures. This increases the workload on the company's specialists taking away the capacity to deliver optimal results. Maptek technology now allows for seamless integration between resource modelling and mine planning, releasing the ability to deliver optimal designs for any given resource.

Finally, as global potash producers strive to increase production output, particularly those in Morocco, Maptek now provides the capability to analyse planning scenarios and realise a strategy that minimises costs, optimises capital expenditure and maximises value. Maptek's latest solution introduces a unique, evolutionary planning algorithm that gives miners the ability to maximise resource value faster and more cost effectively than any existing solution.

MODÉLISATION ET CALCUL DES RÉSERVES EN PHOSPHATE DU GISEMENT SRA OUERTANE (CENTRE OUEST DE LA TUNISIE)

ANIS ZORGATI
L. R: Ressources minérales et environnement, Faculté des Sciences de Tunis, Tunisie
MOHAMED MONCEF SERBAJI
Ecole Nationale d'Ingénieurs de Sfax, Tunisie
WISSEM GALLALA
Département des Sciences de la Terre, Faculté des Sciences de Gabès, Tunisie

Les gisements des phosphates occupent une place importante dans l'économie tunisienne. Le gisement de Sra Ouertane situé dans l'Atlas tunisien central à 45 km au Sud du Kef n'est pas exploité jusqu'à nos jours, malgré les nombreuses études faites sur ce gisement, étant donné que sa teneur en P_2O_5 ne dépasse pas les 15% en moyenne d'après les travaux antérieurs. Mais, sachant que le prix de phosphates a augmenté considérablement, ce gisement constitue aujourd'hui un potentiel qui pourrait faire l'objet d'une éventuelle exploitation.

Le présent travail vise l'utilisation des géomodeleurs afin d'évaluer les réserves de ce gisement et de localiser les zones les plus riches en se basant sur les travaux d'exploration de 1984. Le suivi de la variation des teneurs en P_2O_5 en établissant de cartes isoteneurs en 3D sous formes des blocs modèles s'avère donc utile pour assurer ce suivi. Les variogrammes expérimentaux ont été construits et ajustés par un modèle de régionalisation sphérique pour le P_2O_5 et le MgO et exponentiel pour le CaO et le SiO_2. La méthode inverse à la distance a été utilisée pour l'estimation des teneurs. Les résultats prévoient une teneur moyenne en P_2O_5 de 12% dans le secteur étudié (plateau de M'deina-Jebel El Ayata). Ces teneurs augmentent en allant vers le SW (Jebel El Ayata) pour atteindre les 20%.

Mots-clés: Sra Ouertane, Phosphates, Variogramme, Modèle 3D, Réserves.

GEOLOGICAL MODELING, A KEY STEP INTO MINING OPERATIONS OPTIMIZATION

RAFAL WALECKI
Mine Modeling and Extraction Planning Managing Consultant – EMEIA with VENTYX ABB, Poland
SAADI BENTOUMI
Business Development Manager MENA,VENTYX, ABB, United Arab Emirates

Mining Companies these days are facing number of serious challenges related to quickly changing environment in which they are operating. The quality of the available mineral resource base is still falling and deposits are more complicated so mining is becoming more difficult and therefore more expensive. If you add to this rising energy prices and cost of skilled workforce, it becomes clear that the achievement of the expected financial results and thereby meeting the expectations of investors is becoming a major challenge for modern mining companies.

In those conditions it is crucial to understand how our company – Ventyx, ABB - is operating throughout whole production chain; from the mine face to the client, and have the ability to monitor and optimize those process as a whole. All the IT systems; Geological Modelling, Mine Planning, Material Logistics, Sales & Marketing, Asset & Work Management as well as all supporting processes (such as Laboratories or Back Office) have to talk to each other and allow to make decisions basing on information shared between them. IT layer should directly connect to the automation systems allowing for automatic data collection and processes management.

While not losing the overall picture, we would like to focus on the Geological Modelling part of the process. From many interesting subjects we think crucial are:

1) For any mine, key is ability to effectively work with deposit information as well as mine plans in a group. Every mine have Geologists, Surveyors and Engineers – those people, while focusing on their tasks need to effectively share the data with others. Geologist requires direct access to Exploration data, Surveyor needs information on the deposit structure and Engineer needs both; effects of Surveyor and Geologist Work. We will show key attributes of the system which can lead to maximizing efficiency of Production Preparation team work – in one office as well as in the group of mines and other Company departments.

GEOLOGICAL MODELLING

2) In every Mine whole story begins with full understanding of their major asset: deposit. Crucial is then to keep deposit model which allows understanding of its structure and quality parameters distribution with required level of details. While with significant amount of work this can be achieved using any modelling method, mining activity produces a lot of additional informations which needs to be taken into account – and models needs to be updated.

In this particular moment time becomes a critical factor: an ability to quickly remodel the deposit with new and updated data is crucial as it gives Engineers accurate and most up to date data when making decisions which can cost investors millions of dollars. We would like to show how combination of two modelling methods: stratigraphic for basic deposit structure and block for internal lithologies and quality parameters can maximize perforce of work and modelling while not just keeping the accuracy, but also improving it. Usage of interpolation methods which is affected by trending modelled on structural analysis stage is delivering quick and accurate result, without even a need to correlate all single lithological layers.

SYSTÈME D'INFORMATION GÉOLOGIQUE OCP

Y. DAAFI, E. JOURANI, K. TIDDARINE, O.KHADIRI YAZAMI
OCP S.A., Morocco

La reconnaissance systématique des gisements de phosphate à l'OCP se fait par:

- puits à grand diamètre de 0,80 à 1,20 m dans les zones phosphatées peu profondes;
- sondages mécaniques de diamètre 0,13 à 0,16m dans les zones profondes et noyées et;
- tranchées ou saignées sur les affleurements

Les données géologiques récoltées des ouvrages précités (Logs, descriptions lithologiques, échantillons et analyses physico-chimiques…) sont consolidées dans un système d'information géologique dont l'architecture permet d'intégrer toute la masse de données géologique remontée.

Récemment, une acquisition LIDAR (Laser Detection And Ranging) aéroportée nous a permis de produire une topographie des bassins phosphatés à une précision centimétrique (20cm X, Y, 10cm Z) couplée avec une Orthophoto de haute résolution (8cm).

Le traitement des données numériques se fait via des progiciels et des développements internes adaptés aux besoins des études géologiques, parmi les principales fonctionnalités de ces outils on en cite:

- la compilation des données géologiques des ouvrages de reconnaissance (pondération, élaboration des formations…)
- l'analyse géostatistique des données
- la cartographie des paramètres physico-chimiques,
- l'élaboration de modèles géologiques des zones étudiées,
- l'estimation des ressources et des réserves.
- l'estimation et l'évaluation économique des réserves
- la capitalisation des données et l'analyse multi-critères et multi-couches via des applications SIG.

GEOLOGICAL MODELING AND RESERVES OF PHOSPHATE CALCULATION IN THE OUM ELKHECHEB DEPOSIT USING GEOGRAPHIC INFORMATION SYSTEM (GIS) (MÉTLAOUI BASIN, SOUTHWESTERN TUNISIA)

HABIB SMIDA

Assistant Professor, Science University of Gabès, Tunisia

The present work aims the use and the exploitation of the Geographic Information Systems tools (GIS) for the study and the management of phosphates deposits in the Métlaoui Mining Basin through the construction of a geographic database.

The Eastern closure of Oum El Khecheb is the termination peri-anticlinal of the Oum El Khecheb semi-Drawing. This deposit has a flexure which brings up a perched syncline axis oriented East-West.

The Phosphate series is complete, with 12 m of average power, and average gross of P_2O_5 equal to 24.96%.

Total reserves deposits are estimated to 29.9 MT in an average ratio of 9.35 and a dip between 0 and 35 °. This gives the eastern closure of Oum Elkhecheb an offer to be a site for an open pit mining by current methods of the CPG and represent a transition zone for the exploitation of Semi-Drawing up itself.

Key Words: Geographical information system (SIG), Bases data, Modeling, Oum Elkhecheb, phosphate reserves.

PRODUCTION OF HF FROM H_2SIF_6

THOMAS DAHLKE, MARTINA ECKMANN AND RODERICK CANT
Buss ChemTech AG, Switzerland

Fluorosilicic acid (FSA, H_2SiF_6) is a waste from the production of phosphoric acid. Until now the majority of this waste stream is either neutralised and disposed, pumped to sea or used for drinking water fluoridisation (mainly in the US).

The total amount of FSA produced by the phosphate industry could be used to entirely replace the worldwide production of hydrofluoric acid (HF) using fluorspar (CaF_2).

The production of aluminium fluoride (AlF_3) with FSA as a raw material has been the subject of numerous patents and processes within the last 50 years. The goal of such a process is to achieve a high fluorine recovery, minimisation of waste and reasonable capital and operating cost.

Industrial production of fluorine chemicals with FSA as a raw material started in the 1970ies. For example, aluminium fluoride was produced in a crystallisation process by mixing FSA and aluminium hydroxide ($Al(OH)_3$). Today, there are still plants operating using this process despite the disadvantages the product has. In particular, the flowability of the aluminium fluoride is not accepted by modern aluminium smelters.

Hydrofluoric acid production from FSA has also been the subject of study. Processes have been patented which use an intermediate salt and sulphuric acid to obtain HF, ion exchange processes or which use steam to recover HF from aluminium fluoride. No industrial plants have been built using these processes. Claims made ignore the fact that such plants will require numerous and maintenance intensive unit operations or may be applied to the treatment of pond water which limits the maximum acceptable FSA concentration to less than 2%-wt.

BCT has successfully scaled up and optimised an industrial process for producing anhydrous HF from FSA using sulphuric acid as "catalyst". Plants with 20,000 and 10,000 t/a are in operation for several years and the expected maximum capacity in one line is 30,000 t/a.

The BCT process is simple to control and can be easily operated.

Compared to the current process of making HF using fluorspar, the operating costs and the return on investment of such a plant is significantly less because the costs for raw material of the FSA process is nearly zero (waste stream).

For producers of phosphoric acid, the implementation of a HF plant on their site has the advantage that more revenue is created, costs for the neutralisation can be saved and the market for downstream fluorochemicals can be developed.

OVERVIEW OF THE FLUOROCHEMICALS INDUSTRIAL SECTORS

ALAIN DREVETON
AD Process Strategies Sarl, Geneva, Switzerland

This paper presents a global overview of the industrial sectors producing the fluorochemicals, fluoropolymers with emphasis on applications and requirements for raw materials especially for fluosilicic acid potentially recovered from the conversion of apatite to phosphoric acid.

The various market segments highlighted are water, cement, steel, aluminium, oil refining, nuclear, refrigeration, electronics, solar, glass, pharmaceuticals, agrochemicals, applications for polymers, elastomers, coatings and various other uses.

A tentative estimate of the market segments is outlined. The implications on the raw materials, such as volume, expected growth, logistics, etc and consequences for implementing the production process of the end-products are described. This overview shall assist to evaluate the size and potential of the various markets and select appropriate outlets for consuming fluosilicic acid as a raw material.

THE BENEFITS OF ISOLATING & UTILIZING FLUORINE FROM PHOSPHATE OPERATIONS

RAY WILL
IHS, Santa Clara, California, USA

In the period of 2008-2011 the restricted availability and price volatility of the mineral source of fluorine known as fluorspar (calcium fluorite) made commercial buyers around the world question whether there were alternative fluorine sources for chemical production. Presently there are significant opportunities for producers of phosphates from the mineral fluorapatite to offer a fluorine rich alternative to fluorspar or to sell fluorine-based chemicals isolated from fluorine containing waste streams from phosphate production. The technology to isolate fluosalicic acid (FSA) for sale or as a raw material for the production of downstream fluorine-containing chemicals is proven and available. The markets for fluorine-containing chemicals are valuable and growing in many different applications. This situation gives phosphate fertilizer and phosphate chemical producers the opportunity to serve new customers of fluorine-containing chemicals and reduces the environmental impacts from the disposal of fluorine containing waste streams.

This presentation will further describe major features and events in fluorine market and the opportunities and challenges in supplying a fluorine raw material alternative to fluorspar.

RECOVERY OF RARE EARTHS FROM WET PROCESS PHOSPHORIC ACID, THE SOLVAY EXPERIENCE

ALAIN ROLLAT
SOLVAY Rare Earth Systems, La Rochelle, France

Solvay is involved for more than 50 years in rare earths production. In the 80's, when Solvay operated also phosphates plants, the company conducted a very wide Research and Development program in the recovery of uranium and rare earths from wet process phosphoric acid. This program led to the development of several processes of solvent extraction from laboratory to pilot scale for some of them. Solvay has now the capability of designing and producing specific molecules for solvent extraction application based on the chemistry of phosphine and amines. The combination of both skills is key for addressing the new challenges of Wet Process Phosphoric Acid.

ANALYSE ET DETECTION DES TERRES RARES SUR LES PHOSPHOGIBPS SUR LE TERRAIN

DR ALBERT SOTTO
Tal Instruments, Pantin, France

Les terres rares: Comment les detecter sur le terrain sans faire de la chimie de laboratoire?

Pour les géologues sur le terrain connaitre le milieu dans lequel on travail et identifier immediatement les roches avec certitude,ensuite quantifier les éléments au niveau de trace qui nous interesse et pouvoir relier les appareils d'analyse pour envoyer les informations au serveur de l'entreprise voilà les nouveaux enjeux.
Les nouvelles techniques d'analyse pour detecter au niveau de trace les elements terres rares:

Presentation du LIBS de la fluorescence X et du Raman portable avec base de données, mais aussi pour la premiere fois la spectrometrie par UV Vis NIR dans le domaine minier et exploration.

Les économies sont à grandes échelles car une fois sur le terrain la possibilitè d'envoyer toutes les annalyses directement au serveur et positionnement des prélèvements et des concentrations des éléments chimiques trouvès sur la cartographie.

IN-SITU RECOVERY OF CRITICAL TECHNOLOGY METALS AND OTHER RAW MATERIALS

MICHAEL HASCHKEA, THOMAS HUBRIGA
G.U.B. Ingenieur AG, Dresden, Germany
JAMSHID AHMADIAN
Payame Noor University, Iran
HORST MÄRTEN
Umwelt- und Ingenieurtechnik Dresden GmbH, Dresden, Germany

Two companies GUB and UIT in Dresden, Germany, are jointly developing optimized in-situ recovery extraction technologies for critical technology metals, including Rare Earth Elements (REE), Cu, U, and raw materials. Relevant ongoing projects include (among others): (1) In-situ bioleaching of Cu shale-sandstone in an active ~1 km deep shaft mine in Poland, (2) In-situ bioleaching and near-surface extraction of REE from ion-adsorption clays in Madagascar; similar ion-adsorption clays from southern China have been the global main source of heavy REEs (e.g. Dysprosium, Terbium), and (3) REE extraction and concentration from the Esfordi phosphate (apatite-magnetite) deposit in Iran. These in-situ leaching technologies currently being developed may be adapted technologically and hydrometallurgically for optimized near-surface phosphate extraction in Morocco.

We envisage a combined approach of in-situ leaching of phosphate layers by (1) enhancing hostrock porosity and permeability by cryotechnology, (2) selective in-situ leaching wellfield-design supported by predictive hydrological and hydrometallurgical modeling (thereby also avoiding production of tailings which minimises costs), and (3) optimization of hydrometallurgical in-situ leach chemistry to maximize recovery. Our companies operate state-of-the-art extraction technologies and NORM laboratory facilities for U and Th separation. For a more tailored approach suitable to the needs of OCP, we propose to engage together with OCP Group in a joint company and/or EU-funded R&D project on development of a customized in-situ extraction technology specialized for phosphate extraction (including recovery of economically relevant by-products) in Morocco.

CARBAMOYLALKYL PHOSPHONATES FOR DRAMATIC ENHANCEMENT OF URANIUM EXTRACTION FROM PHOSPHATES ORES

DR. RAPHAËL TURGIS, DR. GUILHEM ARRACHART, DR. SANDRINE DOURDAIN, DR. STÉPHANE PELLET-ROSTAING

Senior Researcher CNRS, Director of the ICSM Laboratoire de Tri-ionique par les Système Moléculaires auto-assemblés, Institut de Chimie Séparative de Marcoule (ICSM), UMR 5257 CEA-CNRS-UM2–ENSCM, Centre de Marcoule, Bagnols sur Cèze, France

DR. ANTOINE LEYDIER, DR. FABIEN BURDET, GILLES BERNIER, DR. MANUEL MIGUIRDITCHIAN

CEA, DEN/DRCP/SMCS/LEPS, Bagnols sur Cèze, France

A novel family of bifunctional ligands was synthesized and studied towards their extraction properties in regards to an aqueous phosphoric acid solution containing uranium. We developed a high yielding synthesis of amido phosphonate ligands and focus our investigation on the effect of steric hindrance on the methylene bridge between the two functions. These new bifunctional ligands were found to extract selectively hexavalent uranium U(VI) with high distribution coefficient (D) and selectivity towards iron Fe (III) in 5 M phosphoric acid solution. From a structure-activity approach a specific ligand called DEHCNPB has been put forward in regards to the outstanding results obtained for the selective extraction, and quantitative recovery of uranium compared to the URPHOS reference system.

HOW WOULD YOU RECOVER 1 MILLION KILOGRAMS U3O8 PER ANNUM?

VAUGHN ASTLEY
Dr Phosphate, USA
REGIS STANA
R Squared S Inc, USA

In the 1950's three plants were built to recover uranium from phosphoric acid, these only operated for a couple of years. When the price of uranium increased in the late 1970's, at least 15 plants were built in the United States and in seven other countries. Over 20 million Kg of uranium were recovered in these plants at operating costs as low as $25/Kg, all ceased operations by 2005. Several phosphoric acid producers are now expressing interest in again recovering uranium from phosphoric acid. A recent FEED Study has allowed the Good Technology to be separated from the Poor or Bad Technology, and also any Incorrect Perceptions.

Thus by combining the Good together with the Operational Knowledge Gleaned from all the prior operations, we can discard the Ugly, and design a facility that optimizes capital and operational costs, and allows a large scale implementation to be economic even at today's low Uranium prices. This Optimized Design will be presented and how it would be applied to the recovery of 1 Million Kg U_3O_8 per Annum at a single location

SYMPHOS 2015

WORKSHOPS

HSE MANAGEMENT ON CONSTRUCTION SITE IN THE PHOSPHATE INDUSTRY

DOMINIQUE BARICHEFF
ARIA Technologies, Boulogne billancourt, France

La présentation aura pour objectifs de décrire comment le HSE (Hygiène, Sécurité, Environnement) a été pris en compte sur des chantiers de construction dans l'industrie des phosphates. Il s'agira de comparer au travers de 4 exemples au Maroc (OCP), en Tunisie (TIFERT), en Egypte (N.FERT) et en Arabie Saoudite (Ma'aden) la base documentaire et les pratiques.

Les 4 points qui seront abordés lors de la conférence seront les suivants:

1) Présentation des 4 projets

2) La gestion du HSE lors de la phase construction et commissionning:

- Base documentaire: le plan HSE,
- Les pratiques et les thématiques traitées:
  - Sécurité: postes de travail, le matériel, les Equipements pour la Protection Individuelle, la circulation,
  - Environnement: eau, air, déchets, bruit,
  - Santé: hygiène, santé,
  - Sureté: gardiennage, l'accueil, l'intégrité du chantier,
- La vérification: contrôle interne, contrôle externe.

3) Comparaison des différentes approches selon les projets et les pratiques des entreprises

4) Les facteurs de progrès: le client, l'ingénierie, le design, l'organisation, la maintenance, le réglementaire.

Ces expériences permettent de faire partager aux entreprises les outils théoriques nécessaires pour prendre en compte le HSE dans les chantiers sur la base des standards internationaux et tenir compte du facteur humain dans l'acte de construire, partager les bonnes pratiques.

STORY OF AN HRS SULFURIC UNIT

ABDENOUR JBILI
Methods Engineer, OCP Group, Safi Site, Morocco
LAHMADI ABDELAZIZ
Process Engineer, OCP Group, safi site, Morocco

Operational transformation gives us an opportunity to review our operation methods in a way to measure our performance and to focus on a rational strategy to improve the PSIII plant productivity and to reduce SO2 emissions.

This paper will detail specific process methodologies such as nondestructive process inspection (for example stick test provides operators with information about acid carryover in acid towers, operators can adjust acid and gas parameters depending on the result of the test and also to prepare spare parts for the next shutdown, another example is the pegasys test: pressure drop and conversion rate measurement of each catalyst bed helps operators optimizing the converter by adjusting the inlet temperature of each bed of catalyst). Other methodologies like process hazard analysis which addressed a cultural change into the team and also reinforced the relationship between operation and maintenance that's what leads us to reach a high level of performance.

We will present after how preventive maintenance has helped us to predict future failures in some strategic equipment such as gas heat exchanger, turbine, blower...etc. An intelligent design modification was also a key factor to improve the reliability of the entire PSIII sulfuric unit.

Our history can't be concluded without talking about overhaul schedules and planning. The capitalization of all best practices and procedures allows us to adapt and standardize our maintenance tasks and activities, in way to create our own systemic overhaul process, that includes mainly safety instructions and CND inspections and controls (vibration, thermography, Oil Analysis, Foucault current measurement, check-list controls for major and risky tasks...etc) adapted for each equipment with specific and detailed reports, and done by experienced and certified OCP Staff (for example ISO certification on vibration and thermography).

"It's a real success story and an amazing journey that we invite you to take with us"

SAFETY MANAGEMENT

PROTECT AND SUSTAIN" CERTIFICATION OF OCP

AHMED SADIK
Health, Safety and Environment manager and Protect and Sustain Responsable
Axe Centre, OCP Group, Morocco

As a leader in the Fertilizer and phosphate international market, OCP decided on April 2014 to be certified in compliance with the IFA's standard "Protect and Sustain". This standard is relating to product stewardship through the value chain of the phosphate: since the Research and Development to customer delivery.

This certification consists on the compliance, of OCP management system and standards relating to security and SHE issues, with IFA's standards and criteria summarized in the 12 principles of IFA.

The scope of this certification concerned Gantour-Safi integrated line from R&D to customer delivery, including mining operations, processing, chemical units, port facilities, external storage, supply chain, commercial and marketing, sourcing and contracting.

The certification audit aims to verify that Fertilizers and raw materials, additives and intermediate products are processed and manufactured, handled, stored, distributed and used in a safe way.

To guaranty the success of this project in Five months, a task force was formed. This project team was motivated and exited to achieve this goal on time.

The product stewardship performance of OCP was analyzed in September 2014 and OCP was awarded in IFA's summit in Marrakech on November 2014.

This award with a high score (product steward excellence) was a result of our commitment to reach a high level in safety, security and sustainability.

LE PROJET ZERO INCIDENT UN MOTEUR POUR REALISER L'EXCELLENCE GLOBALE A L'AXE NORD

ABDELKADER ALOUANI
Responsable Hygiène Sécurité Environnement, Direction Exécutive Axe Nord, OCP S.A., Morocco

La sécurité au groupe OCP, une priorité stratégique et une valeur d' entreprise pour atteindre l'excellence globale World Class.

Depuis quelques années, OCP a mis en place une stratégie intégrée et innovante pour lancer sa profonde transformation et asseoir son leadership sur le marché. Plusieurs actions ont été entreprises pour réussir une véritable révolution industrielle et Managerielle qui a donné des résultats probants et reconnus. Cette transformation a été accompagnée et renforcée par la valorisation des ressources humaines et l'amélioration de la sécurité et des conditions de travail, dans le cadre d'un développement durable global.

L'ambition du Groupe OCP est d'être un leader en matière de performance HSE, dans le domaine des industries des phosphates avec la cible du Zéro Incident durable, comme un choix et une motivation éthique et morale, d'amener toutes les parties prenantes (salariés, communauté locale, fournisseurs et sous-traitants, partenaires en JV) au niveau de ses ambitions HSE et d'assurer de ce fait, un développement durable de ses activités et de celles de toutes ses parties prenantes.

Cette ambition se traduit sur le terrain par:

- Le respect de toutes les dispositions légales en matière de HSE
- Le développement d'une culture HSE basée sur l'anticipation et la prévention;
- L'intégration des exigences HSE dans l'élaboration des nouveaux procédés de fabrication, la conception des nouvelles installations, la distribution et l'utilisation de ses produits;
- Le développement des standards et pratiques HSE de classe mondiale, en se donnant les moyens de leur mise en œuvre efficace;
- L'identification et la maîtrise de tous les risques HSE liés à ses activités;
- Le pilotage de la performance HSE avec des objectifs de moyens et de résultats, ainsi que des indicateurs prédictifs cohérents à travers toute l'organisation;
- La fixation et la réalisation des objectifs et plans annuels HSE.

Les Principes HSE sont les suivants:

- Tous les incidents et accidents HSE doivent être reportés immédiatement avec la transparence et la fiabilité requise, pour éviter leur reproduction;
- Tous les accidents et incidents peuvent être évités;
- Réfléchir avant d'agir et réagir efficacement en toutes circonstances;

SAFETY MANAGEMENT

- La formation et le développement des compétences HSE, à tous les niveaux de l'organisation, sont indispensables pour exercer sa mission;
- La communication et le partage des retours d'expérience (REX)
- L'amélioration de la performance HSE est une condition indispensable à l'amélioration de la performance économique et industrielle de l'entreprise;
- Le travail en sécurité est une condition de préservation de l'emploi.

Le challenge de OCP est d'atteindre le zéro incident, pour ce faire c'est une mobilisation permanente en sécurité et santé au travail à côté d'un engagement solennel de la Présidence, de la Direction Générale et de tout le Management du Groupe. Pour confirmer son engagement dans le domaine de la sécurité. Le Groupe OCP s'est engagé à appliquer les principes de l'IFA et à mettre en place un système de Management global et intégré pour viser l'excellence.

Les principales actions du Master plan OCP en matière de sécurité sont:

- Réorganisation de la filière HSE aves des structures et des comités au niveau Corporate, Directions Industrielles, Directions des Sites et Entités opérationnelles
- Accompagnement sur le terrain par des Experts Internationaux et Nationaux dans le cadre du Partenariat de coopération avec le Groupe Dupont
- Partenariat avec JACOBS à travers la filière JESA, pour professionnaliser la réalisation des projets du programme de développement industriel et intégrer les exigences HSE
- Elaboration et déploiement des standards de gouvernance et opérationnels VOSE, GIASE, EVEPS, D/A, Analyse des risques ADRPT, Consignation, Espaces confinés, Travaux en hauteur, Entreprises extérieures, Gestion des modifications, Circulation routière et Gestion des
- Le renforcement de la présence des Managers sur le terrain
- Déploiement des différents outils et tableaux de Management et de pilotage de la sécurité au niveau des chantiers et ateliers, sur la base des KPIs pertinents avec des revues systématiques;
- Mise en place de équipes «TASK FORCE» dans le but d'avoir un impact visible des actions de la sécurité sur le terrain
- Intégration des recommandations des assureurs.

THE TASK FORCE EXPERIENCE TO ACCELERATE THE DEPLOYMENT OF HSE STANDARDS IN JORF LASFAR

MOHAMED ZAD, SANAA AZZAOUI
OCP Jorf Lasfar, El Jadida, Morroco

"No World Class manufacturing performance without HSE performance." OCP Group too aware is launching a wide HSE excellence program considering the safety sacred value that places human capital as the core of success. This HSE transformation is governed by the project "Zero Incident" to achieve an interdependent culture based on three key pillars: Leadership & Organization, governance and operational standards & process safety management.

In order to reap the benefits on site, a first step was implemented involving the hierarchy in the deployment of standards, however, the group's ambition exceeds the level reached whence the idea of the new approach adopted by Jorf Lasfar "operational discipline in the service of operational efficiency", it is the project "Task Force", which through its members, among other things allowed to accelerate the implementation of the standards, stimulate safety dialogue, conveying the HSE best practices and change staff behavior by strongly involving the operational line as a primordial actor of change.

"SOUTH AFRICA'S MINING INDUSTRY SAFETY JOURNEY" A PERSONAL PERSPECTIVE.

WILCO UYS
Professional Mining Engineer, Bethal, South Africa

There is no doubt that South Africa's Mining Industry played the major role in South Africa's economy for the past 130 years. The Safety and Health of Mineworkers unfortunately were not always of paramount importance as mining and specifically underground mining was viewed to have inherent risks that would inevitably result in harm, often fatal incidents.

The Chamber of Mines of South Africa initiated various Safety campaigns and initiatives early in the previous century with mixed success. These campaigns and initiatives were expanded during the latter half of the previous century to also include the Health of Mineworkers with the prevention of silicosis the main challenge. The democratization of South Africa resulted in organized labour playing a much bigger role in the wellbeing and living conditions of Mineworkers.

This influence of organized labour, improved legislation and investor expectations resulted in the much improved Safety performance of South Africa's Mining Industry.

There is however no doubt that much need still to be done to ensure harm free mining – both from a Safety and especially Health point of view.

This presentation is a personal perspective on South Africa's Safety Journey. Actual performance results over the past two decades are shared with some of the industry and company specific initiatives that resulted in a much improved Safety performance.

MULTIPLE BENEFITS FROM SALT-AFFECTED LANDS AMELIORATED BY PHOSPHOGYPSUM

MANZOOR QADIR
United Nations University Institute for Water, Environment and Health (UNU-INWEH), Ontario, Canada

Considering food security concerns and the scarcity of new productive land, salt-affected soils cannot be neglected, especially in areas where significant investments have already been made in irrigation infrastructure. As important categories of salt-affected soils, sodic and magnesium-affected soils require the application of a source of calcium to mitigate the negative effects of excess sodium or magnesium. Phosphogypsum is the cheapest source of calcium to ameliorate these soils. It also offers additional value as it supplies appreciable quantities of phosphorus. Research and practice have demonstrated beneficial effects of applying phosphogypsum to these soils through improvement in soil quality, soil moisture storage, irrigation efficiency, and crop water productivity. It is important to foster innovation by utilizing together apparently two wastes – phosphogypsum and degraded soils (sodic and magnesium-affected soils) – as potential business opportunities while adding value to the business dimension through multiple benefits to a range of stakeholders – farmers, phosphate fertilizer industry, transportation sector, marketing entrepreneur, infrastructure industry, and public at large.

There is a need to (1) convince public and policy institutions to consider removing barriers to facilitate the use of phosphogypsum as a soil amendment; (2) help farmers for phosphogypsum transportation, its field application method and suitable rate, and irrigation management; (3) develop capacity in local institutions to monitor the quality of phosphogypsum to regulate its use in different environmental settings and soil conditions; and (4) run awareness campaigns highlighting the beneficial use of phosphogypsum as an effective amendment for degraded lands.

PHOSPHOGYPSUM FREE PROCESS FOR MANUFACTURE OF PHOSPHATIC FERTILIZERS, NPK/DAP

SANDEEP DUBE, DR. IYER RAMAKRISHNAN
4R Technologies, I 704, India

Phosphoric acid, manufactured by wet process is one of the main raw materials of phosphatic fertilizers, NPK/DAP. Worldwide, phosphogypsum, by product of wet process phosphoric acid plant is mostly stacked on land and in some countriesdischarged in to sea. More than 200 million tonnes of phosphogypsum are produced annually and less han 5% of production is used commercially, primarily in agriculture and some in cement plants. This paper relates to manufacture of NPK/DAP fertilizers with-out net production of phosphogypsum.

The process involves digestion and solubilisations of tricalcium phosphate content in rock phosphate producing water solution of soluble mono calcium phosphate and insoluble calcium salts. The insoluble salts are filtered and washed. The filtrate solution is reacted with ammonium sulphate solution to precipitate gypsum, which is filtered off to give solution of mono ammonium phosphate (MAP). MAP is sent to pre-neutralizer or pipe reactor in DAP plant. The precipitated and washed gypsum is converted to ammonium sulphate solution by well practiced carbonation process using ammonia and carbon di oxide. The overall process involves reactions of rock phosphate, phosphoric acid, and ammonia and carbon di oxide to produce insoluble calcium salts, MAP solution and Lime. There is no net production of phosphogypsum in the process while producing lime, which has commercial value.

PHOSPHOGYPSUM RECYCLING, AS STRUCTURAL IN A PHOSPHORIC ACID PLANT BUSINESS MODEL

ANAS LAHLOU
Jorf Fertilizers Company V, Jorf Lasfar, Morocco

Phosphogypsum (PG) generation has always been a major issue in the Phosphoric Acid production. Operators in the sector has tried many utilizations of the PG, mainly in the agriculture and construction sectors. However, the recycled quantities stand at a very symbolic level because of technical and logistical constraints.

In order to overcome these constraints, this article propose a global vision about Phosphogypsum that should lead it from a major problem of the Phosphoric Acid Exploitation to an opportunity totally embedded in the Business Model of this industry. The global vision suppose making use of all the following leverages:

- Strategy: Political conviction that it's a necessity based on sustainable development vision
- Finance: Interest rate bonus linked to a sustainable development program, and economy of scale generated by adding new components to the plant.
- Industry: Combining blending capacity with a phosphoric plant
- Marketing: Exploiting all the potential of different utilizations of PG

Keywords: Phosphogypsum, Sustainable developpement, Business model, Integrated production unit.

PHOSPHOGYPSUM AS FERTILIZER: IMPACT ON CROP, SOIL & ENVIRONMENT

Y. ZEROUAL, R. BOULIF
Direction Recherche & Développement, OCP S.A., Jorf lasfar, Morocco
K. EL MEJAHED
Université Mohammed VI Polytechnique, Benguérir, Morocco
Recherche & Developpement, OCP S.A., Jorf lasfar, Morocco
R. EL MRABET
Société GROWTECH, Temara-Rabat, Morocco

Soil sulfur reserves are decreasing because of the use of high-grade fertilizers, accelerated OM decay related to agricultural mining and reduction in atmospheric deposits. Moroccan soils are generally calcareous, alkaline and poor in organic matter. This influences considerably their nutrient availability and efficiency. Moroccan farmers increasingly adopt oilseed rape crop (Brassica) which needs more sulfur than other crops, like cereals. Phosphogypsum valorization as non-conventional fertilizer might be a valuable source of sulfur for oilseed rape in sulfur deficient soils. It can also indirectly affect crop yields through better use of water and nutrients.

A series of field experiments were carried out with oilseed rape in dryland area of Morocco, to evaluate the effect of phosphogypsum on crop and soil and its heavy metal and radionuclides impact on the environment. Oilseed rape yield and its nutrient uptake along with plant and soil analysis were used to evaluate the direct and indirect effect of phosphogypsum.

Phosphogypsum application increased yield, macro and micronutrient uptake, water use efficiencies and even P availability all over the sites. However, its effect was site dependent but without affecting rape uptake of trace elements nor its radionuclides content.

FRAME WORK FOR MAINSTREAMING PHOSPHOGYPSUM USE IN ROAD CONSTRUCTION IN MOROCCO.

Y.BOUABDELLAOUI
IAV, Hassan II, Rabat, Irfane, Morocco
J.HILTON
Aleff Group London, UK

Morocco is engaged in the implementation of the green economy transition. The main sectors adopted sustainability policy framework. The road industry development is facing scarcity of adequate and sufficient conventional construction materials. Because the need for materials is large, depletion of the best materials, the need for resource conservation, and lengthened transport distances have all increased the need to introduce substitute materials for natural sand and gravel. Good quality coarse-grained fills can be obtained, for example, by blasting and crushing rock. Rocks are also lacking while substitute materials have also been sought from materials currently classified as being of fine grade.

The Phosphogypsum (PG) as industrial byproduct derived from wet phosphoric acid (PA) production process, once treated and mixed should be used as alternative compounds of natural materials. But prior to this usage, the PG should be technically proven suitable, and environmentally friendly and economically acceptable by the industry. The current paper focused on 1) the chemical and the engineering characterization of the PG on the base of the international literature review; 2) and suggests (a frame work/guide principals) to promote the use of PG in Morocco on the base of the national R&D program results and inspired by IAEA-Technical meeting working group findings and the lesson learned from experiences achieved in the road construction worldwide.

The use of PG has to satisfy three conditions:

the first one, it must meet the safety requirements from the National Regulatory Agency. Owing to: 1) the remaining amount of the phosphoric acid and the high fluoride concentration which may leach fluoride and contaminate the groundwater, if not stored and handled properly; 2) the presence of radio-nuclide radium -226 which upon decay may emits harmful alpha particles; 3) and the likely presence of heavy metals that may enter into the food chain through potable water and agriculture products.

The second one, PG should have benefited from the road regulatory body acceptance once the engineering performance of PG formula tested and monitored. And finally PG should result from the strong desire /willingness of the decision makers to set up a Frame work for mainstreaming the PG use in any applicability gathering all the stakeholders through evidence-based approach, using the vast technical and scientific knowledge base (on the matter, combining Lifecycle analysis tools and life cost methodologies) as well as the appropriate expertise and very well documented Case Studies.

LES VERTÉBRÉS DES PHOSPHATES DU MAROC, FENÊTRE OUVERTE SUR LA PALÉOBIODIVERSITÉ AU TOURNANT CRÉTACÉ-TERTIAIRE (70,6 - 46,6 MILLIONS D'ANNÉES), ÉTAT DES CONNAISSANCES ET PERSPECTIVES FUTURES

JALIL[1,2], N.E., BARDET[1], N., GHEERBRANT[1] & A AMAGHZAZ[3]

[1] Sorbonne Universités -CR2P -MNHN, CNRS, UPMC-Paris6, Muséum national d'histoire naturelle, Paris, France

[2] Université Cadi Ayyad, Faculté des Sciences Semlalia

[3] OCP S.A. (Groupe Office Chérifien des Phosphates), Morocco

La première découverte paléontologique dans les phosphates du Maroc remonte au début du siècle dernier (Brives 1919), mais ce n'est qu'à partir des années 1930 que les études à grande échelle par le paléontologue français C. Arambourg (1935-1952), révélèrent la richesse des phosphates du Maroc en vertébrés fossiles ainsi que l'importance de ces derniers pour dater les dépôts phosphatés. Les grandes lignes de la stratigraphie des divers bassins à Phosphates marocains sont ainsi précisées dès 1935. Les études paléontologiques tombèrent presque dans l'oubli après les travaux pionniers d'Arambourg, elles ne reprirent que dans les années 1970. En dehors de quelques publications ponctuelles sur les crocodyliformes, les chéloniens et les squamates, ces études focalisèrent surtout sur les sélaciens et sur leur signification biostratigraphique pour la datation de la série des phosphates du Maroc.

Plus récemment, les vertébrés des phosphates ont révélé un volet insoupçonné par la découverte des premiers restes de Mammifères (Gheerbrant et al. 1996). L'importance de cette découverte a ravivé l'intérêt des scientifiques et conduit à la signature de deux conventions de recherche franco-marocaines sur la paléontologie des vertébrés des phosphates. La première en 1997 entre le Centre National de la Recherche Scientifique (CNRS), le Groupe Office Chérifien des Phosphates (OCP.SA) et le Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement (MEMEE), et la deuxième en 2005, a vu la participation d'universitaires marocains, Universités Cadi Ayyad de Marrakech (UCAM) et Chouaîb Doukkali d'El Jadida (UCDJ) et du Muséum national d'Histoire naturelle (Paris).

Les travaux pluridisciplinaires dans le cadre de ces conventions ont permis la constitution d'une importante collection paléontologique et un progrès considérable de nos connaissances des vertébrés fossiles des phosphates. Les bassins à Phosphates marocains sont aujourd'hui une référence mondiale pour l'étude de l'évolution des faunes de vertébrés de la fin du Mésozoïque (Maastrichtien) à l'Eocène (Yprésien), une période clé de l'histoire des vertébrés. A l'exception des amphibiens, tous les grands groupes de vertébrés sont présents: « poissons » cartilagineux (élasmobranches), « poissons » osseux (actinoptérygiens), sauropsides (tortues, plésiosaures, squamates, crocodyliformes, ptérosaures, dinosaures non-aviens, oiseaux) et mammifères, soit environ 330 espèces, 190 genres et 88 familles (Bardet et al., sous presse). La plupart des taxons sont marins mais des formes terrestres ont également été découvertes (dinosaures non-aviens, ptérosaures, mammifères). Notre communication donnera la synthèse des connaissances actuelles sur les vertébrés des phosphates, sur les travaux en cours et les travaux futurs.

Par l'étude de ces fossiles exceptionnels, et dans la continuité de cette longue tradition de collaboration franco-marocaine, nos travaux actuels ont un double objectif scientifique et muséologique.

Le premier consiste à: 1- explorer et documenter encore plus la paléobiodiversité et l'évolution (incl. relations phylogénétiques) des faunes et flores des phosphates du Maroc; 2- établir un calage stratigraphique précis en corrélation avec l'échelle stratigraphique standard, en mettant en parallèle les datations issues des sélaciens avec de nouvelles données issues d'études biostratigraphiques et biochronologiques (nano- et microfaunes ex. radiolaires et foraminifères, pollen et dinoflagellés), et géochronologiques (chemostratigraphie, magnétostratigraphie); 3- caractériser le paléoenvironnement et le contexte de dépôt sédimentaire (incl. taphonomie) des taxons et faunes locales; 4- aboutir à des reconstitutions paléobiogéographiques intégrant les milieux de dépôts, les faunes et flores associées et, préciser les implications paléobiogéographiques à grande échelle (aires d'endémismes, dispersions et relations fauniques).

Les richesses fossilifères des bassins des phosphates marocains dépassent l'intérêt local et même national. Elles constituent un patrimoine mondial qu'il faut sauvegarder, enrichir et valoriser. Nos objectifs d'ordre muséologique sont d'accompagner l'OCP dans sa politique citoyenne par une réflexion sur les actions pertinentes à mener pour la sauvegarde et la conservation de ce patrimoine d'intérêt mondial et pour la mise en place d'un centre d'exposition, de partage culturel et de diffusion des découvertes paléontologiques liées à l'exploitation des phosphates.

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LES « DÉRANGEMENTS » DES SÉRIES PHOSPHATÉES DE LA RÉGION DE KHOURIGBA (MAROC): UNE EXPRESSION DE LA KARSTIFICATION DE LA BORDURE NE DU BASSIN ?

MICHEL SÉRANNE
Géosciences Montpellier, CNRS-Université Montpellier, Montpellier, France
EL HASSANE CHELLAI
Faculté des Sciences Semlalia, Université Cadi Ayyad, Marrakech, Maroc

Le gisement de Oulad Abdoun présente des intervalles de sédiments phosphatés affectés de « dérangements ». Ces structures coniques de plusieurs dizaines de mètres de diamètre et affectant plusieurs niveaux stratigraphiques se distribuent avec un espacement, variable, de plusieurs centaines de mètres. Masquées sous la couverture Quaternaire, de telles structures constituent des obstacles à l'exploitation des couches de phosphate. Les conditions géologiques d'apparition de ces dérangements restent mal connues.

Les « dérangements » sont remplis du matériel encaissant bréchifié et fréquemment diagenétisé (silicifié). La périphérie immédiate des dérangements présente un amincissement des intervalles marneux, associé à des figures de cisaillement centripète. Les surfaces de banc montrent des cimentations préférentielles le long de fractures pénétratives, impliquant des circulations de fluides diagenétiques. L'ensemble correspond vraisemblablement à des structures d'effondrement par dissolution et soutirage, similaire aux dolines créées par dissolution karstique des carbonates.

A l'échelle du bassin, les dérangements ne sont présents que le long de la bordure NE, au dessus du Crétacé supérieur (calcaire du Turonien surmonté de marnes gypseuses du Sénonien) et recouvert par une couche de calcaire Lutécien (Dalle à Thercitées). L'ensemble présente un très faible pendage général vers le sud-ouest. Les dérangements pourraient constituer des structures karstiques de soutirage, en liaison avec la dissolution des séries sous-jacentes (calcaires turoniens ou gypse des marnes sénoniennes) qui affleurent immédiatement au N et au NE de la zone.

Plusieurs questions restent néanmoins en suspens pour confirmer cette hypothèse et pour tirer des enseignements sur la distribution ou l'absence de dérangements dans les séries phosphatées sous couverture: Quel est l'événement géodynamique responsable de l'abaissement du niveau de base permettant la dissolution des séries? Quelle est sa chronologie? Quelle est la signification des modifications diagénétiques (marines ou continentales?) rencontrées dans les effondrements?

LIEN ENTRE LE DEGRÉ D'OXYDATION DE LA MATIÈRE ORGANIQUE ET LA NATURE DE L'EXOGANGUE DANS LES PHOSPHATES DE DJEBEL ONK, ALGÉRIE

MOHAMED DASSAMIOUR
Université Ferhat Abbas Sétif 1, Institut d'Architecture et des Sciences de la Terre, Département des Sciences de la Terre, Sétif, Algérie
HAMID MEZGHACHE
Université Badji Mokhtar – Annaba, Département de Géologie, Laboratoire de Recherche en Géologie (LRG), Annaba, Algérie
BRAHIM ELOUADI
Université de La Rochelle, Laboratoire d'Elaboration des Analyses Chimiques et Ingénierie des Matériaux (LEACIM), La Rochelle, France

L'étude de la matière organique (MO) liée aux phosphates sédimentaires du gisement de Kef Essennoun du bassin minier de Djebel Onk (Algérie) a pour objectif la détermination de leur degré de maturation et les conditions de diagenèse.

Plusieurs méthodes d'analyse ont été utilisées: le microscope électronique à balayage (MEB); la microsonde électronique couplée au système d'analyse par l'énergie des rayons X dispersés (SEM-EDXA); la spectroscopie infrarouge à transformée de Fourrier (IRTF) et la résonance magnétique nucléaire (RMN).

Les résultats obtenus montrent que la MO est dispersée sous forme de larges particules dans l'exogangue et sous forme d'endogangue dans les grains phosphatés. Au cours de diagenèse, le degré d'oxydation exprimé par le rapport O/C organique montre que la MO est plus oxydée dans l'exogangue qu'à l'intérieure des pellets. Ce rapport augmente avec l'augmentation du taux de phosphatisation de la matière phosphatée, exprimé par les teneurs en P et en Ca, dans les pellets et augmente beaucoup plus avec l'augmentation du taux de carbonates dans l'exogangue et il diminue avec l'augmentation du taux de silice de l'exogangue. Deux groupements chimiques majeurs ont été déterminés; aliphatique et oxygéné. La forte présence du groupement aliphatique révèle que la MO est restée conservée sous forme humique.

Mots-clés: Microscope électronique à balayage, la résonance magnétique nucléaire, humique.

SÉDIMENTOLOGIE ET STRATIGRAPHIE SÉQUENTIELLE DES CORTÈGES PHOSPHATÉS D'ÂGE MAASTRICHTIEN-YPRÉSIEN DU GISEMENT DE BENGUÉRIR, MAROC

MUSTAPHA MOUFLIH, HAMID EL HADDI, ABDELMAJID BENBOUZIANE
Sedimentary Georesources and Environment Laboratory, Faculty of Sciences Ben M'sik, Hassan II University, Morocco
EL HASSANE CHELLAI
Département de Géologie, Faculté des Sciences Semlalia, Université Cadi Ayyad, Marrakech.
ESSAID JOURANI, YOUSSEF DAAFI
OCP S.A., Morocco

Les phosphates exploitables du gisement de Benguérir sont d'âge Maastrichtien-Yprésien. Ces cortèges, transgressifs sur un substratum paléozoïque, reflètent quatre types de familles de particules phosphatées: les grains phosphatés, les particules ossifères ou bioclastiques, les grains composites ou sédiments remaniés et les coprolithes. Les grains phosphatés représentent, la fraction la plus dominante, jusqu'à 80 % en poids, des classes granulométriques comprises entre 0,04 mm et 2 mm. La dominance d'un type de grains dans l'ensemble de la série n'est pas envisageable.

Cependant, il est réalisable à l'échelle des séquences de dépôts et des étages stratigraphiques. La cartographie des teneurs en P_2O_5 et CO_2 permet d'explorer toutes les évolutions spatiales de ce gisement. L'application de la stratigraphie séquentielle à cette série sédimentaire, nous a permis de déchiffrer l'ensemble des séquences de dépôts de ce gisement, leur évolution et leur géométrie. Les cortèges sédimentaires ainsi énumérés reflètent une dynamique sédimentaire récurrente de périodes de maximum ouverture et d'autres, d'approfondissement. Les périodes d'ouvertures sont des intervalles transgressifs qui développent une sédimentation phosphatée très influencée par 1'hydrodynamisme du milieu. Les périodes de fermeture sont marquées par des sédiments de comblement plus fins carbonatés et argileux Les séquences de dépôt se démarquent globalement par l'irrégularité de leur extension et surtout le caractère lenticulaire de leurs termes phosphatés à la fin de chaque séquence. Les corrélations de ces séquences illustrent un substratum de sédimentation irrégulier qui a influencé en partie les variations latérales des puissances voir le nombre des séquences génétiques enregistrées.

La géochimie et surtout la richesse des niveaux miniers en éléments Traces Zn et Sr argumente une sédimentation marine lente à taux faible. Les teneurs élevés enP_2O_5 sont expliquées par l'action des vagues de tempêtes et les courants marins de l'époque. Un tel canevas est justifiable par la granulométrie, l'aspect et la forme des particules phosphatées ainsi que les figures et les structures sédimentaires observables dans ces faciès.

Mots clés: Phosphates, Maastrichtien, Séquences de dépôts, Hydrodynamisme, stratigraphie séquentielle, Benguérir, Maroc.

ETUDE DE LA CARACTÉRISATION ET DE LA VALORISATION DU MINERAI DE PHOSPHATE DU GISEMENT TOZEUR-NEFTA (TUNISIE MÉRIDIONALE)

WISSEM GALLALA, MARWA SAÏDI
Département des Sciences de la Terre, Faculté des Sciences de Gabès, Tunisie
KAMEL ZAYANI
Campagnie des Phosphates Gafsa, Tunisie

Le gisement Tozeur-Nefta est situé au sud-ouest du bassin phosphaté de Gafsa à environ 12 Km à l'Ouest de la ville de Tozeur. Ce gisement est représenté par un anticlinal à grand rayon de courbure, caractérisé par l'absence d'affleurements apparents.

La série phosphatée du gisement présente une analogie très nette avec celle des autres gisements du bassin avec puissance moyenne de 6 couches exploitables est 10,61m, et une teneur moyenne de Phosphate brut: P2O5:22,67%.

Les échantillons prélevés ont été caractérisé de point de vue granulométrique, minéralogique et chimique. L'analyse de données a permis de calculer les différents paramètres statistiques, les corrélations existantes entre les éléments chimiques, la détermination des associations minéralogiques et des fractions utiles.

Ce travail est complété par un traitement géostatistique des données géochimiques a consisté à l'établissement des cartes de répartition spatiale par krigeage pour chaque élément. Les cartes thématiques obtenues pouvant conduire à l'élaboration d'un modèle géochimique renseignant sur la répartition des oxydes et des métaux de ce district

Mots Clés: Phosphates, Gisement Tozeur-Nefta, Etude géologique, Caractérisation minéralogique et granulo-chimique, Géostatistique, Réserves.

CHEMOSTRATIGRAPHIC CONSTRAINS ON THE PHOSPHATE SERIES OF THE OULEDABDOUNBASIN INMOROCCO BASED ON STABLE ISOTOPE AND TRACE ELEMENT COMPOSITIONS OF FOSSIL REMAINS

LÁSZLÓ KOCSIS[B], JOHAN YANS[C], PEGGY VINCENT[D], NATHALIE BARDET[D], EMMANUEL GHEERBRANT[D], MUSTAPHA MOUFLIH[E], NOUR-EDDINE JALIL[F], HENRI CAPPETTA[G], OMAR SELLOUM[H], M'BAREK AMAGHZAZ[H]

[a] GeoscienceDepartment, Faculty of Science, Universiti Brunei Darussalam, Gadong, Brunei Darussalam

[b] University of Lausanne, Institute of Earth Science, UNIL - Geopolis, CH-1015 Lausanne, Switzerland

[c] University of Namur, Department of Geology, NaGRIDD, Namur, Belgium

[d] Centre de Rcherche sur la Paléobiodiversité et les Paléoenvironnements (CR2P,UMR 7207), Sorbonne Universités, Muséum national d'Histoire naturelle, Université Pierre et Marie Curie, Paris, France

[e] University Hassan II-Mohammedia, Faculty of Sciences Ben M'sik, Casablanca, Morocco

[f] University Cadi Ayyad, Faculty of Sciences Semlalia, Marrakesh, Morocco

[g] Université Montpellier II, UMR 5554, France

[h] OCP S.A., Centre Minier de Khouribga, Service Géologique, Khouribga, Morocco

The phosphorite deposits of Morocco play a very important role in the country's economy, moreover large part of the world's phosphorite reserve can be found here. Besides the economic highlight, the layers are exceptionally rich in marine and, in lesser content, terrestrial vertebrate fossils. Based on theabundant selachian fauna three biostratigraphically distinct periods – Maastrichtian, Danian-Thanetian and Ypresian – can be recognized. These periods largely correspond to sequence stratigraphic units of three, first-order transgressive-regressive cycles. Other biostratigraphic methods could not provide better age estimates for these beds, mainly because of preservation bias. In order to obtain an improved age resolution, a number of comprehensive geochemical studieshave been carried out during the last years on bulk sediments and marine fossils. Stable isotope data across the phosphate series derived from carbon isotope composition of bulk organic matter in the sediments, plus carbon and oxygen isotope compositions of selachian teeth could be correlated with global isotope signals and events.

The most important outcomes based on comparison with the International Geologic Time Scaleare: (a)there is no major phosphate accumulation during the Lutetian; (b) the third megasequence (C) was partly deposited during the Early Eocene Climatic Optimum (lower-middle Ypresian); (c) there was a lack of sedimentation during the late Thanetian and most possibly during the Paleocene-Eocene Thermal Maximum (i.e., gap between megasequences B and C); (d)In the second megasequence (B) the Early Late Paleocene Event is recognized supporting sedimentation during the Selandian. Study on rare earth element (REE) content of the fossils also revealed time-wise variation. While the overall shale-normalized REE patterns are similar in all the fossils and reflect oxic-seawater distribution, Ce-anomaly yielded a clear increase from older to youngerbeds. This "age-wise" change hasalso the potential as a local stratigraphical tool and, with some uncertainties, reworked specimens or fossils of unknown origin may possibly be traced.

GEOLOGY AND MINERALOGY OF PHOSPHORITE CONCRETIONS IN THE MA'AN AREA, SOUTH JORDAN

KHALID TARAWNEH
Faculty of l Engineering, Al Hussein Bin Talal University, Ma'an, Jordan
KHALED MOUMANI
Natural Resources Authority, Geology Directorate, Geological Mapping Division, Amman, Jordan

Phosphorite concretions are recorded for the first time within the lower part of the Umm Rijam Chert Limestone Formation (Eocene) in the Ma'an area, southern Jordan. The phosphorite concretions are typically hosted and encountered as individual layer in moderately lithified sediments of marl, chalk and chalky marl.

The phosphorite concretions are present in thin layer (10–30 cm thick). They are localized on a hardground surface that formed as a result of cementation of soft ground by bioclastic materials. Light grey and brownish to black colors are encountered with isometric, ellipsoid, elongated, subangular to subrounded phosphorite concretions (up to 6 cm in length).Most of the phosphorite concretions preserve bioturbation structures; they also include fecal pellets of various sizes.

The main biogenic components are fragments of macrofossils (bivalves) andmicrofossils (planktonic foraminifera) in different proportions. Petrographic examinations reveal that the phosphorite concretions are composed of cryptocrystalline apatite that characteristically appears in cross-polarized light almost as isotropic phosphate and minor anisotropic phosphate. Apatite and calcite are the main mineral constituents of the phosphorite concretions identified by XRD. The apatite is identified as francolite (carbonate-flour-apatite). Chemical analyses of the phosphorite concretions using X-ray florescence indicate that the P_2O_5 content ranges from 18.8 to 31.19%, whereas SEM–EDS analyses indicate that the phosphorus proportion is around 14% by volume. It could be argued that the phosphorite concretions were transported after being reworked, or were derived from carbonate and chalk pebbles that were later phosphatized and subjected to erosion, forming residual lag deposit along the hardground surface.

Keywords: Eocene, Phosphate, Concretions, Jordan.

THE GEOLOGICAL SOCIETY OF AFRICA, MORE THAN 40 YEARS OF GEOSCIENCE SERVICES IN AFRICA: FUTURE CHALLENGES

HASSAN M HELMY
GSAf Vice President for Northern Africa. Department of Mineralogy, Minia,Egypt
YOUSSEF DRIOUCH
GSAf Councillor for northern Africa Mohamed Ben Abdallah, University Faculty of sciences Dhar El Mehraz. Geology department, Fez. Morocco.
BERRA MOGESSIE
GSAf president. Institute of Earth Sciences,University of Graz, Graz,Austria

The Geological Society of Africa (GSAf) was established in 1973 in Addis Ababa, Ethiopia to encourage geoscientific collaboration and cooperation across the continent. It is an affiliated organization of the IUGS (International Union of Geosciences), Geological Society of America (GSA) and the American Geoscience Institute (AGI). Its main objectives are to promote understanding of the Earth Sciences and improve standards of Earth Science education and research in Africa, as well as providing a forum for discussion and dissemination of information across national boundaries between scientists, associations and institutions engaged in African geology and Earth resources. GSAf also promote the development and sustainable management of the continent's Earth resources, and aim to improve natural hazards assessment and disaster mitigation.

The GSAf works with different organizations and, as part of the expert/ technical group, is actively engaged in helping decision makers formulate the right strategy in these sectors. Organizations we work with include UNESCO/IUGS in Earth Science Education and Research; the ACP (African-Caribbean Secretariat, Brussels); the European Commission (Brussels); the European Federation of Geologists; the African Union (AU) and Economic Commission for Africa (UNECA) on Sustainable Mineral resources management in Africa. We are also a member of the steering committees of the African- European Georesources Observation System (AEGOS) and Geoscience Information in Africa-Network (GIRAF). We also manage, in collaboration with UNESCO, the ANESI program (African Network of Earth Sciences Institutions).

Principally, GSAf calls for sustainable management of the continent's resources, further focus on Africa's young people and emphasises the need for developed countries to view Africa as a partner to work with rather than a continent in need of help. Global phosphate rock demand is rising due to a growing world population and associated food demand, increasing the demand for phosphate fertilizer. With North Africa being the leading countries in global phosphate trading and with the newly established technical and environmental concerns in phosphate industry, GSAf with its well-established international network of specialized organizations can play an important role in increasing the awareness of the Geoscience education centers about phosphate industry as a source of development in Africa and worldwide.

PRELIMINARY DATA OF REE IN ALGERIAN PHOSPHORITES: A COMPARATIVE STUDY AND PALEO-REDOX INSIGHTS.

RABAH KECHICHED [A-B], RABAH LAOUAR [A], OLIVIER BRUGUIER [C], SIHEM LAOUAR-SALMI [A], OUAFI AMEUR-ZAIMECHE [B] & ATIF FOUFOU [D]

[a] Département de Géologie, Université Badji Mokhtar, Annaba, Algérie.

[b] Laboratoire des réservoirs souterrains: pétroliers, gaziers et aquifères, Université Kasdi Merbah Ouargla, Algérie.

[c] Géosciences Montpellier, Université de Montpellier II, CNRS-UMR 5243, Montpellier, France

[d] Faculté des sciences de nature et de la vie. Université Ziane Achour-Djelfa, Algérie

This study deals with the preliminary data of rare earth elements (REE) obtained from northeastern Algerian phosphorites, in the Tébessa region. These phosphorites are located in two different basins: the northern basin represented by Dj. El Kouif, Dj. Dyr and Tazbant showings and the southern basin with the giant Dj. Onk phosphates. The host sedimentary formation is of Late Paleocene to Early Eocene age. Twenty-seven (27) samples from the four (4) localities were collected and analyzed for their REE contents using ICP-MS techniques. The southern basin (Dj. Onk) deposit shows ∑REE contents varying between 174.41 and 906.39 ppm (average ∑REE = 623.01 ppm), while the northern phosphorites have a lower content ∑REE (from 125.45 to 472.44 ppm; average = 265.57 ppm). PAAS-normalized REE patterns and binary Box plot of $(Sm/Pr)_N$ vs $(Sm/Yb)_N$ show enrichment of HREE in the northern localities while the majority of samples are depleted in HREE in the southern basin. Normalized $(La/Yb)_N$ vs $(La/Sm)_N$ plot shows that $(La/Sm)_N$ ratios of all samples are similar to those of modern seawater (from 0.83 to 1.55). However, the $(La/Yb)_N$ ratios of the two basins are significantly higher (from 0.67 to 1.18), which indicates an early digenesis.

The Ce/Ce* vs Pr/Pr* diagram shows that the Ce anomaly recorded by seawater contents was not affected by digenesis and represents more likely redox indication. The obtained results show that northern phosphorites were formed in more oxic environment with more pronounced negative Ce anomalies, whereas, southern phosphorites have low Ce anomalies. Northern phosphorites are different from those of the south probably because the northern basin was more connected with an open sea as did the Sra Ouartan basin in northern Tunisian phosphorites. These results have also been confirmed by statistical methods studies, such as factorial discriminate analysis.

Keywords: Phosphorites, HREE, LREE, Ce anomaly, Tébessa.

MULTIMICROBIAL INOCULANTS: MYCORRHIZAL FUNGI AND ASSOCIATED BACTERIA FOR AN OPTIMAL USE OF PHOSPHATE FERTILIZERS

SILVIO GIANINAZZI
INOCULUMplus sas, Bretenière, France

A healthy soil harbours an enormous diversity of beneficial microorganisms that are essential actors for soil functions: nutrient element and carbon cycling, aeration, water purification, soil structuring, pest control ... Research has identified a number of these as active in solubilizing natural sources of nutrients and/or facilitating plant nutrient uptake. For example in the case of soil phosphate, uptake by plants by a direct pathway is faster than replacement and phosphate close to roots is depleted, inhibiting further uptake, whilst in mycorrhizal plants a specific phosphate uptake and translocation pathway by fungal hyphae continuously delivers phosphate to host cortical cells.

The mycorrhizal pathway is active at soluble phosphate thresholds in soil that are less than what is required by the direct plant pathway, and consequently effective with amounts of phosphate released in soil by the solubilizing activity of bacteria. Therefore, a more rational use of phosphate fertilizers can be achieved in crop production, not only by using mycorrhizal inoculants as such, but moreover by developing new biofertilizers that associate insoluble sources of phosphate with mycorrhizal fungi and bacteria. Such development can also lead to completely new products combining in a unique formulation biofertilizers and soil microbes acting as plant bioprotectors. Results already obtained and perspectives will be presented and discussed.

GESTION ET VALORISATION DES RESSOURCES MICROBIENNES DES SOLS (RHIZOBIUMS ET CHAMPIGNONS MYCORHIZIENS POUR UNE REVÉGÉTALISATION DURABLE DES MILIEUX SAHÉLIENS

TATIANA WADE KRASOVA, IBRAHIMA NDOYE

Laboratoire Commun de Microbiologie IRD/ISRA/UCAD, Centre de Recherche de Bel-Air, Dakar, Sénégal

Département de Biologie Végétale, Université Cheikh Anta Diop, F.S.T., Dakar, Sénégal

La pression foncière, liée à la démographie augmente rapidement, et entraine la dégradation des sols et du couvert végétal, notamment les arbres (sources de sécurité alimentaire, nutritionnelle et économique). Il faut (1) Intégrer les connaissances paysannes dans le choix des espèces et aussi dans l'amélioration des techniques et technologies utilisées par les paysans dans la gestion de l'environnement et l'amélioration de leurs conditions de vie et (2) Proposer des techniques et technologies permettant leur gestion et assurant la diversification des cultures.

L'intégration de ces espèces et les technologies proposées pourraient contribuer à mieux prendre en compte la préoccupation des producteurs dans la mise en place de la Grande Muraille Verte.

Les perturbations observées dans la structuration du couvert végétal (diversité spécifique, abondance) permettent généralement d'évaluer l'impact des phénomènes de désertification dans l'évolution spatio-temporelle de la strate herbacée, arbustive et arborée. Parallèlement, la dégradation du couvert végétal aggrave les effets néfastes des processus d'érosion éolienne et hydrique sur la qualité des sols, en altérant leurs caractéristiques physiques, chimiques et biologiques. Plus particulièrement, la structure et la diversité fonctionnelle de la microflore tellurique, composante fondamentale dans la dynamique des principaux cycles biogéochimiques des sols (C, N et P), est significativement modifiée et peut ne plus remplir son rôle quant au maintien durable de la fertilité des sols et en conséquence, une productivité optimale de l'agrosystème ou de l'écosystème. Parmi les composantes microbiennes majeures particulièrement sensibles à la désertification figurent les rhizobiums et les champignons mycorhiziens, microorganismes évoluant en symbiose avec les plantes et qui sont considérés comme des éléments clés dans le bio-fonctionnement du sol. Ces symbiotes optimisent la nutrition minérale des plantes (N, P) ainsi que leur résistance aux stress biotiques et abiotiques environnementaux.

La gestion de cette ressource microbienne pour améliorer la croissance des plantes dans des sols dégradés est généralement envisagée selon deux approches (1) Une gestion du potentiel mycorhizien par des plantes hautement mycotrophes (ou plantes facilitatrices, pionnières) ou (2) Un apport en masse d'une souche mycorhizienne préalablement sélectionnée pour un donné (mycorhization contrôlée).

MYCORRHIZA-BASED INOCULANTS, A SUSTAINABLE SOLUTION FOR GLOBAL FOOD SECURITY

MOHAMED HIJRI
Institut de recherche en biologie végétale, Département de sciences biologiques, Université de Montréal, Canada

The global population is expected to reach 9.6 billion people by 2050 implying more food production in nutrient-efficient systems will be required to simultaneously meet global food needs while reducing the environmental agricultural footprint. This represents a great challenge for the future of agriculture, since millions of people currently die annually of malnutrition. Plant breeding has increased the genetic potential for yield, but this has leveled off for some crops. Beneficial soil microbes such as mycorrhizal fungi have the potential to enhance crop yield, but their efficiency has yet to be demonstrated in large-scale crop production systems. Here, I collected and analyzed a dataset consisting of 231 field trials in which mycorrhiza-based inoculants were applied in potato fields over a period of four years in North America and Europe. Farmers themselves performed these trials through an international incentive program. Overall, I found a highly significant increase of potato yield (ANOVA, P←0.0001) for inoculated fields (41.8 tons/hectare) compared to the non-inoculated control (38.3 tons/hectare), regardless of the trial year. The average yield increase was 3.92 tons/hectare, 9.5 % of total yield. Importantly, the application of mycorrhiza-based inoculant is profitable at 0.49 tons/hectare yield increase, a threshold reached for almost 80% of the trials. One implication of this is that farmers should be able to reduce by at least 25% the volume of fertilizers they use, which will both save them money and help to mitigate environmental damage from N_2O emissions and cyanobacterial blooms in watersheds. This finding clearly demonstrates the benefits of mycorrhizal-based inoculation on crop yield using potato as a case study, and similar inoculants are also available for other important crops. Further improvements of these beneficial inoculants, combined with controlled or slow release fertilizers, could thus help solve crop production needs and sustainability problems.

MISE AU POINT D'UN ENGRAIS PHOSPHATÉ BIOLOGIQUE POUR AMÉLIORER LA PRODUCTION DU BLÉ (TRITICUM ASTIVUM) CULTIVÉ AU MALI.

AMADOU HAMADOUN BABANA, FASSÉ SAMAKÉ, KADIA MAÎGA, ADOUNIGNA KASSOGUÉ, AMADOU HAMADOUN DICKO, DIAKARIDIA TRAORÉ, ROKIATOU FANÉ, FATOUMA ALHADJI FARADJI

Laboratoire de Recherche en Microbiologie et Biotechnologie Microbienne (LaboREM-Biotech), Faculté des Sciences et Techniques, Université des Sciences, Techniques et Technologie de Bamako, Bamako, Mali

Le phosphate naturel de Tilemsi (PNT), exploité au Mali, est une bonne et peu coûteuse alternative aux engrais phosphatés importés. Les bactéries Thiobacillus thioparus, Thiobacillus thiooxidans and Thiobacillus ferooxidans, sont connues pour leurs capacités à oxyder le soufre et les sulfures des sols et influencer la solubilisation des phosphates inorganiques. Ces bactéries ont un bon potentiel pour améliorer la croissance des plantes. Dans le but d'améliorer la réponse du blé à la fertilisation avec le PNT nous décrivons, dans ce travail, l'isolement à partir de sols agricoles et la sélection de différentes souches de Thiobacille à activités élevées dans la mobilisation du phosphore du PNT.

Initialement, 91 bactéries acidifiantes ont été sélectionnées, mais après 10 repiquages sur milieux gélosés et en milieux liquides, seules quatre bactéries ont été retenues pour leur fort pouvoir de solubilisation du P. Aucun Thiobacillus ferroxidans, n'a été isolé des sols agricoles testés. Une corrélation significative a été observée entre la production d'acide par les souches isolées et la solubilisation du PNT.

Le blé (Triticum aestivum cv. Tetra) a été inoculé avec les souches de thiobacilles sélectionnées et fertilisé avec le PNT ou le phosphate diammonique (DAP) dans un essai au champ conduit à Koygour au Mali. Les paramètres de croissance mesurés étaient la hauteur de la plante à 30 et 60 jours, le nombre de feuilles par tige principale à 60 jours.

La colonisation des racines par les mycorhizes arbusculaires autochtones (MA), de même que le poids de la matière sèche des feuilles et racines, ont également été mesuré chez les plantes âgées respectivement de 45 et 60 jours. Des interactions significatives ont été observées entre l'inoculation avec les thiobacilles solubilsant le phosphore et la fertilisation phosphatée pour la colonisation des racines avec MA, la hauteur des plantes à 30 jours et le rendement en matière sèche des racines. L'isolat bactérien, Thiobacillus thiooxidans AHB36, a causé une augmentation du rendement en matière sèche des racines de 128%. Deux autres isolats bactériens, Thiobacillus thiooxidans AHB411 et Thiobacillus thiooxidans AHB417 ont également causé des augmentations respectives de 60 et 44% du rendement en matières. Le choix de Thiobacillus thiooxidans AHB 436, ainsi que la formulation du BioPNT seront discutés.

Mots-clés: Thiobacilles, phosphate naturel, solubilisation, rendement, Mali.

BIO FERTILIZERS FOR FOOD SAFETY PRODUCTION IN GEORGIA

DR. KAKHA NADIRADZE, MRS. NANA PHIROSMANASHVILI
Association for Farmers Rights Defense, Georgia

Environmental and Ecological stresses are becoming a major problem and productivity is declining at an unprecedented rate in Georgia among organic Farmers. Our dependence on chemical fertilizers and pesticides has encouraged the thriving of industries that are producing life-threatening chemicals and which are not only hazardous for human consumption but can also disturb the ecological balance.

Bio fertilizers can help solve many problems in safe food production and same time when agriculture is facing various environmental stresses. It is important to realize the useful aspects of bio fertilizers and implement its application to modern agricultural practices. The new technology developed using the powerful tool of molecular biotechnology can enhance the biological pathways of production of phytohormones which can help provide relief from environmental stresses.

SYMBIOTIC RHIZOBACTERIA FOR IMPROVING OF THE AGRONOMIC EFFECTIVENESS OF PHOSPHATE FERTILIZERS

K. OUFDOU, N. BECHTAOUI, A. EL ALAOUI, L. BENIDIRE
Laboratory of Biology and Biotechnology of Microorganisms, Faculty of Sciences Semlalia, University Cadi Ayyad, Marrakech, Morocco.
M. GOTTFERT
Technische Universität Dresden, Institut für Genetik, Dresden, Germany
K. DAOUI
Institut National de la Recherche Agronomique, INRA, Maroc

After nitrogen, phosphorus is the main element for plant growth. Most agricultural soils worldwide are deficient in phosphorus and therefore require a contribution of phosphorus for the plant needs. According to Hinsenger (2001), 5.7 billion hectares cultivated over the world are in phosphorus deficiency conditions. There is an urgent and continuing need to improve soil fertility, to increase yields and agricultural productivity and feed. According to the African Development Bank (ADB, 2007), Africa fertilizer consumption is estimated at 8 kg per year per hectare against 120 kg in the world. Forecasts project of the "African Green Revolution" is to reach 50 kg / ha during the next years. During the application of phosphate fertilizers, soluble phosphorus assimilated by plants is rare because of its precipitation and then become unavailable to the plant. Rhizospheric bacteria including the plant growth promoting rhizobacteria (PGPR) are of growing interest for their potential role in improving soil fertility and enhancing an increase of crop yields and their nutrients contents. These bacteria make the insoluble phosphorus in soluble forms during the application of phosphate fertilizers and make the phosphorus available to the plant. This work gives a review and experimental studies on these symbiotic rhizobacteria for improving the agronomic effectiveness of insoluble phosphate.

Keywords: Rhizobacteria, phosphate fertilizers, symbioses, phosphorus deficiency, agronomic effectiveness.

DIAGNOSIS OF PHOSPHORUS REQUIREMENTS FOR COCOA SOILS IN CÔTE D'IVOIRE

L. KOKO
CNRA Divo, Programme Cacao, Divo, Côte d'Ivoire
K.J.C NGUESSAN
Université Félix Houphouët-Boigny
D. SNOECK
CIRAD, UPR Systèmes de pérennes, Montpellier, France

After more than 50 years of cultivation, declining soil fertility in cocoa growing systems in Côte d'Ivoire is recognized as a constraint to sustainable cocoa production. In this context where cocoa yields are relatively low (less than 500 kg / ha), fertilization is required as part of the technology package to improve the productivity of plantations.

A study was conducted to assess the phosphorus fertility of more 600 soils in cocoa areas in order to propose a fertilization program adapted to the current soil and climate conditions.

The diagnosis of soil fertility in cocoa regions showed the existence of a decreasing gradient of phosphorus fertility from the Eastern region to the Western region of Côte d'Ivoire. The low level of phosphorus fertility is closely related to the soil acidity through a large pH levels below 5.5 and calcium deficiency. To improve yields of cocoa on these soils, fertilizers of reactive phosphate rocks could help provide more liming and available phosphorus for the cocoa soils.

Key words: Cocoa, phosphorus, liming, soil acidity, Côte d'Ivoire.

IPNI NORTH AFRICA
CHALLENGES IN NUTRIENT MANAGEMENT UNDER RAINFED AGRICULTURE OF MOROCCO

MOHAMED EL GHAROUS
Consulting Director, IPNI North Africa, Settat, Morocco
HAKIM BOULAL
Executif Director, IPNI North Africa, Settat, Morocco

Agriculture in Morocco has always been a strategic sector for the socio-economic development of the country. Since the country's independence, the agricultural sector has undergone many agricultural and rural development programs and structural reforms to enable the country to achieve food security and contribute to the economic growth.

Fertilizer use in Morocco is still low and covers barely 50% of the real needs. Also, the quantities used in average are well below the recommended ones. The mean consumption is about 50 kg fertilizers/ha with excessive application in some areas. Given this fact, fertilizer use must increase in order to reverse the current trends of low crop productivity and land degradation.

Soils and soil fertility research conducted in Morocco have played a major role in the improvement of fertilizer use. Initial efforts focused on the identification of nutrient constraints in the field, mainly nitrogen and phosphorus. However, despite such developments, the impact at farm level is still far from satisfactory in terms of yield increases.

IPNI North Africa is focusing on the implementation of the concept of 4R Nutrient Stewardship by conducting research platforms on efficient use of fertilizers through the evaluation of fertilizer sources and their application rates and time in dryland and irrigated agriculture under Mediterranean climatic conditions.

The approach is the integrated plant nutrition approach which seeks to improve nutrient-use efficiency, to build up nutrient stocks in the soil, and to limit losses to the environment.

During the last two years several research platforms were conducted in such a way to cover different agro-ecological zones, soil types and cropping systems in order to establish fertilizer recommendations for crops base on the cropping system practiced. Also, brochures, training materials and pocket guides on best management practices were developed. In addition to training, field days and farmers field schools.

Research platforms concerned both cereal and olive tree production systems. Fifty platforms on cereals have been conducted in four different regions in Morocco and one region in Algeria and four platforms on olive trees two in Morocco and two in Tunisia.

ETHIOPIA TRANSFORMING SMALL FARM HOLDERS LIVELIHOOD THROUGH THE APPLICATION OF CUSTOM MADE FERTILIZER

HEZEKIEL TASSE, TEKALIGN MAMO

Ethiopian Agricultural Transformation Agency and Ministry of Agriculture of Ethiopia, Addis Ababa

After many decades of stagnating crop yields, Ethiopia has started to register increased agricultural productivity. The overhaul of the Ethiopian agriculture is characterized by the use of improved crop varieties, agronomic practices and scaling up the implementation of improved land/soil management practices such as rehabilitation of acid soils using lime, increasing productivity of Vertisols or dark clay soils by draining excess moisture using modified plough known as broad-bed maker (BBM)] and promoting the use of compost and bio-fertilizers. These interventions have helped farmers to increase their productivity to some extent but it was lately felt that the potential of growth in agricultural production will be immense if soil fertility status of the country is well understood so that appropriate fertilizers can be recommended to address crop and soil specific fertilizers.

Realizing the knowledge gap in soil fertility information of the agricultural land in the country and in an effort to more than double agricultural production by end of 2015, The Ministry of Agriculture and the Ethiopian Agricultural Transformation Agency jointly launched the Ethiopian Soil Information System (EthioSIS) whose mandate is to assess the fertility status of the agricultural areas of the country and recommend appropriate fertilizers to farmers.

EthioSIS is a project designed to leverage technological platforms that relies on satellite imagery, field observation and laboratory results to forms the basis of geo-statistical predictions so appropriate fertilizer can be recommended at the district level to increase farmers productivity.

In this presentation, we will try to inform the successes made in national soil fertility mapping, establishment of fertilizer blending plants, introduction and popularization of new fertilizers, and the partnership we established with leading fertilizer companies and various programs.

TRANSFORMING WORKPLACE CULTURE AND CLEARING BOTTLENECKS THROUGH MOBILE TECHNOLOGY, INTEGRATED BUSINESS INTELLIGENCE, AND PROCESS CHANGE

DR. SEAN DESSUREAULT
President, MISOM Technologies Inc., Tucson AZ, USA
Associate Professor, Mining Engineering Department, University of Arizona, Tucson AZ, USA

Many processes and systems have been created to improve productivity and safety over the past several decades. However, mines, plants, and other facilities frequently revert to paper-based data collection and reporting especially for compliance to legislation and /or corporate safety standards results. Advances in mine technology, such as, equipment health, ERP's, and operator fatigue monitoring has added to the potential safety data at mine sites.

Meanwhile, the ubiquity of tablets, web-apps, and on-demand business intelligence is creating opportunities to both consume as well as create data digitally, further overloading safety and continuous improvement practitioners. Data overload without prescribed processes and easy access to integrated data reduces the positive impact of initiatives. Modern Business intelligence, with a particular focus on personal interaction, and application of systematic processes can result in cultural transformations leading to improved safety and productivity. Even commercial-grade tablets can be used to capture and consume data in the field improving timeliness, data quality, and detail.

Several case studies at a variety of mines in North America is presented first, to show the benefits of a scorecard process and digital collection of safety data, and second, to show the benefits of a fully deeply integrated mine-to-plant big data system that dramatically improved throughput by focusing on the system's bottlenecks and teams without having to invest additional capacity and capital.

DIGITAL MINING

CODELCO DIGITAL: HISTORY ADVANCES AND CHALLENGES.

MARCO ORELLANA
Codelco, Santiago, Chile

Codelco is the main copper producer in the world, but the industry in which it operates has been intensive in the use of labor with low application of technologies focused mainly on administrative processes and sparsely supporting some production processes with low levels of integration. Thus, the focus of the mining industry towards Information Technology and Communication (ITC) has had greater success in administrative processes, but not on the application of ITC in the mining processes, which represents the core business and where ITC can provide greater value.

The first step to change this approach was to design an adequate vision that describes the mining industry of the future, enabled and supported by new technologies TICAR (Information Technology, Communications, Automation and Robotics): intelligent mining sites with robust and wireless communication platforms, equipped with large quantity and variety of sensors, with robotic platforms and autonomous mining equipment and/or teleoperated (remotely operated), predictive control systems and centralized decision making panels. Thus, it has radically changed the paradigm of mining industry activity based primarily on physical effort to the one where technology and knowledge are the main assets. We called this vision "DIGITAL CODELCO".

In fact, now the future of the company depends on the full implementation of the vision, which allows to successfully adapt to the new market conditions in global mining, for example, variability in copper prices, declining mineral laws, increasing haul distances, the need to protect mine workers in hazardous occupations and ensuring the protection of the environment. Since five years ago until today, "DIGITAL CODELCO" is a fundamental part of our business strategy and has become the icon that represents the company we dream about. Today the field of TICAR is a strategic element integrated into all business processes, especially in the most productive ones of the main activity and the dream mining of the future is more real every day. Today the future of mining depends greatly on the integration of these technologies in both existing mines and new projects, and is a key element for the mining industry in a difficult current global market scenarios.

CISCO EXPERIENCE ON DIGITALIZING THE MINE

DEAN SMITH
Cisco, United Kingdom

The mining industry is evolving, it has to, that much is clear, with declining commodity prices, ageing assets, depleting ore grades and a declining amount of people joining the industry it has to adapt and modernise to make itself more efficient.

As the industry changes and mining companies are all seeking the mine of the future (NOW) the reliance on technology will dramatically increase. The future of mining as we know it will rely on technology to help it streamline operations and build sustainable mining companies that will survive the next fifty years.

This discussion is to focus on how communications technologies can and do aide the connecting "People, Process, Data and Things" and the impact it will have on operations, our lives and the cities we live in.

DIGITAL MINING

INTELLIGENT MINE - OPTIMIZATION, GUIDANCE, ROBOTICS.

MIKHAIL MAKEEV
VIST Group, Russia

Intelligent mine concept is based on the idea of overall automation of the open pit mine combined in one management system. Starting from the drilling planning and guidance using the high precision navigation and moving to quality management using optimal distribution of the trucks between on the excavators and stockpiles at the end the system comes to unmanned technology for mining. Autonomous and tele-operated technology provides the maximum of safety and productivity of mining equipment and make miners live safer and healthy. Intelligent mine will return the investments in less than 1 year period due to increased productivity and safety and, reduced operation costs.

EVOLVING DRAGLINE FLEET APPLICATION: TECHNIQUES TO REDUCE COST

RANDY GOVIER
Caterpillar Global Mining, South Milwaukee, USA

Caterpillar will provide a presentation on the features of various dragline working methods and the effect each has on productivity. The presentation will focus on optimizing the mine plan to reduce cost per ton. Examples will be shown comparing alternative mine plans utilizing draglines and shovel/truck operations, and the effect the dragline working method has on profit margin.

DISRUPTIVE INNOVATION IN DIGITAL MINING

ALEXANDER CONTI
Technology Strategy, Accenture Plant and Commercial Services, São Paulo, Brazil

Mining companies are shifting their strategies and adopting new business and operating models to include new technologies and are doing so on a more rapid and global basis than ever before. A combination of market volatility, changing global demand, radically different input economics, new locations in search of more reserves, a focus on a longer asset lifecycle and a commitment to operational excellence as well as policy shifts around the globe are all contributing to a seismic shift in the industry.

Decades of cost reduction and the aging workforce has left mining companies with limited resources to adjust. Now, a rapidly evolving set of new technologies – the digital transformation – open new possibilities to improve operating efficiency, develop more accurate and agile planning, heighten vendor awareness and collaborate with business partners throughout the value chain.

The mining industry is at the epicenter of this digital transformation, which is very real and can drive considerable differentiation and competitive advantage within the industry. Automation of the mines, new analytic capabilities, digital workers, remote and autonomous operation are just some of the examples where the technologies are disrupting the mining industry today. All of these need to be looked at very closely to drive growth and increase efficiencies.

It is critical for mining companies to understand the digital transformation and its associated opportunities and risks. A more inter-connected and information based operation will continue to push the envelope of what needs human interaction. The possibilities for new operating models and new levels of optimization will create the next wave of differentiation in the industry.

MOBILE WEIGHING SYSTEMS AND DATA TRANSMISSION: SAVE TIME AND MONEY - OPTIMIZE PROCESSES - REDUCE COSTS

MUSTAPHA KOUMIH
Area Sales Manager PFREUNDT GmbH, Südlohn, Germany

Mobile weighing systems offer users a variety of potentials for savings and optimization. The scales used in construction equipment of the mining industry such as in wheel loaders, dump trucks and conveyor belts as well as in other branches of industry. With the machine-integrated scales transport capacities are used optimally, because the loaded weights already known during the loading. So detours to stationary scales can be avoided, transport capacities will not be wasted and costs reduced. Overloads with increased wear, due to overload downtime and increased repair costs can be prevented. This reduces costs, saves time and optimizes the internal processes. With the optional data transmission from the scales to headquarters, the integrated weighing systems also ensure maximum transparency in the logistics and the material movements and can support the logistics planning.

The PFREUNDT GmbH founded in 1979, is one of the world's leading providers of mobile weighing systems. Located in North Rhine-Westphalia (Germany) the company currently employs more than 80 people. The sales and service in foreign countries is provided by subsidiaries and agents in all EU countries, America, India, China, Russia, Mongolia and Australia.

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EXPLORATION OF SULFUR AND POTASH IN MOROCCO: STATE OF PLAY

ADDI AZZA
Ingénieur Général, Ex-Chef du « Projet Soufre »
Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement

The phosphate industry is dependent on three main minerals: phosphorus, sulfur and potassium. These elements are mainly associated with sedimentary deposits whose formation conditions are complex in that phosphates are biogenic sulfur is secondary and potash deposits at the end of evaporate sequences.

As Morocco is a country whose phosphate resources are recognized around the world, as no sulfur or potash deposit is in operation.

For sulfur, after mine Kettara (pyrrhotite) closure, Morocco had undertaken research in Jebilet for massive sulphides and, in 1986, a project to research the native sulfur had been undertaken which had delineated some considered potential areas.

On potash, research had been carried out Khémisset Basin and led to the discovery of carnallite and sylvite mineralization and delimitation of economic interest area.

In this presentation, we will describe the different work done for both the research of sulfur and potash and the results obtained.

INNOVATION IN THE PHOSPHATE INDUSTRY: A REVIEW AND ANALYSIS OF PATENTS RELATING TO THE PHOSPHATE INDUSTRY

BOB STEMBRIDGE
Senior Patent analyst, Thomson Reuters, London, United Kingdom

Although a long-established industry, innovation continues apace in phosphates. From enhancements in extraction processes from mineral ores, through better ways to clean up toxic by-products, to novel compounds and applications of phosphates, the drive for improvements across the industry is never-ending.

Patents are a rich source of technical and competitive intelligence. They provide detailed descriptions of novel technology, are assigned to specifically identified organizations, and as regional rights can provide information about where technologies and companies are developing innovation and seeking to market that innovation.

This paper will provide a review and analysis of patents information relating to the phosphate industry to identify potential emerging hot technologies, key and emerging players and geographical areas of activity and commercial interest.

COMPETITIVE DRIVERS IN THE PHOSPHATES BUSINESS

OLIVER HATFIELD, ADAM PANAYI
Integer Research, Invicta House, London, United Kingdom

This paper will outline and describe the competitive drivers of the phosphate business and how these influence finished phosphates production costs and capacity growth patterns both now and in the future. The paper willdiscuss phosphate rock, ammonia and sulphur market fundamentals and how producers' performance differs based on their integration into raw materials using our extensive research in these product areas.

The paper will draw conclusions on the profitability of the phosphate business and how this has changed over time. Further the presentation will discuss how this is likely to change in the future showing projected cost and profit margins curves for ammoniated phosphates and their raw materials. Finally, the paper will also discuss how the geography of investment has changed over the past two decades and how integrated producers are set to keep the advantage and why.

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