

2nd INTERNATIONAL SYMPOSIUM ON INNOVATION AND TECHNOLOGY IN THE PHOSPHATE INDUSTRY

6-10 May, 2013 - Agadir, Kingdom of Morocco



www.ocpgroup.ma

M. Mohamed AMALHAY
Symphos Project Manager & Program Director, OCP S.A.





A word from the President



Dear SYMPHOS participants,

After a successful first edition in 2011, I am pleased to welcome you, this year, to the second edition of the International Symposium on Innovation and Technology in the Phosphates Industry, in Agadir.

SYMPHOS 2013 is the phosphate industry event of the year, offering a rich technical program and a valuable participation of world renowned experts, scientists, engineers and professionals from active companies in the phosphate industry.

The latest technology and scientific knowledge in various fields will be discussed through :

- 6 exceptional plenary conferences
- 10 keynote presentations
- 144 presentations in 15 themes covering a wide range of professions and areas of interest of the phosphate industry
- 9 short courses on important topics for the phosphate industry
- 3 debate conferences addressing the innovation issue and presenting the guidelines and ethics of writing scientific articles
- 10 workshops addressing the phosphate industry challenges from mining to chemicals and covering all the related themes in more than 40 oral communications.
- 4 novelty show sessions of 4 companies exposing their latest innovations
- 2 site visits to Khouribga & Jorf Lasfar are scheduled for 80 participants
- An exhibition space with more than 100 booths for companies presenting their activities, products and services.
- A space for up to 3450 B-to-B meetings giving you the chance to initiate or develop direct contact with your current or future partners.
- Without forgetting the innovation of this year which is SYMPHOS TV that will cover most of the SYMPHOS 2013 activities.

I hope that this year's edition will be an unforgettable experience for each participant. I am honored to take part in this incredible event that will strengthen not only our sector but our national economies as well. We are all here today because we have the same objectives and ambition to:

- Share knowledge, innovative ideas, sustainable development and economic progress, along our passion for the phosphate industry,
- Learn from each other's experiences;
- Imagine a new future for our field.

Thanks to your participation and involvement, SYMPHOS was a great success in 2011. This year, we look forward to amplifying this experience and taking it to new heights. We are thankful for your presence in Agadir and we hope you enjoy your stay in Morocco.

Mr. Amar DRISSI

EVP operations, OCP
SYMPHOS President





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6-10 May, 2013 - Agadir, Kingdom of Morocco



Sponsored by
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Mr. James HENDRIX	Professor, Department of Chemical & Biomolecular Engineering College of Engineering, University of Nebraska-Lincoln, USA.
Mr. Patrick ZHANG	Research Director – Beneficiation & Mining, Florida Industrial and Phosphate Research Institute FIPR, USA.
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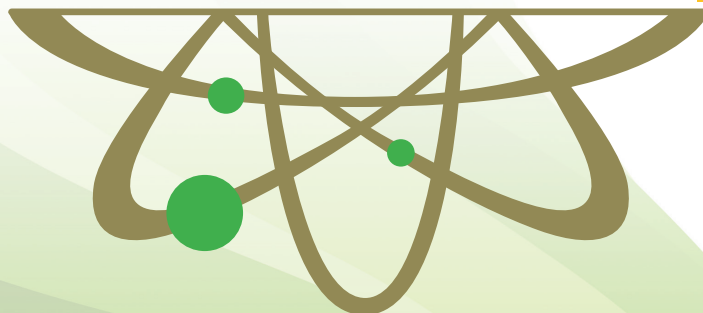


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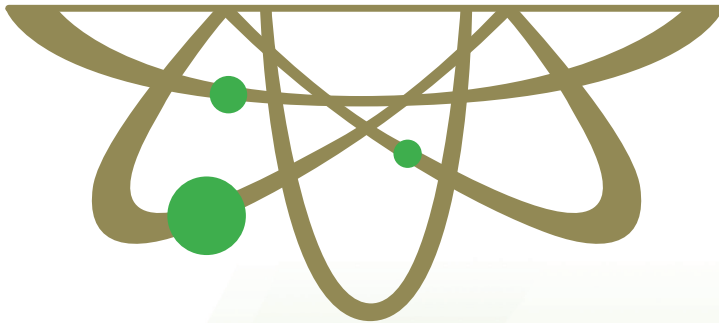
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TECHNICAL PROGRAM





RECEPTION AND REGISTRATION OF PARTICIPANTS

DAYS	Sunday May 5 th to Friday May 10 th
TIME	9:00 am - 7:00 pm
LOCATION	Lobby Hotel Sofitel Royal Bay Resort



OPENING & CLOSING CEREMONIES

OPENING CEREMONY	
DAY	Wednesday May 8 th
TIME	10h00 am -12h00 am
LOCATION	ROOM SAFRAN
CHAIRPERSON	Mr Fouad LAROUÏ - Amsterdam University, Netherlands
PROGRAM	Welcoming remarks from: • The Chairman & CEO of OCP • Moroccan Ministers • The President of SYMPHOS & EVP Operations, OCP
12:00pm - 12:30pm	EXHIBITION AREA INAUGURATION
CLOSING CEREMONY	
DAY	Friday May 10 th
TIME	7:00 pm - 8:00 pm
LOCATION	ROOM SAFRAN
PROGRAM	Closing Speech of Mr. Amar DRISSI EVP operations, OCP & SYMPHOS President



B2B MEETINGS & EXHIBITION VISITS

DAYS	Monday May 6 th - Friday May 10 th
TIME	8:00 am - 7:00 pm



SITES VISITS

DATE	Monday, May 6 th
CIRCUIT	Visits to the OCP facilities Jorf Lasfar & Khouribga



PLENARY & KEYNOTE SESSIONS WEDNESDAY MAY 8TH

TIME: 10:00 am - 12:00 am
LOCATION: ROOM SAFRAN

INAUGURATION	CHAIRMAN : Mr Fouad LAROUÏ – Amsterdam University, NETHERLANDS
	OPENING CEREMONY Welcoming remarks from • The Chairman & CEO of OCP • Morocco Ministers • The President of SYMPHOS & EVP Operations, OCP
	PLENARY CONFERENCE 1: L'Innovation: Concepts, Pratiques et Enseignements M. Elmar Mock Président (Co-créateur de Swatch) – CREAOLIC, Suisse

TIME: 2:00 pm - 3:30 pm
LOCATION: ROOM SAFRAN

MINING	CHAIRMAN : Mr Amit ROY – President and CEO of the international Fertilizer Development Center, USA CO-CHAIRMAN : Mr Houssaine BOUHIAOUI – Directeur Site de Khouribga, OCP – Maroc
	PLENARY CONFERENCE 2: Innovation and technology, Engines for the Future of Mining: DIGITAL CONDELCO'S case Mr. Silva Marco Orellana Chief Information Officer Cdt, Codelco, Chile
	KEYNOTE 1: Mining of Phosphate: Review of mining methods and equipment used in phosphate mines around the world. Mr. Daniel Gagnon P. General Manager – Mining group – Met-Chem, Canada
	KEYNOTE 2: Comprehensive Recovery and Sustainable Development of Phosphate Resource Mr. Patrick Zhang Ph.D. Research Director – Beneficiation & Mining
	Debate with the audience (15 mins)



PLENARY & KEYNOTE SESSIONS THURSDAY MAY 9TH

TIME: 8:30 am - 10:00 am
LOCATION: ROOM SAFRAN

WATER, ENERGY & SUSTAINABLE DEVELOPMENT	CHAIRMAN : Mr David FUNG - Chairman and CEO. ACDEG Group. Canada CO-CHAIRMAN : Mr Jamal Chaouki – Director of Biorefinery Center Chemical Eng. Dept.E Montréal – CANADA
	PLENARY CONFERENCE 3: Lessons in sustainability from the mining industry Mr Robin Batterham Kernot Professor of Engineering & former Group Chief Scientist of Rio Tinto and President of the Australian Academy of Technological Sciences and Engineering. The University of Melbourne AUSTRALIA
	KEYNOTE 3: Building a Business Case for Sustainability Mr. James Weigand President, DuPont Sustainable Solutions - USA
	KEYNOTE 4: Numerical Simulation and High Performance Computing in some industrial applications - Examples in Oil and Gas Industry Mr Philippe Ricoux Directeur IT, Modeling and Numerical Processing, Scientific division; Total SA - France
	Debate with the audience (15 mins)

TIME: 2:00 pm - 3:30 pm
LOCATION: ROOM SAFRAN

MATERIALS & NEW PRODUCTS	CHAIRMAN : Mr. Robin BATERRHAM - Kernot Professor of Engineering & former Group Chief Scientist of Rio Tinto and President of the Australian Academy of Technological Sciences and Engineering CO-CHAIRMAN : Mr Patrick ZHANG – Ph.D. Research Director – Beneficiation & Mining – FIPR - USA
	PLENARY CONFERENCE 4: A forward look into rare earth Supply and demand: a role for sedimentary phosphate deposits? Mr. Patrice Christmann Deputy Director of BRGM's Corporate strategy directorat. BRGM, France
	KEYNOTE 5: Processus Innovation, son articulation et son pilotage Mr. Antoine Dubedout President PROPENERG et responsable de la chaire «Ingénierie et innovation». Ecole des Mines de Nancy, France
	KEYNOTE 6: Energy Storage Opportunities in Morocco Mr. Ilias Belharouk Materials Scientist Energy storage Expert - Argonne National Laboratory. USA
	Debate with the audience (15mins)



PLENARY & KEYNOTE SESSIONS FRIDAY MAY 10TH

TIME: 8:30 am - 10:00 am
LOCATION: ROOM SAFRAN

CHEMICALS	CHAIRMAN : Mr. Lal Rattan - Distinguished University Professor of Soil Science, SENR, USA CO-CHAIRMAN : Mr Mustapha EL OUAFI - Directeur de Production et de Site Jorf Lasfar, OCP SA Morocco
	PLENARY CONFERENCE 5: Rapid growth and evolution of the global chemical industry, Impacts on the Phosphate Industry M. David FUNG. Chairman and CEO. ACDEG Group. Canada
	Keynote 7: Performance Phosphate Products Brand Reveal Mhamed IBNABDELJALIL EVP & Chief Commercial Officer, OCP, MOROCCO
	Keynote 8: From mine to speciality advanced materials, future challenges and potential innovations for the phosphate industry M. Fabrice RENARD Chief Innovation Officer. Prayon, Belgique
	Debate with the audience (15mins)

TIME: 2:00 pm - 3:30 pm
LOCATION: ROOM SAFRAN

AGRONOMY & FERTILIZERS	CHAIRMAN : Mr Fouad Laroui – Amsterdam University, NETHERLANDS CO-CHAIRMAN : Mr Mohamed Mahmoud Ali - Studies Department Manager - AFA , Egypt
	PLENARY CONFERENCE 6: A New food equation Mr. Mohamed Ait KADI President of the General Council of Agricultural Development, Morocco
	KEYNOTE 9: « Food Security and Soil Fertility Restoration in Africa». Mr. Rattan Lal Distinguished University Professor of Soil Science, SENR Carbon Center sequestration, Colombia
	KEYNOTE 10: Cadmium and Phosphorous Fertilizers : The Issues and the Science Mr. Terry ROBERTS President - International Plant Nutrition Institute (IPNI), USA
	Debate with the audience (15mins)



SHORT COURSES

Monday 9:00 am - 1:00 pm / 3:00 pm - 5:00 pm

Room ouarzazate**SHORT COURSE 1:**

ICM versus JORC guidelines, 43-101 regulation for mineral resources and reserves estimation

Dr Daniel Gagnon, Ing. (General Manager – Mining Group, Met-Chem Canada Inc.)
et Schadrac Ibrango, Ph.D., P.Geo. (Senior Geologist, Met-Chem Canada Inc.)

Course language: French

Room tarroudant**SHORT COURSE 2:**

Techniques de flottation des minerais phosphatés

Professeur Mohammed El Asri, Faculté des Sciences et Techniques Fès

Course language: French

Room draa**SHORT COURSE 3:**

The direct use of reactive phosphate rocks in crop production

Mr Abderrahim Nassir and Limamoulaye Cisse (OCP) Sri Rochayati and Husnain Husnain (ISRI)

Course language: English

Room lounge art**Short course 4:**

HSE in design

Mr. Rachid M'Hamdi, Chef de department HSE in Design
et M. Zakaria Rachdad, ingénieur senior au department HSE in design à Jacobs Engineering S.A.

Course language: French

Tuesday 9:00 am - 1:00 pm / 3:00 pm - 5:00 pm

Room tarroudant**SHORT COURSE 5:**

Technologies de Dessalement des Eaux de mer et des Eaux Saumâtres : Aspects Techniques, Energétiques et Exploitation

M. Azzedine Elmidaoui, Professeur (Président de la Société Marocaine des Membranes
et de Dessalement, Université Ibn Tofail, Kénitra, Maroc)

Course language: French

Room zagora**SHORT COURSE 6:**

Mining and Sustainable Management

Mr Rachid Hakkou, Professor at Cadi Ayyad University,
Mr Mostafa Benzaazoua, Professor UQAT, Canada,
Mr. Chawky Beldjelida, Professor at CEGEP Abitibi, Québec, Canada

Course language: French

Room ouarzazate**SHORT COURSE 7:**

Modélisation et simulation des procédés de transformation des phosphates

Pr. Tijani Bounahmidi

Course language: French

Room draa**Short course 8:**

4 R Nutrient Stewardship for Improved nutrient use efficiency

A. Johnston, M. ElGharous, S. Zingore and H. Boulal (IPNI)

Course language: English

Room lounge art**Short course 9:**

Process transformation in production, safety, and sustainability through information technology

Dr Sean Dussereault, Associate Professor - University of Arizona - USA

Course Language : English

Coffee break: 10:45 am - 11:15 am

Lunch: 1:00 pm – 3:00 pm

THEMATIC SESSIONS WEDNESDAY MAY 8TH

	Thematic session 1: Mining, extraction	Thematic session 2: Sulfuric Acid	Thematic session 3: Sustainable development
	Room: Salle SAFRAN Chairperson M. Silva Marco ORELLANA, Chief Information Officer Cdt, Codelco, Chile Co-Chairperson M. EL KASSI, Directeur site Gantour, OCP	Room: ARGAN Chairperson Ms. Kathy HAYWARD, Publisher, Sulfuric acid Today Co-Chairperson M. Ahmed HANINE, Directeur études & développement chimie, OCP	Room: Romarin Chairperson M. Andersen VOKLER, Director, Technical Committee, IFA Co-Chairperson M. Rachid HAKKOU, Professeur Université Kadi Ayyad, Maroc
4:00 pm - 4:20 pm	Méthodes d'extraction des phosphates à l'OCP : Une histoire de ruptures et défis pour la R&D Mr. Mansour Asri, OCP SA, Maroc	Spray Injectors within Large Capacity Molten Sulfur Combustion Spray Efficacy: Fluid-Structure Interaction Study Mrs. Kathleen Brown, Wojciech Kalata, and Rudolf Schick, Spraying Systems Co., USA	Waste valorization in phosphate industry: taking profit from the existing technologies. M. Abdelhak Kabbabi, OCP SA, Maroc, & Mme Hind Baddag, ECOVAL. HOLCIM Group, Maroc
4:20 pm - 4:40 pm	Recent advances precision surface mining techniques, Mr. Stephan Oppelaar, Mr Jim Hutchins. Vermeer EMEA, Netherlands.	Modélisation et développement d'un code de calcul pour la simulation de convertisseurs S02/S03 Mr. Belkacem Abdous, Lhachmi Khamar, Omari Lhoussaine. OCP SA, Maroc	Lead and Cadmium removal from aqueous solution using an industrial by-product gypsum. Mr. Mohamed Raii, Doan Pham Minh, Francisco Javier Escudero Sanz, Ange Nzihou, Ecole des Mines d'Albi-Carmaux, France
4:40 pm - 5:00 pm	ETF Haulage Trucks – Advanced Maintenance Systems. Mr. Eddy De Jongh ETF European Truck Factory GmbH. Germany	H2S Emission Control by Converting to NaHS Mrs. Safaa IbnGhazala, Salaheddine Albustami, Allal Khoudir, Abdessamad Nasri JESA, Maroc	Phosphates Limestone Wastes Drains to Increase pH and Remove Dissolved Metals from Acidic Mine Drainage. Mr. Rachid Hakkou, O. Ouakibi, S. Loqman and M. Benzaazoua LCME, Université Cadi Ayyad Marrakech Maroc
5:00 pm - 5:20 pm	Integrated Support Centres – the future of Dragline fleet monitoring, Mr. Mark Conolly. MineWare Pty Ltd. Austria	Optimization of S02 Scrubber using CFD Modeling Mr. Rudolf Schick, Kathleen Brown, Wojciech Kalata, Spraying Systems Co., USA	Le Management environnemental lors des réalisations des projets industriels : Cas du programme industriel de développement du Groupe OCP Rachid M'Hamdi, Zakaria Rachchad; Raja Al Echcheikh Jacobs Engineering S.A, Maroc
5:20 pm - 5:40 pm	Dragline Retrofit for AC Motion Power. Mr. Michael Casson. Flanders, USA	Polishing Filters, The answer to the increasing need for cleaner sulphur Mr. Jeroen Bouwman, Twin Filter, The Netherlands	Integrated Asset management - An Investment in Sustainability. Mr. Ken Henderson, Georg Pahlenkemper, Olaf Kraska ThssenKrupp Resource Technologies, Germany
5:40 pm - 6:00 pm	Monitoring of mine induced geotechnical hazards: a review of methods, technologies and future directions. Mr Pascal Bigarre, INERIS, France	Conception, réalisation et mise en service d'une « DUCT VALVE » à l'atelier sulfurique de Pakistan Maroc Phosphore Oudie Senhajie OCP SA, Maroc	The Latest Generation Of The Electronic System Mr Sami Kara, William R. Adamson, William J. Reisz, Davey Bickford S.A.S, France
6:00 pm - 6:20 pm	Dust control management in the mining environment MM. Stefan Van Zweek, Louis Ledoux, Dust-A-Side, Centurion, South Africa	Nettoyage et neutralisation des bacs de stockage de l'acide sulfurique par un système à jet automatique EL Bahraoui Abdellah et Arhnafe Elmostafa KIMIA, Maroc	

THEMATIC SESSIONS THURSDAY MAY 9TH

	Thematic session 4: Desalination technologies	Thematic session 5: Phosphoric acid production	Thematic session 6: Geology
	Room Argan Chairperson Mme Myriam BALABAN, Secretary General European Desalination Society Co-Chairperson M. Azeddinne EL MIDAOU , Doyen Faculté des sciences Kénitra - Maroc	Room Safran Chairperson M. Marc COLLIN, Managing Director Prayon Technologies Belgium Co-Chairperson M. Brahim MOUFID , Directeur ODI, OCP	Room Romarin Chairperson M. Patrice CHRISTMANN , Deputy Director of BRGM's Corporate Strategy Directorate, BRGM - France Co-Chairperson M. Essaid JOURANI , Responsable Recherche géologique et minière, OCP SA
10:30 am - 10:50 am	Intake and Brine Discharge in SWRO Desalination : Two Case Studies Mr. Miguel Sanz , Sophie Bertrand Degremont, Spain	The Use of Automatic Controls in a Phosphoric Acid Reactor Mr. Astley Vaughn Dr Phosphate, USA	Reconnaissance géologique des phosphates du Maroc Mr. M'barek Amaghazaz , Es-said Jourani, OCP SA, Maroc
10:50 am - 11:10 am	Current and Future Technologies for Enhanced Desalination Facilities Mr. Abdelkader Gaid , Jérôme Leparç, Philippe Bréant Veolia Water Technical Direction, France	New effective method to reduce sulfates in phosphoric acid NISSAN PROCESS Ahmed Mahrou , A BEN EL BOU - M LOUHZ OCP SA, Maroc	La géologie et la planification minière des gisements de phosphate. Mr. Youssef Daafi , Ahmed Chakir, Essaid Jourani, Sidi Mohammed Ouabba OCP SA, Maroc
11:10 am - 11:30 am	The pretreatment in the reverse osmosis plant Manuel Rubio Visiers AEDyR, Spain	Mersen mixers : An innovative design combining process optimization and energy efficiency Mr. Erik Loiseau MERSEN Brignais, France	Gisements de phosphate d'Afrique de l'Ouest : analogies géologiques et pré-enrichissement naturel des phosphates éocènes de Taïba-Tobène (Sénégal) et Saliquinhé-Farim (Guinée Bissau) Mr. Jean-Pierre Prian BRGM, The French Geological Survey, France
11:30 am - 11:50 am	Optimizing Process Designs with Energy Recovery Devices Mr. Borja Blanco Energy Recovery Inc., USA	From lab to plant: first industrial experience of the new high efficiency dihydrate hemihydrate process (DA-HF) for phosphoric acid production Mr. Tibaut Theys , Ms Dorina Fati, Mr Olivier Schrevens, Ms Agata Tarnowska, Ms Monika Zienkiewicz Prayon & Grupo AZOTY, Belgique	Gestion des risques post-miniers : Opération «Scanning mouvement de terrain». Mr. Frédéric Poulard , INERIS, France
11:50 am - 12:10 pm	Energy Recovery in desalination plants. Mr. Beat Schneider , DWEER	Filtration technologies in phosphoric acid plants. Mr Mohamed Belghiti Alaoui , OCP SA, Maroc	Minéralogie des formes siliceuses de la série phosphatée des Oulad Abdoun (Maroc) Mr. Hamid EL Haddi , Benbouziane Abdelmajid, Mouflih Mustapha, Jourani Es-said & Amaghazaz M'barek Faculté des Sciences Ben M'Sik, Maroc
12:10 pm - 12:30 pm	Advanced pretreatments in large desalination plants Mr. Manuel Fariñas Iglesias , Presented by Mr Mohamed Sebbane Acciona Agua, Spain	Optimization for Tilting Pan Filters Mr. Scott Yeo . Metalcraft Service of Tampa, USA	Geological modelling and estimation techniques of phosphate deposits. Mr. Schadrac Ibrango Met-Chem Canada Inc, Canada

THEMATIC SESSIONS THURSDAY MAY 9TH

	Thematic session 7: Environment	Thematic session 8: OCP Industrial Management	Thematic session 9: Phosphate beneficiation
	Room Argan Chairperson M. François DEMARCO, Directeur Général délégué, BRGM France Co-Chairperson M. Mostafa BENZAAZOUA, Professor, chair holder, University of Quebec A.T. Research Institute in mining and environment	Room Safran Chairperson M. Amar DRISSI , EVP Operations OCP Co-Chairperson M. El Mar MOCK, Président CREAHOLIC, Suisse	Room Romarin Chairperson M. Mohammed EL ASRI, Professeur FST Fès Maroc Co-Chairperson M. Chakour MOUNTASSIR, Maitre de recherche OCP SA
4:00 pm - 4:20 pm	Globalization of Phosphogypsum Regulations Mr. Nadim Fuleihan Ardaman & Associates - USA	OPS-OCP Production System MM. Hassan Chadli & Amine Louali OCP SA, Maroc	Le développement des procédés et des techniques d'enrichissement et de traitement des phosphates à l'OCP. Un chemin vers l'excellence pour assurer l'exploitation rationnelle et équilibrée des gisements de phosphates. Cas du Site de Khouribga. Mr. Alouani Abdelkader, Znibar Ahmed, OCP SA, Maroc
4:20 pm - 4:40 pm	Utilisation des phosphates marocains dans la dépollution des eaux contenant le Cadmium Mrs. Hind Yaacoubi, O. Zidani, M, Mouflih, M.Gourai, S.Sebti FS Ben M'sick, Maroc	OCP industrial Program- Management & innovation in complex industrial program Moutaouikil El Baraka OCP SA, Maroc	New technology for disagglomeration and slurring of Florida phosphate matrix Mr. Hagen Müller , Haver Engineering, Germany
4:40 pm - 5:00 pm	Effect of chemical and thermal treatment on the pollution and geotechnical properties of dredged sediment Mr. Jocelyn Ramarason, M Dia, A. Nzihou, R.Zentar, N.E. Abriak, G. Depelsenaire, A. Germeau Université de Toulouse, Mines Albi, France	Transformation du Management HSE à OCP Mr Ahmed fouda Bahbouhi OCP SA, Maroc	Synergistic effects of environmentally friendly collectors in pre-concentration step of double float process on sedimentary phosphate ore Mr. Klaus-Ulrich Pedain, J.-C. Bezuidenhout, G. Lipowsky Clariant Produce GmbH, Germany
5:00 pm - 5:20 pm	Apatitic calcium phosphate based heavy-metal accumulator: treatment of gas phase pollutions Mr. Ange Nzihou, Mohamed Kemiha, Doan Pham Minh, Nathalie Lyczko, Patrick Sharrock Presented by : Mr Doan Pham Minh Université de Toulouse, Mines Albi, France	OPM- Innovation in managing production units Adil Bachiri OCP SA, Maroc	Procédés de la flottation des phosphates carbonatés et silico-carbonates: Etat de l'art et perspectives Mr. My Brahimi JOUTI, Chakour Mountassir, Hafid Zouhair et Etahiri Abderahman OCP SA, Maroc
5:20 pm - 5:40 pm	Hydroxyapatite and Alizarin sulfonate ARS modeling interactions for textile dyes removal from wastewaters Mr. Mohammed Oimar Mecherri Université de Tizi-Ouzou, Algérie	The Ecosystem Initiative of OCP Group Mr Youssef EL Bari OCP SA, Maroc	Innovative RTS Technology for Dry beneficiation on phosphate Mr. Daniel TAO, Ahmed Sobhy, University of Kentucky, USA
5:40 pm - 6:00 pm	Calcium phosphate sorbent for environmental application Mrs. Nathalie Lyczko Université de Toulouse, Mines Albi, France	OCP Advanced phosphates training Mr Robert Beauchemin, SNC-Lavalin Mr Amine Louali, OCP SA, Maroc	Triboelectric belt separator for beneficiation of minerals Mr. Herve Guicherd , Stephen Gasiorowski, James D. Bittner, Frank J. Hrach Separation Technologies, USA
6:00 pm - 6:20 pm	Composite material with calcium sulfate and calcium phosphate for heavy metals retention Mr. Patrick Sharrock Université de Toulouse, Mines Albi, France		



THEMATIC SESSIONS FRIDAY MAY 10TH

	Thematic session 10: Agronomy and fertilization	Thematic session 11: Industrial Management	Thematic session 12: Materials & corrosion
	Room Safran Chairperson Terry ROBERTS, President IPNI – USA Co-Chairperson Abderahim NASSIR, Agronome en chef – Pôle commercial, OCP SA	Room Argan Chairperson M. Jamal CHAOUKI, Professeur Ecole Polytechnique Montral - Canada Co-Chairperson M. Philippe RICOUX, Directeur IT, Modeling and Numerical Processing, Scientific division Total, France	Room Romarin Chairperson M. Antoine POURBAIX, Directeur CEBELCOR, Belgique Co-Chairperson M. Rachid BOULIF, Maître de Recherche Principal, OCP SA
10:30 am - 10:45 am	Responsiveness of different potato varieties (Solanum tuberosum) to phosphorus application Mr. Khalid DAOUI, A. Benbouaza, and E.H. Achbani, Institut National de la Recherche Agronomique, Maroc	On-Line XRF Analysis of Phosphate Materials at Various Stages of Processing Miss. Jelena Hasikova BALTIC SCIENTIFIC INSTRUMENTS, Latvia	Corrosion et abrasion dans l'industrie des phosphates: problèmes et solutions Ms. Nawal Semlat, R.Boulif, A. Kossir OCP SA, Maroc
10:45 am - 11:00 am	Etude du mélange phosphogypse/ phosphate naturel pour application en agriculture Mrs. Khadija Saja, M.Ouammou, J. C. Benezet, A. EL Kanit, E. Le-Cadre Barthelemy, P.Hinsinger Université HASSAN II à Casablanca, Maroc	Potentiels de développement et d'usage des SNCC dans les Unités de Fabrication d'Acide Phosphorique et des Fertilisants Expérience de Jorf Lasfar, OCP Mr.Mounsiif Ehlali & El Asri Said OCP SA, Maroc	Mersen heat exchangers: Innovations that guarantee reliability, lifespan and energy efficiency Mr. Laurent Trably, Mersen Chemical equipment Activity, France
11:00 am - 11:15 am	4R Nutrient Stewardship for Improved Nutrient Use Efficiency Mr. Adrian Johnston International Plant Nutrition Institute, IPNI, Canada	Gestion et prévention des risques. Mr. Thierry VerdeL Ecole des Mines - Université de Lorraine France	Use of Stainless Steels in the Industry: Recent and Future Developments Mrs. Pauline Boillot, Jérôme Peultier Industeel, ArcelorMittal Global R&D, France
11:15 am - 11:30 am	Nutritive solutions : Innovative fertilizers to help growers meet global food challenge Mrs. Valerie Renard PRAYON, Belgique	Optimizing Value Extraction from Turnarounds Mr. Nicolas Lepeu DuPont Sustainable Solutions - France	
11:30 am - 11:45 am	Deficiency and management options for phosphorus in maize production in East and southern Africa Mr. Shamie Zingore, Boaz Waswa International Plant Nutrition Institute, Kenya	ThyssenKrupp Plant technologies & services for Phosphate ore processing Mr. Luc Rudowski ThyssenKrupp Resource Technologies, France	Metallic Evaporator in Sanicro28 for 54% Phosphoric Acid Mr. EL KAYAR Khaled, Mr. Perrot Vincent Sandvik Materials Technology, E.A.U & ACM Company, France
11:45 am - 12:00 pm	Teractiv Cacao as a new fertilizer based reactive phosphate rock for cocoa productivity in Côte d'Ivoire: A participatory approach to update fertilization recommendation Mr. Louis. K Koko, CNRA, Côte d'Ivoire	Project Management Procedures Needed to Design the Newest Four Phosphoric Acid Evaporators in North America Mr. Richard D. Harrison Pegasus TSI, USA	
12:00 pm - 12:15 pm	Improvement of soil fertility and crop production through direct application of rock phosphate on maize in Indonesia Mrs. Husnain Husnain, Nuryani, Sri Rochayati, A. Nassir ISRI: Indonesian Soil Research Institute, Indonesia	Phosphate Processing Using the Latest Sensor based Sorting Technology Mr Michele Bergmann, Presented by Markus Dehler Tomra Sorting GmbH, Germany	Experience with two high-alloyed super austenitic stainless steels in the phosphoric acid industry – Alloy 31 and Alloy 31 Plus Nicholas Houlle, Helena Alves Outokumpu VDM GmbH, Germany
12:15 pm - 12:30 pm	Efficacy of two Moroccan Sulphur-enriched fertilizers on tea and some important staple crops in smallholder farming in Kenya Mr. Esther ,W Gikonyo, Cisse, L, Kamau, D.N, Mangale N, Mumbua A. and Kibunja, C Kenya agricultural research institute, Kenya		Experience with MICROFER 3127 HMO – ALLOY 31 [UNS8031] Abdelhak MOUSTAQSSA OCP SA, Maroc

THEMATIC SESSIONS FRIDAY MAY 10TH

	Thematic session 13: Fertilizer Manufacture	Thematic session 14: Energy and water	Thematic session 15: Phosphate based materials
	Room Argan Chairperson M. EL OUAFI, Directeur Site Jorf Lasfar, OCP SA Co-Chairperson M. David IVELL, Director of Process Technology, JESA, USA	Room Romarin Chairperson M. Tijani BOUNAHMIDI, Professeur EMI, Maroc Co-Chairperson M. Abdeljalil BOURRAS, Project manager for desalination, OCP SA	Room Draa & Lounge Art Chairperson Mr. Gilles LEFLEM, Directeur de Recherche CNRS - France Co-Chairperson M. Rachid HAKKOU, Ph. D. Professeur, Université Cadi Ayyad, Maroc
4:00 pm - 4:20 pm	Indirect Plate Heat Exchangers offer long term operating performance Mr. Neville Jordison, Jean Marc Reichling Solex Thermal Science, Canada	Optimizing Energy Efficiency: An Imperative for Improved Business Performance Mr. Chris Smith DuPont Sustainable Solutions - USA	Effects of temperature and clay content on microstructure and ceramic properties of phosphate sludge-clay blends Mr. Mohamed Loutou, M.Hajjaji, M.Mansori, R.Hakkou, C. Favotto, M.Benzaazoua, N.Semlal, K.Morsli FSSM, Université Cadi Ayyad, Maroc
4:20 pm - 4:40 pm	Dynamic Operator Training Simulators for Sulphuric Acid, Phosphoric Acid, and DAP Production Units Sergio Joao, Coral Siminovich SNC-Lavalin, Canada	Uranium, the hidden treasure in phosphates Mr. Ewald Schnug, Mr.Nils Haneklaus Technical University Braunschweig, Germany	Comprehension of the phenomena involved in the recovery of uranium from phosphate by D2EHPA/TOPO system and development of new cationic extractants. Mr. Denis Beltrami, A. Chagnes, H. Mokhtari, B. Courtaud, G.Cote. ENSCP, France
4:40 pm - 5:00 pm	Scale-up and On-Line Monitoring of Gas-Solid Systems Using Advanced and Non-invasive Measurement Techniques Mr. Aldahhan Muthanna University of Science & Technology, Rolla, USA	The recovery of Uranium from Phosphoric Acid, the Third Time Around Mr. Astley Vaughn, Regis Stana Dr Phosphate, USA	Phosphate glasses as a new energy density dielectric materials Mr. Lahcen Bih, M. Azrou, A. El Bouari, M. Amalhay, H. Mossadik, B. Belhorma, M.P.F. Graça, M.A. Valente FST-Errachidia, Maroc
5:00 pm - 5:20 pm	The Evolution of Screening Systems for Optimum Granular fertilizer Product Quality Mr. David Ivell, Van T. Nguyen Jacobs engineering, USA	Novel Technique for Fert Phosphoric Acid Purification with Simultaneous Recovery of Uranium Mr. Rohit Sanghani Kamorphos, India	Phosphate Glass Optical Fibers for Electro-optical Applications Mr. M. Rioux, Ledemi, Y; Viens, J.F; Gravel, J.F., Lessard, F.; Messaddeq, Y. Laval University, Canada
5:20 pm - 5:40 pm	Solar to Ammonia - via Proton's Nfuel units Mr. Lucas Laumans, Anish Patil, Hans Vrijenhoef Proton venture, The Netherlands	Comprehension of synergistic mechanisms for uranium extraction from phosphate ores Mrs. Olivia Pecheur, D.Guillaumont, S.Dourdain, F.Testard, H.Mokhtari CEA, France	Electro-chemical phosphate sensor Mr. C.O Normandeau; Viens, J.F.; Messaddeq. Laval University, Canada
5:40 pm - 6:00 pm	A Thermodynamic Model for the NH_4^+ , K^+ // H_2PO_4^- , $\text{H}_2\text{P}_2\text{O}_7^{2-}$, NO_3^- , Cl^- - H_2O System Mr. Patrice Chartrand, Frédéric Gemme and Christian Robelin CRCT, Ecole Polytechnique, Canada	Utilisation du procédé membranaire pour la purification d'acide phosphorique Mrs. Khaoula Khaless, Abdelali Kossir OCP SA, Maroc	High Density Phosphate Olivine for Lithium Batteries M.Ilias Belharouak Argonne National Laboratory, USA
6:00 pm - 6:20 pm	DAP from low grade phosphate, an economically viable process Frédéric Sauvage & Svet Valkov SNC-Lavalin, Belgium	Economie d'Energie dans un Complexe d'Acide Phosphorique Mr. Abdelkader Bourass Freelance, Maroc	



CONFERENCES

DAY : Tuesday May 7th
LOCATION : ROOM ROYALE

9:00 am - 9:45 am	CONFERENCE 1 : INNOVATE - YES YOU CAN Pr. Jamal Chaouki, Principal Chair Holder NSERC - Total Group Director of Biofineray Center Chemical Eng. Dept Ecole Polytechnique de Montréal
9:45 am - 10:45 am	CONFERENCE 2 «INNOVATION» : IMPLEMENTATION OF INNOVATION MANAGEMENT - LESSONS LEARNED Huub Rutten, VP Research and Application Development, Co-Founder, Sopheon
10:45 am - 11:00 am	COFFEE BREAK
11:00 am - 12:30 am	CONFERENCE 3 «ELSEVIER» : HOW TO GET PUBLISHED IN A RESEARCH JOURNAL Dean Eastbury, Executive Publisher Chemical Engineering: Minerals & Separation - Elsevier, Oxford, UK «
1:00 pm - 3:00 pm	LUNCH
3:00 pm - 3:45 pm	CONFERENCE 4: THE AUDACITY TO INNOVATION Lotfi El-Ghandouri, CEO Creative Society Group
3:45 pm - 4:30 pm	CONFERENCE 5: LA CONFIANCE: UN FONDEMENT DE L'INNOVATION Youssef Gaboune, Associate Director MENA, Oxford Leadership Academy Founder, Ethical Leaders™ & How Humans Work™



SYMPHOS TV

DAY	WEDNESDAY MAY 8 TH
TIME	8.00pm -9.00pm
TOPIC	INNOVATION
MODERATOR	MR FOUAD LAROUJ MR EL MAR MOCK
PANEL	MR FRANÇOIS GUINOT, Honorary President - Académie Française des Technologies
	MR HUUB RUTTEN, VP Research and Application Development, Co-Founder - Sopheon
	MR SILVA MARCO ORELLANA, Chief Information Officer Cdt - Codelco



WORKSHOPS WEDNESDAY, MAY 8TH

	Workshop 1: Innovation in Mining Industry	Workshop 2: Phosphogypse management
	Room ATLANTIQUE Chairperson M. Mohamed SMANI, Directeur R&D Maroc Secretary M. Abdellah MAHSOUNE, Responsable Axe Merah-Beni Idir, OCP SA M. Moulay ZEMMARI, Chef projet DCP/MCP OCP	Room ATLAS Chairperson M. Nadim FULEIHAN, President Ardaman Associates USA Secretary M. Ahmed fouda BAHBOUHI, Directeur HSE OCP M. Abdelhak KABBABI, Responsable Environnement OCP
4:00 pm - 4:20 pm	Failure has to be acceptable, Mr. Jamal Chaouki, EPM - Montréal, Canada	The Phosphogypsum Dilemma : Closure Vs beneficial Use Mr. Nadim Fuleihan, Ashraf H.Riad ARDAMAN & Associates, Inc., a Tetra Tech Company, USA
4:20 pm - 4:40 pm	Le processus d'innovation : son articulation et son pilotage. M. Antoine Dubedout. Mines Nancy France	Potentially Heavy Metals Contamination in Tomato and Green pepper Plants Grown in Soils Amended with Phosphogypsum in Jordan. Mr Mohammad Al-Hwaiti, Omar Khashmana. All-Hussein Bin Tala University, Jordan
4:40 pm - 5:00 pm	Integrated Innovation Performance [the overall Sopheon value proposition] M. Michel Delifer. SOPHEON, USA	Beneficiation of Phosphogypsum within sulfur concrete: valorization potential and reuse horizons. M. Mohamed Choura, M. Mohamed Gouider. Sfax University, Tunisia
5:00 pm - 5:50 pm	Debates	Debates
5:50 pm - 6:20 pm	Recommendations and conclusion	Recommendations and conclusion

	Workshop 3: Sustainable Mine	Workshop 4: Smart Mine & Automation
	Room ATLANTIQUE Chairperson M. Abdelkader ALOUANI, Directeur Support Khouribga, OCP Secretary M. Youssef DAAFI, Ingénieur R&D, OCP Mme Meriem EL MEHDI, Responsable Méthodes, Planning et Performance, OCP	Room ATLAS Chairperson Mr. Orellana Silva Marco, Chief Information Officer Cdt& Chief Information Security Officer, CODELCO, Chile Secretary M. Hicham KABBAJ, Testing & Innovation Director, OCP M. Mansour ASRI, Maître de Recherche, OCP
10:30 am - 10:50 am	L'émergence de l'après mine en France, retour d'expérience pour une mine durable Mr. Jean-Luc Foucher BRGM, France	Optimum Fleet Recommendation Komtrax plus Mr. Nicola Roussau KOMATSU France
10:50 am - 11:10 am	La mine durable, rôle de la modélisation numérique dans l'aide à la décision – Exemples de cas industriels Mr. Ahmed Hosni Geoderis, France	Case studies of the success and remaining challenges of automation. Dr. Sean D. Dessureault The University of Arizona Tucson, USA
11:10 am - 11:30 am	Rôle de l'expertise minière Mr. Christophe Didier INERIS, France	Operational excellence in the management of industrial processes Jean Luc Tworek Rockwell, France / USA
11:30 am - 12:20 pm	Debates	Debates
12:20 pm - 12:30 pm	Recommendations and conclusion	Recommendations and conclusion

	Workshop 5: Desalination	Workshop 6: Phosphoric acid process manufacture
	Room ATLANTIQUE	Room ATLAS
	Chairperson M. Azeddine EL MIDAoui, Doyen FS Kénitra - Maroc	Chairperson M. Abdelali KOSSIR, Directeur R&D – OCP SA
	Secretary M. Abdeljalil BOURRAS, Chef de projet Dessalement OCP, SA Mme Khaoula KHALESS, Chargé de recherches OCP	Secretary M. Mohammed BELGHITI, Chef de projet ACP, OCP M. Ahmed MAHROU, Responsable Phosphorique, OCP
4:00 pm - 4:20 pm	SCALE2000 – Logiciel de modélisation des processus thermocinétiques de formation de l'encrassement dans les unités de dessalement M. Mohamed Azaroual BRGM, France	Phosphoric Acid Production Processes Developed by Prayon Mr. Collin, Benoît Van Massenhove PRAYON S.A, Belgique
4:20 pm - 4:40 pm	New Tendencies in Reverse Osmosis plants Mr. Antonio Casañas DOW, Spain	Isothermal Phosphoric Acid Process Richard D Harrison PegasusTSI, USA
4:40 pm - 5:00 pm	TORAY Membrane Product Presentation Haci Özgencil, TORAY, Turquie	Optimal Recirculation Rates in Phosphoric Acid Production James Byrd Jacobs Engineering SA, USA
5:00 pm - 5:20 pm	Innovations in the inhibition and cleaning of reverse osmosis membrane scaling and fouling Stephen P. Chesters Presented by: Mr Stephane Jarrige Genesys International Ltd., United Kingdom	Debates
5:20 pm - 6:00 pm	Debates	
6:00 pm - 6:20 pm	Recommendations and conclusion	
		Recommendations and conclusion



WORKSHOPS FRIDAY, MAY 10TH

	Workshop 7: Fluoride valorisation	Workshop 8: Phosphoric acid filtration technologies
	Room ATLANTIC Chairperson Mr. Fabrice RENARD, Chief Innovation Officer, Prayon BELGIUM Secretary Mr. Fayçal BENAMEUR, Director Market Research & Communication, OCP SA Mr. Lhousaine OMARI, Chargé de recherches OCP	Room ATLAS Chairperson Mr Marten WALTERS, Kemworks, USA Secretary M. Mohammed BELGHITI, Chef de Projet OCP SA Mr. Hamid MAZOUZ, Chargé de recherche OCP SA
10:30 am - 10:50 am	Fluoride and Silica products from Pond Water and FSA Mr. Astley Vaughn Dr Phosphate, USA	Technologie de filtration de profile (filter basculant et TDI) Mr. Erik Desmet, Profile, Belgique
10:50 am - 11:10 am	Economic aspects of utilizing fluosilicic acid as raw material for the manufacture of hydrofluoric acid and aluminium fluoride Mr. Alain Drevet AD Process Strategies Sarl, Switzerland	Phosphoric Acid Filtration Gabriel Ghiringhelli, FLSmith Milano Srl, Italy
11:10 am - 11:30 am	FSA Neutralization with Calcium Compounds Mr. Salah Albustami, Stephen W. Hilakosa Jacobs engineering, USA	Aoustin™ Table Filter, the Logical solution for Filtration of Phosphoric acid Mr Florent Bouquet RPA PROCESS, France
11:30 am - 12:20 pm	Debates	Debates
12:20 pm - 12:30 pm	Recommendations and conclusion	Recommendations and conclusion

	Workshop 9: Flotation	Workshop 10: Fouling in phosphoric acid
	Room ATLANTIC Chairperson M. Daniel TAO, Professor, University of Kentucky, USA Secretary M. Ahmed ZNIBAR, Chef de Projet OCP SA M. Chakour MOUNTASSIR, Maitre de recherche OCP SA	Room ATLAS Chairperson M. EL BAHRAOUI, Directeur Général KIMIA, Maroc Secretary M. Said EL ASRI, Chef de Projet OCP SA M. Kacem ABDOUSS, Maitre de recherche OCP SA
4:00 pm - 4:20 pm	Nouveau mécanisme de flottation – Float Force MM. Luis Rudolphy and A. Khamsine OUTOTEC, Germany	Modélisation et compréhension des problèmes d'encrassement lors de la fabrication d'acide phosphorique. MM. AMALHAY, KHAMAR, AZAROUAL OCP SA - BRGM, Maroc/France
4:20 pm - 4:40 pm	Process and Flotation Cell Design Considerations For Phosphate Applications MM. Asa Weber and JC SERBON FLSMIDTH, USA/France	Amélioration de la performance de la concentration d'acide phosphorique par la réduction du phénomène d'encrassement Mr. Hamid MAZOUZ OCP SA, Maroc
4:40 pm - 5:00 pm		Scale controlling chemical additives for phosphoric acid production plants Mr. John CARR Cytec Industries, Inc., USA
5:00 pm - 5:20 pm		Utilisation de la technique des radiotraceurs pour l'évaluation et la localisation des problèmes d'encrassement dans les unités de fabrication d'acide phosphorique. MM. OMARI & ALAMI OCP / CNESTEN, Maroc
5:20 pm - 6:00 pm	Debates	Debates
6:00 pm - 6:20 pm	Recommendations and conclusion	Recommendations and conclusion



WIRTGEN «TECHNOLOGIES IN SURFACE MINING»

NOVELTY SHOW PROGRAM

Location & Date	Room ROMARIN - Thursday, May 9 th , 2013
Time	8:30 am - 10:00 am
Moderators Name & Occupation	Mr. Andreas Marquardt, WIRTGEN GmbH Mr. Amine Lahrichi, S.M.D.M.
Language	French
Target Audience	Everybody is welcome to attend

Technical Program

Time	Title	Speaker
8:30 – 8:45	Presentation of Wirtgen Group Technology Experience and Machine Distribution in the World	Mr. Andreas Marquardt
8:45 – 9:00	Technical Presentation on Surface Mining & Applications	Mr. Andreas Marquardt
9:00 – 9:15	Experiences and Results in Mines & Minerals Lime Stone, Gypsum, Oil Shale, Coal, Bauxite, Iron Ore, Phosphate	Mr. Andreas Marquardt
9:45 – 10:00	Open Panel Discussion Questions & Conclusions	Mr. Andreas Marquardt Mr. Amine Lahrichi

SYMPHOS TV & Showcase Programs

Time & Location	SYMPHOS TV - 10:00 am - 10:30 am
Presenter's Name	Andreas Marquardt & Amine Lahrichi
Description of the product to expose	
Weight	
Size	



DUPONT SUSTAINABLE SOLUTIONS EMEA

NOVELTY SHOW PROGRAM

Location & Date	Room ROMARIN - Thursday, May 9 th , 2013
Time	2:00 pm - 3:30 pm
Moderators Name & Occupation	Mr. Thierry Marin, EMEA Clean Technologies Director Mr. Giovanni Marchesi, Sales Manager MECS®
Language	English
Target Audience	Everybody is welcome to attend

Technical Program

Time	Title	Speaker
2:00 pm	Welcome speech	Mr. Thierry Marin
2:10 pm	SO2 Emissions: MECS® Innovations for Sulphuric Acid Plants with Clean Technologies	Mr. Giovanni Marchesi
3:00 pm	Q&A session	

SYMPHOS TV & Showcase Programs

Time & Location	
Presenter's Name	
Description of the product to expose	
Weight	
Size	



NOVELTY SHOW PROGRAM

Location & Date	Room ARGAN - Friday, May 10 th , 2013
Time	08:30 am - 10:00 am
Moderators Name & Occupation	Mr. Nicolas Rousseau, European Fleet Manager, Komatsu Europe Mr. Thomas Harsk, Area Manager, Komatsu Mining Germany GMBH Mr. Chakib Benelkhadir, Directeur Général, Stokvis
Language	English / French
Target Audience	Everybody is welcome to attend

Technical Program

Time	Title	Speaker
8:30 – 8:45	Optimum Fleet Recommendations	Mr. Nicolas Rousseau
8:45 – 9:15	KOMTRAX/PLUS (Smart Mining Management System)	Mr. Thomas Harsk
9:15 – 9:30	STOKVIS Skills Program	Mr. Chakib Benelkhadir
9:30 – 10:00	Discussion and recommendations	KOMATSU - STOKVIS

SYMPHOS TV & Showcase Programs

Time & Location	SYMPHOS TV - 10:00 am - 10:30 am
Presenter's Name	Chakib Benelkhadir, Managing Director, Stokvis
Description of the product to expose	
Weight	
Size	



DUPONT SUSTAINABLE SOLUTIONS EMEA

NOVELTY SHOW PROGRAM

Location & Date	Room ROMARIN - Friday, May 10 th , 2013
Time	2:00 pm - 3:30 pm
Moderators Name & Occupation	Mr. Thierry Marin, EMEA Clean Technologies Director Mr. Pascal du Bois d'Enghien, Alloy Project Manager
Language	English
Target Audience	Everybody is welcome to attend

Technical Program

Time	Title	Speaker
2:00 pm	Welcome speech	Mr. Thierry Marin
2:10 pm	Alloy Equipment in Sulfuric Acid Production - Solution for Efficient, Reliable and Safe Operations	Mr. Pascal du Bois d'Enghien
3:00 pm	Q&A session	

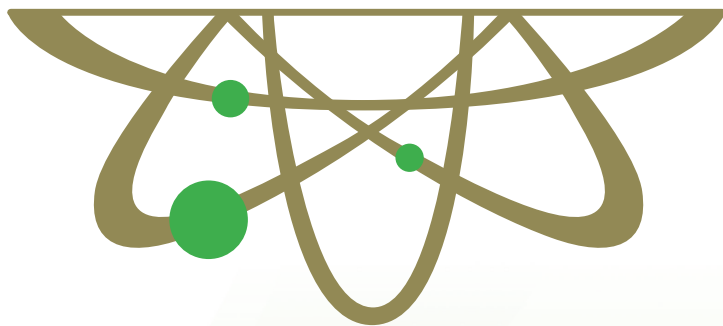
SYMPHOS TV & Showcase Programs

Time & Location	
Presenter's Name	
Description of the product to expose	
Weight	
Size	





PLENARY LECTURES





L'INNOVATION, CONCEPTS, ENSEIGNEMENTS ET PRATIQUES

PL1

El mar MOCK
Creaholic, Switzerland

Comment écloit une innovation de rupture ? Comment les concepts et les connaissances s'influencent-ils réciproquement dans la fabrique de l'innovation ? Quels sont les « états mentaux » des innovateurs ? Cette conférence d'ouverture de SYMPHOS est une opportunité d'échange et de récit du fruit des travaux d'un innovateur en série et entrepreneur reconnu dans le monde des affaires. A travers cette conférence on essayera de transmettre la passion de l'innovation et le désir de comprendre et de faire comprendre les processus créatifs de rupture. On présentera une analyse rigoureuse d'une variété de cas inédits d'innovations « en train de se faire ». En particulier, on présente une grande partie de l'histoire de la conception de la Swatch. De cette formidable innovation, de nouveaux enseignements seront proposés. Cette conférence se veut résolument optimiste. On conclura qu'il n'est pas nécessaire d'être génial pour être innovant. Nous pouvons tous être des innovateurs. Pourtant, l'innovation de rupture est rare et si tout le monde hurle à l'innovation, chacun travaille à l'évolution. L'innovation de rupture est difficile à engendrer et à répéter, mais nous sommes tous responsables de ce qui lui permet d'advenir.

INNOVATION AND TECHNOLOGY, ENGINES FOR THE FUTURE OF MINING: DIGITAL CODELCO'S CASE

PL2

Marco Orellana
Codelco, Chile

Codelco is the main copper producing company at world-wide level, but the industry in which our company develops has been intensive in the use of manual labor with application of technologies focused on its different productive processes but with low integration levels among them.

In particular, the approach of this industry towards the Information and Communications Technologies (ICT) has been applied from administrative procedures. This situation has led to ICT are not considered part of the core business as the Retail industry and Finances, leading to an approach centered in the cost reduction in decline of an approach centered in the creation of value for these technologies.

The first step to change this way was to shape the proper vision that would describe the mining industry of the future, enabled and sustained by the new ICT technologies: intelligent mining sites with robust wireless communication platforms, with robotics, handling remote operations and autonomous equipment to achieve full integration of the complete value chain. Thus, radically changing the mining industry paradigm from an activity primarily based on physical effort to one where technology and knowledge are the principal assets. We named this vision "DIGITAL CODELCO", propelling the company's IT area from a unit just supporting the administrative processes of the company to one that is crucial to its development strategy.

Indeed, now the future of the company depends on fully implementing the vision, allowing it to successfully adapt to new conditions of the world mining market that demand competitive and safe process leading to environmentally friendly high quality standards of life. Five years later, DIGITAL CODELCO is a fundamental part of the business strategy of the company and has become the icon that represents the company we dream of. Today the ICT area is a strategic element embedded in ev» of the company, particularly in the productive ones of the core business and the dream about the mining of the future is more real every day.



A FORWARD LOOK INTO RARE EARTH SUPPLY AND DEMAND: A ROLE FOR SEDIMENTARY PHOSPHATE DEPOSITS?

PL4

Patrice Christmann
BRGM, France

Rare Earth elements, key to many high-technology applications, are regularly making headlines, even in general public newspapers. Will the world run short of rare earth elements and of the many applications who rest on their use?

In support to French and European Union policy making, as well as in support to industrial clients, BRGM is monitoring rare earth markets from the supply and the demand sides, as well as technological shifts that drive them. Not every rare earth element is rare and there are well over 400 ongoing rare earth exploration projects worldwide. Nevertheless, some rare earth elements such as dysprosium, europium and terbium are rare, in high and fast growing demand; as they either are indispensable to the production of Fe-B-Nd (Dy) permanent magnets, the highest performance magnetic material currently being available at industrial scale, or to the production of phosphors essential to the production of fluorescent compact, energy saving, light bulbs and video displays. At the current 10% compound annual growth rate of the demand, for these elements the question arises of their future availability. Among the many rare-earth bearing minerals apatite is of particular interest as a potential source, as it is a widespread mineral, forming huge deposits such as the sedimentary and magmatic phosphate deposits. An overview of the potential of sedimentary phosphate deposits as an important source for future rare earth production is presented and discussed.



GETTING AHEAD OF THE CURVE - SOCIAL LICENSE BEFORE OPERATIONAL EFFICIENCY

PL5

David T. Fung,
ACDEG Group, British Columbia

Many chemical industries are characterized by a combination of resource extraction, chemical processing and product applications. Petrochemicals, synthetic crude from oil sands and phosphates are typical examples. The environmental sustainability of these operations is under growing scrutiny by civil societies.

Environmental protests against phthalates, chemical pesticides, the oil sand extraction and phosphate-induced eutrophication of water bodies have been growing around the globe. In 1996, 82% of the phosphorus loading in Canadian surface and ground water was attributed to phosphates from fertilizer applications. Regulatory restrictions on the use of phosphates in detergents, gardening products and farming have spread across the developed economies and are being adopted in the major emerging economies, including China. It is a serious threat to the sustainable growth of the global phosphate industry.

"Responsible Care" was initiated by the chemical industry in Canada in 1985 and has since been adopted in over 50 countries around the world. Responsible Care is a chemical industry commitment to manage the complete life cycle of chemicals to better society with minimal adverse impacts on the environment and society. It is a voluntary industry



culture of doing the right thing subject to public scrutiny.

Community, including industry, civil society, consumers and regulators, endorsed global standards governing the proper restoration of mine sites and tailing ponds, safe chemicals handling and processing and the responsible application of phosphate products will help to generate broad social acceptance for the phosphate industry to maintain sustainable growth.

A consistently successful community-of-interest standards development framework established and tested by the Canadian Standards Association (CSA Group) of Canada over several decades may offer such a platform for the chemical industry to get ahead of the curve.



A NEW FOOD EQUATION

PL6

Mohamed Ait Kadi

General Council of Agricultural Development, Morocco

In the global context food security faces an uncertain future. Food supply is increasingly threatened by scarcity and degradation of natural resources namely water and land as well as by the growing competition between agricultural, domestic and municipal uses of water and energy.

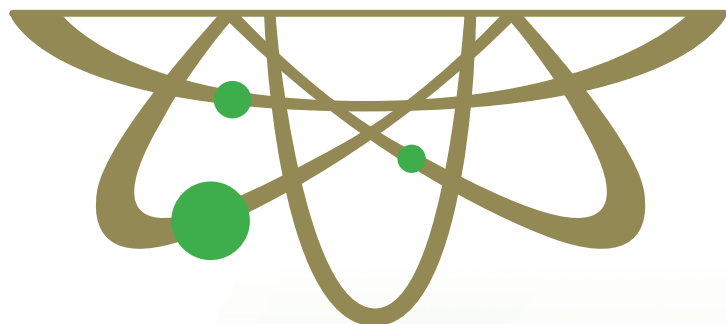
Feeding the world's growing population and finding enough resources to grow food have continued to be basic yet sizeable challenges. These are enormous tasks because the required increase in production to meet future needs will have to be achieved with fewer land and water resources. Many countries lack the luxury of unused resources. Some regions face severe and increasing resource scarcity. South Asia, Near East and North Africa have exhausted much of their rain-fed land, and depleted a significant share of their renewable waters.

In addition to this "hunger for land" and "thirst for water", global agriculture will have to cope with the burden of climate change whose likely impacts have been documented in many reports. Most of them have concluded that the global food production potential is expected to contract severely, yields of major crops like wheat and maize may fall globally. Severe weather occurrences such as droughts and floods are likely to intensify and cause greater crop and livestock losses. The implications are that food prices will rise and their volatility will increase. The 2007-2008 food crisis was an early sign of what is to come.

Heads of states and governments have listed food security as a major global risk. A consensus on a global food security agenda has emerged. It calls for (1) increasing investments in agriculture, rural infrastructure and market access for farmers especially smallholders ones; (2) expanding social protection for the poorest in urban and rural areas; (3) enhancing the efficiencies of agricultural markets through a more transparent and fair global trade; and (4) facilitating agriculture production response by science and technology based solutions.



KEYNOTES





MINING OF PHOSPHATE

REVIEW OF MINING METHODS AND EQUIPMENT USED IN PHOSPHATE MINES AROUND THE WORLD AND HOW SOME OF THESE COULD BE APPLICABLE AT OCP'S OPERATIONS

KN1

Daniel M. Gagnon^a, Abdellah Mahsoun^b

^aMet-Chem Canada

^bOCP, Maroc

Met-Chem Canada Inc. 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 around the world, including Northern Africa and the Maghreb.

This technical paper will review the different mining methods and equipment used in phosphate mining around the world and discuss how some of these methods could or couldn't be effective at OCP's operations.

COMPREHENSIVE RECOVERY AND SUSTAINABLE DEVELOPMENT OF PHOSPHATE RESOURCES

KN2

Patrick Zhang

Florida Industrial and Phosphate Research Institute, USA

It is well known that phosphate is a non-renewable resource essential for plant growth and crop production, and it is, therefore, vital to feeding the fast growing population of the world. But it is not widely aware that there are many other valuable elements in phosphate ore, which may play significant roles in the development of future energy, particularly green energy, high tech equipment, and advancement of various key technologies. These elements include rare earths, uranium and thorium. Uranium in phosphate accounts for more than 80% of the world unconventional uranium resources, while rare earth elements in the world's annual production of phosphate rock (about 170 million tons) total nearly 100,000 tons. If these elements are not recovered during phosphate mineral processing and phosphoric acid manufacturing, they mostly end up in fertilizers and eventually being spread on farm lands, making it impossible to ever recover. Except for the two "waves" of uranium recovery from phosphoric acid when uranium price was high, millions of tons of these critical elements have been discarded with fertilizers and other processing streams. More than 70% of the world phosphate rock is used for making phosphoric acid, which generates 4.3-4.9 tons of waste phosphogypsum (PG) per ton of P₂O₅ produced, depending on the acidulation technology used. PG could be a valuable resource, but only a small fraction is used currently.

Under the stewardship of many phosphate companies worldwide, the Florida Industrial and Phosphate Research Institute and the International Atomic Energy Agency, comprehensive recovery and sustainable development of phosphate resources are becoming the new trend in business planning, production, and research and development. Research in Florida demonstrated that rare earth content and thorium concentration in a flotation tails



could be upgraded by nearly one hundred folds using an inexpensive gravity separation technique.

New development in uranium recovery from phosphoric acid using the ion exchange method achieved encouraging results. Selective solvents have been developed for extracting thorium prior to extraction of rare earth elements from leaching solution. Two of the major phosphate producers in China have achieved PG consumption of over 50%, while Brazil is starting some major PG use projects. Recent industrial practices have demonstrated the potential for sustainable phosphate processing with little waste accumulation. Amazing results have been achieved by some of the “green” phosphate mines, where nearly all solid, liquid and gas wastes are utilized either directly or by further processing and recycling.



NUMERICAL SIMULATION AND HIGH PERFORMANCE COMPUTING IN SOME INDUSTRIAL APPLICATIONS EXAMPLES IN OIL AND GAS INDUSTRY

KN4

Philippe RICOUX
TOTAL S.A., France

Applications in industry are underpinned by research in the field of Engineering Science, and for reducing the number of long and expensive experiments to ones only essential and useful, by more and more numerical simulations. Consequently, industries of all kinds are facing opportunities and challenges driven by the development of “numerics” and the application of High Performance Computing (HPC). The efficient use and successful exploitation of modern HPC therefore play a significant role in delivering increased understanding of realistic engineering problems through high fidelity modeling, simulation, and optimization, and also provide a real advantage of competitiveness for those industries which will know how to benefit.

The topics covered by computational engineering are extremely diverse and cover, for example, earth sciences, oil and gas (seismic, multi fluids flows,...), aeronautics, automotive, nuclear and fusion sciences, transportation,... many applications in the fields of chemistry, biology and life sciences. Many of these fields have interlinked challenges such as energy.

The HPC and numerical simulation development allows merging in many cores applications at the same time improvement of more accurate “physical” model and improvement of numerical methods and algorithms.

HPC allows also facing the challenge in code coupling: both a horizontal direction -multi-physics-, (chemistry and transport, or structural mechanics, acoustics, fluid dynamics, and thermal heat transfer,...) and in the vertical direction -multi-scale models- (i.e. from continuum to mesoscale to molecular dynamics to quantum chemistry) which requires bridging space and time scales that span many orders of magnitude.

All these improvements of numerical simulations are illustrated in the present paper by their application, use and impact in TOTAL (Oil and Gas Company) strategic activities such as:



- Seismic, Depth Imaging by solving waves equation,
- Oil Reservoir modeling by solving transport, thermal and chemical equations,
- Multi scale process modeling and control, such as fluidized bed reactors or slurry loop process,
- Molecular simulation for thermodynamic properties, for polymer development, for adhesion...

In all these domains, for an efficient many core application, the numerical simulation requires the best coupling between computer architecture, multi-physic model, mathematics, numerical analysis and algorithmic. And so, that leads industrial companies to build multidisciplinary teams, which will be one of the key issues of performance and competitiveness in the next future.



LE PROCESSUS D'INNOVATION : SON ARTICULATION ET SON PILOTAGE

KN5

Antoine DUBEDOUT
Société PROPENERG, France

« L'innovation ne se réduit pas à avoir une idée, il faut aussi engager les activités qui vont lui donner toute sa valeur. En termes industriels, il faut enclencher un processus pour transformer cette idée en application réussie. Ce n'est pas une œuvre individuelle, mais un processus transversal qui implique toute l'entreprise et qui doit être mené avec rigueur et dans un souci d'efficacité à tous les stades.

Ce processus n'est pas régulier et continu. Il se décompose en plusieurs phases : création d'idées, sélection des projets et développement. Chacune d'entre elles a sa propre structure et s'appuie sur des compétences spécifiques. Comme pour tout processus industriel, chacune a aussi ses modes de pilotage particuliers avec des objectifs de performance, des moyens de mesure et des leviers d'action. Leur bonne articulation est une condition de succès du processus.

Dans un environnement compétitif, la capacité d'une entreprise à mener le processus jusqu'à son terme devient ainsi un facteur crucial de succès. C'est bien dès l'origine du processus qu'il faut se poser la question des conditions de réussite : qui, quelle organisation, sera le plus à même de le faire aboutir ? »



ENERGY STORAGE OPPORTUNITIES IN MOROCCO

KN6

Ilias Belharouak
Argonne National Laboratory, USA

Lithium battery technology was first commercialized for the consumer electronics industry in the early 90s. The increasing global energy demand, fluctuations in crude oil prices and environmental concerns have made electrification a reality in the vehicle industry. Stationary batteries are also making strides for larger markets such as wind farms and solar plants. Morocco has the potential to be a key player in the international



energy storage arena for the following reasons: 1) reinforcement of the vision of investing in solar and wind technologies by implementing battery systems that can help lessen variability in grid voltage and frequency; 2) valorization of the national mineral resources including phosphates by producing high functionality materials that have energy storage values; 3) reinforcement of the economical and political relations by partnering with Europe on its ambitious efforts in the electrification of vehicles and stationary batteries; 4) accompaniment of the US. Strategic policy on alternative energies; 5) last but not least, incorporation of cutting edge chemical and energy engineering sciences within the Moroccan university and engineering schools. The presentation will shed the light on the latest information and results on materials and technologies for energy harvesting and storage in connexion with some unique opportunities for Morocco.



CADMIUM AND PHOSPHOROUS FERTILIZERS: THE ISSUES AND THE SCIENCE

KN10

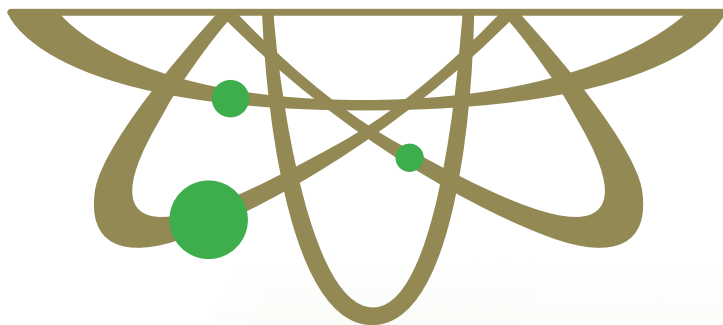
Terry L. Roberts and Armando Tasistro
International Plant Nutrition Institute, USA

Non-nutritive metals, such as cadmium (Cd), occur naturally in all agricultural soils, in soil amendments (e-g, Biosolids), and to varying degrees in phosphatic fertilizers. Public concerns about the occurrence of Cd in fertilizers, because of the potential negative impact on human health, have resulted in government regulations restricting the Cd content of phosphorous (P) fertilizers. This paper will review the health concerns, Cd behavior and availability in agricultural soils and fertilizers, and scientific risk assessments examining the level of health and safety from Cd in fertilizer.





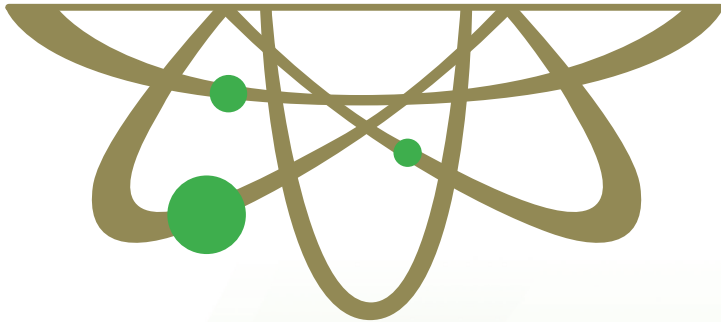
THEMATIC SESSIONS







Mining, Extraction



MÉTHODES D'EXTRACTION DES PHOSPHATES À L'OCP : UNE HISTOIRE DE RUPTURES ET DÉFIS POUR LA R&D

Mansour ASRI

OCP S.A., Morocco

ME1

L'extraction minière à l'OCP commença en mode souterrain dit « classique » avant de connaître une série de transformations dictées autant par des soucis d'adaptation aux conditions changeantes des gisements que par la volonté de l'entreprise d'innover ses modes de production.

Après une période d'une trentaine d'années au cours de laquelle la récupération n'a concerné qu'une seule couche de minerai, d'abord sur le site pionnier de Khouribga et puis une dizaine d'années après à Youssoufia, l'OCP a décidé de remettre en question sa méthode d'extraction en optant parallèlement pour la longue taille (mécanisation du souterrain) et pour l'extraction en découverte. Si la première approche maintenait le principe d'une extraction en monocouche, la seconde ouvrait des perspectives plus intéressantes en rendant possible la récupération sélective des gisements dans des environnements multicouches.

Aujourd'hui, la Recherche et Développement de l'OCP est en face d'un défi majeur car elle a le devoir d'améliorer l'existant et de réétudier les méthodes d'extraction actuelles. Cela concerne aussi bien les méthodes et les technologies dont une partie reste encore à développer que des aspects aussi capitaux que l'environnement et la sécurité.

Les méthodes actuelles, basées sur le principe de l'Open Cast, devront être reconsidérées selon une optique d'optimisation technico-économique et notamment sous l'aspect d'une récupération maximale des gisements dans les meilleures conditions de sélectivité possibles. Cette remise en question des méthodes d'extraction devra inéluctablement s'opérer sous le signe de la rupture et de l'innovation.

Pour être en mesure d'atteindre ce but, la R&D OCP mettra à profit les moyens de recherche disponibles aujourd'hui. Cela va de la modélisation géostatistique à la simulation des processus d'extraction et de transport en passant par la modélisation géomécanique car le défi d'une méthode en multicouche réside en grande partie dans la maîtrise de la stabilité du massif rocheux. Cela passe également par la mobilisation de toutes les synergies en termes de compétences internes et par des partenariats avec les Centres de Recherches Nationaux et Internationaux spécialisés en la matière.

Mots-clés : Extraction, R&D, innovation, rupture, multicouches, sélectivité, récupération des gisements, optimisation, géostatistique, géomécanique, modélisation, simulation, partenariats.



RECENT ADVANCES IN PRECISION SURFACE MINING TECHNIQUES

ME2

Stephan Oppelaar
Vermeer, NETHERLANDS

Jim Hutchins
Vermeer, USA

Precision surface mining is gaining traction in the iron ore, copper, iodine, limestone, bauxite, coal and gypsum markets. In this paper, we first address improvements of surface miner control using GPS techniques. An application in an iron ore mine in Western Australia is presented.

The second item addressed is development of a new drum driving technique for the T1255 Terrain Leveler® surface excavation machine (SEM). This technique involves installing the slow speed hydrostatic motor directly on the cutting drum rather than driving the drum through chain and sprockets. Details of the performance of the direct-drive versus the chain-drive are detailed.

Building upon the success of its T1255 Terrain Leveler SEM, Vermeer has introduced a larger model: the T1655 Terrain Leveler® SEM. This larger machine has 1600 hp (894.8 kw), and has been successfully introduced into a large iron ore mine in Western Australia. Performance of the T1655 Terrain Leveler SEM in various iron ore hardnesses is detailed using GPS tracking techniques.

Some comments on the cost effectiveness of using a built-in loader versus loading with wheel loaders are included.



ETF HAULAGE TRUCKS - ADVANCED MAINTENANCE SYSTEMS

ME3

Eddy de Jongh
ETF European Truck Factory, Germany

ETF has developed a mine haulage truck with a number of unique features that impact positively on productivity, environment, fuel consumption, tire wear, manoeuver and flexibility. The truck is guaranteed to be available for 95% of the time. The modular design of the truck virtually allows all maintenance and repair work to be performed independent of haulage operations. Should a truck require tire replacement it will be done in 15 minutes, the complete axle can be replaced from the truck in 45 minutes.

Should work be required on an engine, it can be replaced in 15 minutes and repaired independent of haulage operation. The modular design and advanced IT systems result in the most advanced maintenance & repair system in the industry in terms of turnaround time, quality of work, and cost.

The maintenance shop includes 24/7 stock updating with automatic parts ordering leading to reduced human error and shortest lead times. The system provides superior



truck performance, 95% technical availability during the full life cycle of the vehicle with sustainable quality improvement and longer life. Automated warrantee processing is also featured. A mine that adopts the ETF truck system is certain to have significantly lower capital, operating, and maintenance costs over the full life cycle of the fleet.



INTEGRATED SUPPORT CENTRES - THE FUTURE OF DRAGLINE FLEET MONITORING

ME4

Mark Connolly
MineWare Pty Ltd, Australia

Overview: MineWare's General Manager shares the vision and journey in creating an Integrated Support Centre for the monitoring of dragline operations.

The global mining industry continues to explore opportunities to improve production efficiency and safety. MineWare's journey in creating an Integrated Support Centre (ISC) at its head office in Brisbane, Australia, is a compelling example of how today's advances in monitoring technology are fast shaping the future of global dragline operations.

Established in the heart of Australia's mining technology centre, the Brisbane-based ISC currently monitors 58 draglines in operation around the world. A leap ahead of traditional dragline monitoring approaches, the centre vastly improves the quality and visibility of production and maintenance data available from some of the industry's largest mining machines.

The prototype centre is the first of its kind, enabling mines to view, measure and understand the performance of their dragline operations more accurately than ever before.

The centre facilitates the fast turn-around time of information to help managers respond quickly and take a proactive approach. It interfaces with multiple draglines and other mining equipment located across the globe, in real time, fully mobilising information and presenting it in a context that builds a complete view of the operation to allow proactive management of the mining assets.

Due to MineWare's strong focus on industry research and development, the ISC has been established as a demonstration centre for industry to see first hand the opportunities presented by the centre's advanced technology infrastructure.

MineWare's General Manager, Mark Connolly is passionate about improving the productivity of dragline operations. He will discuss the significance of the ISC, the industry's growing move towards wireless networking across mine sites, and the opportunities presented by high-bandwidth, high-capacity communication systems.

He will share his insights on how technology will continue to change the way mines collect, analyse and derive value from machine data to improve mine planning, reduce maintenance costs, improve safety and deliver sustained increases in overall mine and machine performance, efficiency and effectiveness.



Key discussion points:

- The team and vision – realising the potential.
- The operating platform, technology infrastructure and environment.
- The journey – obstacles and challenges along the way.
- Benefits and implications for industry including practical examples.
- The future of remote dragline monitoring. What role will integrated support centres play?

About MineWare

As the leading provider of dragline monitoring systems, MineWare has developed a reputation for integrated technologies that optimise mine, machine and operator performance.

MineWare's Pegasys Dragline Monitoring System provides complete and accurate measurement of dragline performance that goes beyond monitoring to improve dragline efficiency, safety, and productivity. Pegasys is also a flexible solution with functionality that can be tailored to fit the specific requirements of any size or type of dragline operation, and integrates to compliment third-party fleet systems.

Pegasys is the system of choice for the leading dragline operations across the world. MineWare's growing client base of global mining sector leaders includes BHP Billiton Mitsubishi Alliance (BMA), Wesfarmers, Anglo Coal, Xstrata Coal, BHP Billiton Energy Coal South Africa (BECSA), Peabody Energy, Prairie Mines, and PCS Phosphate.



DRAGLINE RETROFIT FOR AC MOTION POWER

Michael L. Casson
Flanders, USA

ME5

Dragline motion power systems have remained relatively unchanged for almost 100 years. Over the last few years however, significant advances in potential motion power systems and methodologies have occurred. DC is still by far the most common control system on draglines and many machines will remain DC for many years to come, however technology has advanced to the point that the early problems surrounding AC control for a dragline have been addressed. If a significant investment is to be made to upgrade a machine, particularly one with a role as important as a dragline is to production, it would seem to make sense to invest in current proven technology rather than technology that is many decades old. Today's modern AC drive technology can provide excellent torque regulation in all four quadrants as well as being able to provide full torque at start/zero speed. The proven Flanders AC drive system is the world's only AC drive system designed and built specifically for a dragline retrofit application. The only three large draglines that have been converted in North America have chosen the Flanders system for the significant benefits of increasing both safety and production rates, while decreasing maintenance and utility costs.



MONITORING OF MINE INDUCED GEOTECHNICAL HAZARDS: A REVIEW OF METHODS, TECHNOLOGIES AND FUTURE DIRECTIONS

ME6

Pascal BIGARRE

INERIS, the French National Institute of Industrial Environment and Risks,
France

Monitoring of mine induced geotechnical hazards plays an increasing role in the mine industry. Whether underground or open pit, ground failures are of a rising cost in terms of socio-economics, i.e. safety at work and technical remediation. Then risk management strategies rely increasingly on the combination of numerous methods applied to a wide diversity of hydromechanical issues encountered on the field, at different scales, from slope instability problems in opencast setting to rockburst hazard in deep hard rock mines. Available methods range on a broad spectrum, from the indispensable routinely visual surveys of the ground conditions by mine workers to sophisticated geodetic 3D monitoring of field displacement, based on GPS-RTK or radar terrestrial recent technologies, through passive microseismic monitoring and geotechnical instrumentation of boreholes.

First, monitoring offers a temporary solution for detailed diagnosis of an uncertain situation and then favors a cautious investment strategy in hazard mitigation.

For those situations clearly rated at risks, early warning systems (EWS) may appear as a major component in the prevention plan, providing delay for appropriate decision making, timely action and important investments to be planned.

Eventually, long term real-time monitoring reveals of great help to refine on a continuous basis a hazard scale, rating numerous zones rationally and accurately on quantitative information, to help the mine management deciding for better prioritization of mine development, remediation or vulnerability reduction works.

The intention of the presenter is to give a broad overview of the main geotechnical issues related to the mine industry, the importance and objectives of a monitoring approach and strategy, the principal methods and most recent technologies available, including their application on the field, their benefits and limits.

The presentation will emphasize the potential gain provided by a multi-parameter monitoring approach. Then cloud monitoring technologies and solutions as the next generation tools to ameliorate the cost benefit of global monitoring services to the industry will be evoked, based on the e.cenaris cloud monitoring platform developed by INERIS in France. Such a network centric approach offers seamless access to datasets, easy-to-access and easy-to-read advanced results to be shared in near-to-real-time between mine workers, ground engineers, managers and outsourcing experts whenever needed.



DUST CONTROL MANAGEMENT IN THE MINING ENVIRONMENT

ME7

Stefan Van Sweel

Dust-A-Side, South Africa

Louis Ledoux

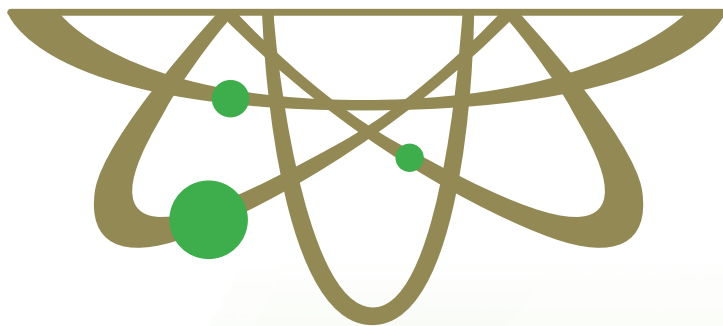
Dust-A-Side, South Africa

Efficient dust control management is becoming a prominent concern in the mining industry worldwide. Transport of material on haulage roads and material handling in the course of industrial processes are significant sources of dust creation in mines. Dust-A-Side, service provider offering total dust control management for the mining industry, have developed, in particular, solutions using bitumen emulsion technology for dust management on haul road and high pressure mist system technology for dust suppression on plant. These technologies have proven successful sustainable solutions and bring additional benefits in term of reduction of water consumption, vehicle fuel consumption and tyre wear.





Sulfuric Acid





SPRAY INJECTORS WITHIN LARGE CAPACITY MOLTEN SULFUR COMBUSTION SPRAY EFFICACY: FLUID-STRUCTURE INTERACTION STUDY

SA1

Kathleen Brown, Wojciech Kalata, and Rudolf Schick

Spray Analysis and Research Services

Spraying Systems Company, USA

An efficient combustion process of large molten sulfur volumes is a requirement in current and future phosphate production technology. The use of precision spray injectors in the combustion of molten sulfur represents an active and growing field. Over the past decade there have been rapid advancements in computer and software technologies for simulation of complex applications. These strides have allowed for more complex simulations at a reasonable cost point for industry engineers, such as the design of spray injectors with stress analysis coupled with fluid dynamics and heat transfer.

A Fluid-Structure Interaction (FSI) study of molten sulfur injectors into a large capacity sulfur combustion chamber was performed with usage of Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA). This work focuses on the FSI results of the detailed spray injector to evaluate suitability of the design to withstand the harsh combustion environment. The structural loads (obtained via FEA) due to stresses exerted by molten sulfur, gas flow and combustion process (obtained via CFD) were combined to define worthiness of the injector for the long term application of up to 25 years of continuous service.



MODÉLISATION ET DÉVELOPPEMENT D'UN CODE DE CALCUL POUR LA SIMULATION DE CONVERTISSEURS SO_2/SO_3

SA2

Belkacem Abdous, Lhachmi Khamar, Omari Lhoussaine

OCP S.A. Maroc

L'industrie de transformation des phosphates au sein du Groupe OCP repose fortement sur l'usage de l'acide sulfurique. Ce dernier est requis lors de la réaction d'élaboration de l'acide phosphorique. Il est également exploité pour produire une grande partie de l'énergie nécessaire au fonctionnement du complexe chimique.

La conversion de l'anhydrite sulfureux SO_2 en anhydrite sulfurique SO_3 est une réaction de catalyse hétérogène réalisée dans des réacteurs à lits fixes (convertisseurs). Elle constitue une étape clé du procédé et dépend de plusieurs paramètres et facteurs.

Pour atteindre des taux de conversion les plus élevés possibles, il est primordial d'avoir une bonne maîtrise des phénomènes et mécanismes se déroulant dans le réacteur de conversion.

Afin d'apprécier les effets et le rôle des paramètres en jeu, nous proposons un modèle phénoménologique et une application informatique qui offrent les possibilités suivantes :

- Calcul de la conversion optimale et détermination du trajet adiabatique permettant de minimiser la quantité de catalyseur utilisé et d'améliorer le taux de conversion.



- Détermination optimale des conditions d'écoulement hydrodynamique de mélanges réactionnels via des modèles phénoménologiques performants.
- Une bonne conduite des procédés de production d'acide sulfurique industriel ;
- Estimation optimale des paramètres de marche des convertisseurs SO_2/SO_3 ;
- Conception et design de nouveaux réacteurs de conversion SO_2/SO_3 ;
- Minimisation des pertes en matière première (soufre)



«H₂S EMISSION CONTROL BY CONVERTING TO NAHS»

SA3

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Emissions regulations are getting strict and there is a growing demand to reach higher sulfur removal from sulfur emissions in chemical facilities.

This paper discusses a scrubbing system for an H₂S gas stream leaving a melting sulfur unit with sulfur recovery as sodium hydrogen sulfide NaHS. The gas stream mainly contains H₂S, water vapor, SO₂ traces and sulfur particles.

The particularity of this work is to treat the H₂S gas stream to produce NaHS with zero liquid effluent, combining a venturi wet scrubber and a simultaneous condensation of water vapor to increase efficiency of scrubbing and NaHS concentration.

Wet flue gas desulfurization process, known as wet scrubbing, is the most popular technique for removing acid gases, predominantly using aqueous alkaline solutions.

The reliability of wet scrubbers has direct impact on facility's ability to ensure compliance with permissible pollutant limits. Environmental legislation that has been introduced in recent years is based on World Bank regulations, where H₂S and SO₂ should do not exceed 5 and 3.6 mg/Nm³ respectively, in the gas stream leaving the stack.

Various types of wet gas scrubbers for removing solid and liquid particles from gases are known, including those which utilize the Venturi effect. This system has many advantages: inexpensive to build, simple operation and the capability of handling a wide range of H₂S gas flow rates. In addition, this system is quite simple in construction and requires minimum start-up time.

In this effort, the inlet gas stream is treated in a venturi to remove sulfur particles. Two recirculating streams "cooled water, caustic soda" are introduced to condensate water vapor and convert H₂S to NaHS respectively. This reaction will produce NaHS and/or Na₂S depending on the pH of the reacted solution. Tight control of pH and sulfide is eminent to produce the favorable NaHS product.



OPTIMIZATION OF SO₂ SCRUBBER USING CFD MODELING

SA4

Kathleen Brown, Wojciech Kalata, and Rudolf Schick

Spray Analysis and Research Services

Spraying Systems Company, USA

The reduction of environmental contaminants that contribute to smog and soot is a worldwide goal that has seen an increased focus in recent years. In the United States, for example, it is estimated that by 2014 new rules will lead to a 71% reduction of sulfur dioxide emissions and 52% of nitrogen oxide emissions as compared to 2005 level. Thus, medium-sized plants (100-500MW) that currently do not have flue gas desulfurization (FGD) units or selective catalytic reduction systems (SCRs) will be required to adapt. Similar emission reduction efforts are expected to be adopted globally, albeit at different levels. Wet-scrubber FGD is characterized as one of the most effective SO₂ removal techniques with low operating costs. However capital cost for implementation is considered high. Hence an effective optimization procedure is required to reduce these capital costs of conversion.

Power plants commonly use a lime slurry spray reaction to reduce SO₂ emissions. Control of the droplets throughout the tower geometry is essential to ensuring maximum reduction while minimizing scale. The liquid slurry is known to have density, surface tension and viscosity values that deviate from standard water spray characteristics, which complicates process optimization. In order to improve the scrubber, nozzle characteristics and placement must be optimized to reduce the cost of the system implementation and mitigate risks of inadequate pollution reduction. A series of large flow rate, hydraulic, hollow cone sprays were investigated for this study.

A Computational Fluid Dynamics (CFD) model was used to examine potential scrubber designs for optimization of the system. Nozzle parameters were modeled to allow particle tracking through the system. An ANSYS Fluent Lagrangian particle tracking method was used with heat and mass transfer. The alkaline sorbent material and SO₂ reaction is modeled to determine uniformity and efficacy of the system. Volumetric chemistry mechanisms were used to simulate the reaction. These results demonstrate the expected liquid-gas interaction relative to the system efficiency. Drop size, liquid rheology, and spray array layout were examined to achieve SO₂ removal above 90%. Wall impingement and flow pattern results were evaluated due to their impact in minimizing equipment plugging and corrosion required as for long-term scrubber utilization.



POLISHING FILTERS, THE ANSWER TO THE INCREASING NEED FOR CLEANER SULPHUR

SA5

Jeroen Bouwman

Twin Filter B.V, The Netherlands

Twin Filter is one of the world leaders in filtration equipment and consumables for air-, gas- and liquid filtration, with its own manufacturing facilities. To guarantee immediate service to our customers all over the world we have sales offices and production facilities in Europe, North America, South America and Australia. We have a strong focus on quality,



environment and working conditions and therefore received the highly recommended ISO 9001 and 14001 certificate.

At Twin Filter we understand the difficulties in sulphur burner plants and its filtration processes. The filtration of liquid sulphur is required to remove solids, which might plug the sulphur spray nozzles or accumulate in catalyst beds. Solid sulphur is generally stored outdoor and will therefore collect dust and dirt from the surrounding environment. Indoor storage will help to minimize the accumulation of dust but will not prevent it. After melting, the sulphur needs to be filtered. The removal of solids reduces maintenance costs and improves the operation of the burners.

Sulphuric acid plants (sulphur burning), need to filter the solid sulphur before it's fed to the burner. The better the filtration process is run, the more solids can be removed from the sulphur. Impurities present in imported sulphur such as ashes, metals, organics can:

- plug spray nozzles;
- contaminate the convertor tower and;
- reduce efficiency of catalyst beds.

Sulphur burning plants are in the process of tightening specifications for liquid sulphur to better protect their acid plants.

This presentation discusses (liquid sulphur) polishing filters as an answer to comply with stricter requirements for liquid sulphur (lower ash levels). In addition polishing filters are known for the ability to correct a malfunction of the primary (pressure leaf) filter. Root causes for such a malfunction are discussed as well.

Liquid sulphur (primary) filters

Sulphur filters vary in size, complexity, capacity and performance and are typically designed for each sulphur burning plant. In general, pressure leaf filters (horizontal tank, leaves in vertical position standing on a manifold) are used to clean the sulphur by a cake filtration process. Filter aids like diatomaceous earth, celite, cellulose or similar, are used to establish a precoat layer. If these filters are well designed and properly operated, the impurity level in the sulphur can be reduced till 10 ppm (expressed as ppm ashes). Typically, the filtrate leaving the primary (pressure leaf) filters, will contain 15-20 ppm on ashes.

In this case, a 1000 MT/day sulphur burning acid plant will accumulate 15-20 kgs of solids. Most of this material will settle in the convertor tower causing higher pressure drops a reducing catalyst activity.

The Twin Filter Liquid Sulphur Filter is one of the most suited filter for sulphur filtration. It is a horizontal filter tank with vertically positioned filter plates. The tank is fully steam jacketed on the sides, dish heads cover closure and all nozzle connections. Filters are normally of Carbon Steel construction. Standard design pressure is 6 bar, with 3,5 bar differential pressure across the filter plates. Steam jacket design pressure is 5,5 bar. The filter should be insulated with a minimum of 50 mm insulation.

The filter is equipped with a bajonet closure, hydraulically operated. Our standard design includes a heated closure flange to prevent solidification of sulphur on the sealing surfaces. The three part quick-opening closure is provided with safety devices which have to be unlocked before opening the filter.



No Disconnection of Piping

Twin Filter offers 2 variations of Vertical Leaf Liquid Sulphur Filters, both systems with fixed piping which offers the best safety and operating conditions for the operators.

Advantages:

- Filter plates stay stationary at all time, no premature cake dropping during retraction.
- No disconnection of piping during cleaning.
- No moving parts such as a chain or cylinder above the filter plates when the filter is opened. The vapors coming from the filter are aggressive and polluting and may cause problems on above moving parts.
- The filter will be supplied on a frame as a “Plug and play” construction. Difficult and time consuming alignment is not necessary.
- All steam connections are combined in a central steam inlet nozzle to enable easy/quick installation.
- In case of a power failure the tank can be manually retracted . • Hydraulically operated with a bajonet closure. • Retractable shell - By having a retractable shell, the filter bundle does not move.

Polishing filters for liquid sulphur filtration

Polishing filters used to filter liquid sulphur are vertical vessels equipped with nominal filter cartridges and are positioned in series with the primary filters discussed before. Commonly, the filter cartridges used for sulphur polishing, are rated 3 to 5 micron (nominal).

By installing these polishing filters in series with the primary filters, the apparent benefits are an improved operation and a reduced number of shutdowns. The level of solids in the liquid sulphur leaving the polishing filter will typically drop 3 ppm (ashes).

In the example of a 1000 MT/day sulphur burning plant, this means that the same acid plant now will accumulate only 3 kgs of dirt (solids) per day. This is a reduction of 80% compared with the situation in which only a primary filter is installed.

The presentation discusses the working principle and design of the polishing filter.

Correction of a malfunction of the primary filter

A malfunctioning primary filter, may cause a sudden hike of impurities ending up in the filtrate leaving it. Causes for a malfunctioning primary filter can be:

- Sudden change in pressure drop over the filter leaves;
- Damage of the filter mesh (that wasn't detected before the filter was put into filtration mode again);
- Inefficient pre coating;
- Un installed filter elements.

If a polishing filter is installed in series, it will stop the impurities before these enter the burner and consequently the convertor tower/acid plant. A sudden hike in pressure drop over the polishing filter alarms the operator that something is wrong in the sulphur burning plant and corrective action is required.

Operation of polishing filters

The last issue that is addressed by the presentation is the choice of filter cartridge and how a polishing filter is typically operated (cleaned).

The demand for polishing filters has grown substantially over the last couple of years. It is the solution to lower the ash levels ending up in the acid plant and it will act as a “police” filter in case the primary filter malfunctions.



CONCEPTION, RÉALISATION ET MISE EN SERVICE D'UNE « DUCT VALVE » À L'ATELIER SULFURIQUE DE PAKISTAN MAROC PHOSPHORE

SA6

SENHAJI OUADIE Azzedine
OCP, Maroc

L'usine de fabrication d'acide sulfurique à Pakistan Maroc Phosphore, s'est trouvée un jour face à un problème technique aux lourdes conséquences en termes de sécurité et de perte de production. En effet, cette unité est équipée d'un système “Duct valve” qui a pour rôle de protéger les équipements en amont et notamment la turbosoufflante contre le retour des gaz chauds, chargés de sulfures pouvant atteindre des températures de 1000°C. Tout mauvais fonctionnement du système précité conduit à des dépôts de sulfates au niveau de la roue de la soufflante, provoquant un balourd et engendrant des vibrations excessives nécessitant la limitation de la capacité de l'unité, voire l'arrêt immédiat de l'usine.

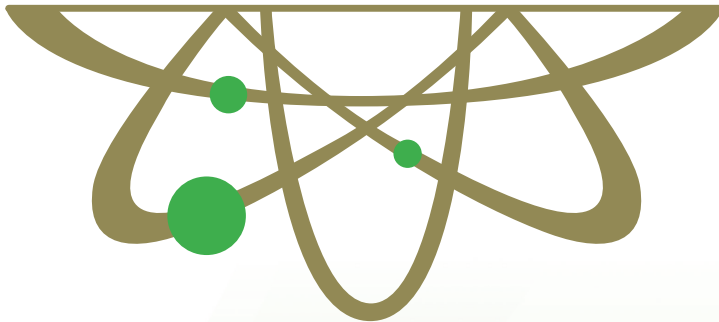
Le “Duct valve” présentait des anomalies répétitives : des vibrations excessives, avec des fissures au niveau du corps, des fuites exagérées de gaz SO₂. Le problème n'a pu être résolu, en dépit de toutes les solutions adoptées pour la remise à plomb du système dans des conditions d'intervention très pénibles (présence massive de SO₂).

La présente communication retrace l'expérience vécue et gérée par les responsables de maintenance mécanique de Pakistan Maroc Phosphore pour palier à cette difficulté technique et éviter tout risque touchant la sécurité du personnel. Après analyse du problème et des difficultés d'inadaptation des réponses des constructeurs et ingénierie de telles unités par rapport aux attentes de Pakistan Maroc Phosphore, l'équipe de maintenance s'est résolue à la conception, la fabrication et la mise en service d'un « Duct valve » au sein des ateliers centraux de Maroc Phosphore. L'étude de design, de dimensionnement, de choix de matériaux et les travaux d'exécution de fabrication et d'assemblage ont duré 6 semaines. La “duct valve” a répondu aux attentes et fonctionne depuis son installation il y a 4 ans sans incident ni anomalie à ce jour.





Sustainable Development



WASTE VALORIZATION IN PHOSPHATE INDUSTRY: TAKING PROFIT FROM THE EXISTING TECHNOLOGIES

SD1

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^aOCP Group S.A., Morocco

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Management of waste is a major concern of industry. However, the efforts made by different industries remain below their ambitions. The reason lies in the fact that they did not implement sufficient processes or procedures for adequate care of their waste.

At OCP, industrial leader in the world of fertilizers and their derivatives, our approach was based on two axes:

- Optimization upstream: to generate the least possible waste.
- A support downstream waste for waste management and develop the ultimate maximum possible waste from other industrial place who themselves have technologies already in place.

In this paper, we will highlight the results of this approach and the partnership that the OCP has begun with other industrial place to take advantage of existing technologies to enhance certain types of waste. The case of a successful pooling of resources between two groups leaders in their fields (OCP Group and Holcim Group) will be treated in recounting the achievements of a recent project, and open other opportunities for development in this sector.

La gestion écologique des déchets fait partie des préoccupations majeures des industriels. Cependant, les efforts consentis par ces dernières restent en dessous de leurs ambitions. La raison réside dans le fait qu'ils ne mettent pas en place suffisamment de procédés ou des procédures pour une prise en charge suffisante de leurs déchets.

A l'OCP, industriel leader dans le domaine des fertilisants et leurs dérivés, notre approche a été basée sur deux axes :

- une optimisation en amont : pour générer le moins possible de déchets.
- une prise en charge en aval des déchets pour gérer les déchets ultimes et valoriser le maximum de déchets possible chez d'autres industriels de la place qui eux, disposent de technologies déjà mises en place.

Dans cette communication, nous mettrons en relief les résultats de cette approche et du rapprochement que l'OCP a entrepris avec d'autres industriels de la place, afin de profiter des technologies existantes pour valoriser certains types de déchets. Le cas d'une mutualisation réussie des moyens entre deux groupes leaders dans leurs domaines (OCP Group et HOLCIM Group) sera traité, en relatant les réalisations d'un projet mené récemment, et ouvrir d'autres perspectives de développement avec ce secteur.

→ LEAD AND CADMIUM REMOVAL FROM AQUEOUS SOLUTION USING AN INDUSTRIAL BY-PRODUCT GYPSUM

SD2

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 Université de Toulouse ; Mines Albi ; CNRS; Centre RAPSODEE, France

Phosphoric acid production is accompanied with the formation of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), which is considered as a by-product. The valorization of gypsum plays an important role from both economic and environmental viewpoints, taking into account great amounts of gypsum generated worldwide.

Our research project aims to valorize an industrial gypsum (IG) as permeable reactive barrier for the remediation of wastewater and groundwater. Firstly, IG was investigated in the removal of model pollutants including lead and cadmium. The adsorption capacity and selectivity of IG were reported and compared to a commercial gypsum (CG). Kinetic adsorption study was performed in order to understand the retention mechanisms, which were also confirmed by chemical simulation. Different chemical and physicochemical characterizations and analyses (XRD, TG-DSC, BET, SEM, ICP-AES etc) were used to determine the morphology, crystalline phase, surface and composition of adsorbents before and after use.

Keywords: calcium sulfate, valorization, adsorption capacity, wastewater treatment.

→ PHOSPHATES LIMESTONE WASTES DRAINS TO INCREASE PH AND REMOVE DISSOLVED METALS FROM ACIDIC MINE DRAINAGE

SD3

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Alkaline precipitation of heavy metals from acid mine drainage (AMD) is a popular and long standing treatment process. As this process is efficient, it requires continuous addition of an alkaline material such as lime. This process becomes expensive for a long-term effluent treatment or when treating large volumes. In Morocco, sedimentary phosphate mines located in the neighboring region of contaminated sites such as the abandoned pyrrhotite Kettara mine, which generates a highly contaminated AMD, produces large quantities of the overburden waste rock or Phosphate Limestone Wastes (PLW) which contains significant quantities of calcite (46 wt%) and dolomite (16 wt%).

The efficiency of PLW as an alternative alkalinity generating material for the passive treatment of AMD was assessed in the laboratory. Series of experiments were designed for the passive treatment of a low pH (3) AMD synthetic solution containing 500 ppm Fe, 3,4 g/L SO_4 , 220 ppm Ca, 160 ppm Al, 20 ppm Mn, 15 ppm Zn, 23 ppm Cu, and traces of Co, Cr and Ni. The tests are realized both in anoxic and oxic conditions: in batch and in columns having a hydraulic retention time of 24 and 15 hours respectively. Carbonates from



phosphate limestones wastes can be effective for increasing the alkalinity and pH of AMD water, causing precipitation of heavy metals. For the batch tests, the results show that the neutralizing capacity of PLW by different particles size is similar. The initial pH AMD value increases from 3 to values between 5 to 6.5 during the batch tests and between 6.5 to 8 in the columns. After 48 hours of the tests in the batch of anoxic and oxic conditions, the increase in pH and alkalinity is accompanied by a significant decrease in the concentration of metals as Fe (500 to 120 ppm), Al (160 to 1.7 ppm) and Cu (23 to 0.002 ppm). In the case of columns, the obtained result is Fe (618 to 300 ppm), Al (177 to 2.5 ppm), Cu (26 to 0.002 ppm).

Keywords: Water pollution, acid mine drainage, passive treatments, anoxic and oxic limestone drains, Phosphate mine wastes



LE MANGEMENT ENVIRONNEMENTAL LORS DES RÉALISATIONS DES PROJETS INDUSTRIELS : CAS DU PROGRAMME INDUSTRIEL DE DÉVELOPPEMENT DU GROUPE OCP

SD4

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^aJacobs Engineering S.A, Maroc

Le Groupe OCP SA a entrepris un vaste programme de développement de ses capacités minières et industrielles dans l'axe Khouribga - Jorf lasfar.

Dans ce cadre ses projets à Khouribga : Laverie El Lahlassa, les adaptations MEA et Daoui et le projet Slurry Pipeline d'acheminement de phosphates via un minéroduct vise l'augmentation de la capacité de production annuelle de la mine de Khouribga de 20 Mtpa à 38 Mtpa (avec possibilité d'extension à 44 Mtpa) à l'horizon 2020.

Le projet Jorf Phosphate Hub (JPH) situé au complexe chimique de Jorf lasfar consiste à construire plusieurs usines : Downstream ; dix nouvelles usines de productions d'engrais, l'extension et la modification des usines existantes de Maroc Phosphore MP III et IV et les infrastructures JPH pour desservir toutes les nouvelles installations de production.

L'OCP exige, dans le cadre de la réalisation des études d'impact sur l'environnement pour ces projets, le respect des exigences en matière d'environnement établies par l'état Marocaine et les organismes internationaux tels que l'Agence américaine de protection de l'environnement et les bailleurs de fonds : Banque Mondiale, Agence Française de développement (AFD), la Banque Islamique de développement (BID),...

Par notre intervention, nous souhaitons, à travers des exemples des projets OCP, vous montrer un aperçu des étapes à suivre par les équipes mixtes JESA/OCP, contractants et sous-contractant pour s'assurer que les nouvelles installations seront conçues, construites et exploitées selon les paramètres et conditions énoncées dans l'étude d'impact sur l'environnement.

Mots clés : Projets OCP; réglementation, étude d'impact sur l'environnement, enquête publique, plan de Gestion environnemental et social.



INTEGRATED ASSET MANAGEMENT - AN INVESTMENT IN SUSTAINABILITY

SD5

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Maintenance has traditionally been viewed as a negative aspect of doing business, incurring cost and causing downtime. For the mining sector, maintenance can be up to 30% of direct costs and much more in terms of the hidden costs of lost production, higher energy costs, reduced asset life and increased safety and environmental issues. By combining leading edge proactive maintenance strategies with the unique knowledge of an experienced equipment supplier, the concept of an «integrated asset management» partnership can turn this traditional view of maintenance into an investment that will improve all aspects of sustainability in an increasingly competitive and complex business environment.



THE LATEST GENERATION OF THE ELECTRONIC SYSTEM ENHANCED SAFETY AND PRODUCTIVITY

SD6

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Digital blasting systems represent a new, enabling step forward in in mining process optimization, providing the mining industry with different ways to improve operational efficiency or even to develop new extraction methods. The new features of the systems also reinforce both the security and the safety of the blasting process.

At this point in time; the second decade of the commercial use of electronic detonators, we introduce the fourth generation system; DTSP. As the need for efficiency increases in the mining and construction industry operations, Davey Bickford has adapted its technology to meet this demand. As the use of the system is taken up by many companies, the achievable benefits are more extensively monitored and accepted in many blasting operations.

Two principal points are explained in this paper. Firstly; new system features such as RFID, GPS, multiblasting, synchroblasting, remote blasting through wireless networks, etc. are explained. Secondly a number of case studies are used to demonstrate the value added by these technologies, for the mining operations.

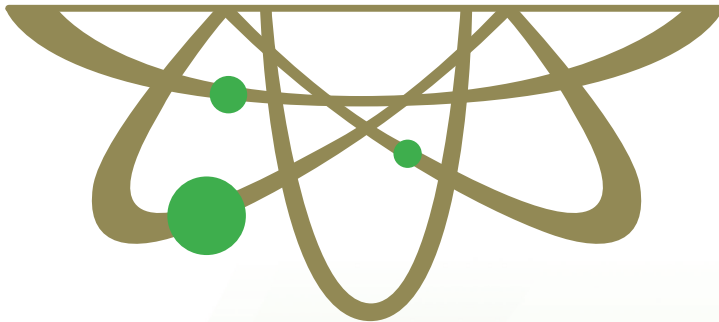
These case studies include a large open cast mine in North America as well as a number of surface quarries where electronic initiation has been adopted for specific reasons, including safety, environmental compliance, productivity, and economic concerns. The current initiation techniques are described, as are the Key Performance Indicators used in the quantification of benefits and justification process.

While emphasis is placed on the opportunities that the technology offers, constant consideration is always given to the practical aspects of the blasting process, which will ultimately drive the success or failure of this program.





Desalination Technologies



INTAKE AND BRINE DISCHARGE IN SWRO DESALINATION: TWO CASE STUDIES

DT1

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In seawater desalination there is always two important points to decide even before to design of the plant: the intake and the brine discharge. These subjects are especially critical in large seawater reverse osmosis plants.

In design phase the water intake determines two things: the quality of seawater and the pretreatment selected. Both are very important in the operational costs, life time of membranes and availability of the plant.

The brine discharge is second subject to be taken in consideration due to impact in the marine life and environment.

Every project is different due to the local conditions and regulations, and there is not an only solution for a reverse osmosis plant. There are a lot of factors to take into consideration: temperature, deepness, sea streams, local currents, organic matter, algae, suspended solids, sea grass, marine life, proximity of rivers, harbours, industries or beaches, discharge of treated or untreated sewage, etc.

To illustrate the different approaches two cases studies are presented in this paper: Barcelona-Llobregat and Perth Desalination Plants. Both present diverse conditions for the intake and discharge and have been solved by different solutions having both very good results:

- In **Barcelona** two different types of intakes were evaluated: deep offshore intake and sub-seabed drains; for brine discharge a blending with treated waste water was the solution, using the same pipeline to discharge.
- In **Perth** case the permission for construction implied the use of a narrow and short area in the sea to build both, intake and discharge, including also some special conditions to protect and preserve the marine life.

The two cases separates for more than 14000 km, in two different hemispheres and different seas are good examples to show how can be solved both problems in a seawater RO plant.



CURRENT AND FUTURE TECHNOLOGIES FOR ENHANCED DESALINATION FACILITIES

DT2

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²Veolia Water Technical Direction, France

Through significant technological and engineering developments, desalination has become a real alternative for the supply of freshwater for communities and industries. As communities further improve and secure their drinking water supply scheme, regions faced with water scarcity and/or with ever increasing freshwater demand will see their naturally-available freshwater resources be proprietarily geared towards community needs, and industries will need to rely on desalination of seawater (or brackish water) to meet their own demand. Industries can already rely on robust and ever-improving technologies, such as Reverse Osmosis (RO) and Thermal Distillation (TD). Incremental enhancements have already been achieved on many aspects and components of these processes:

- for RO: more robust pretreatment withstanding more challenging seawater conditions (e.g. algal blooms); lower consumption of chemicals upstream (coagulant, antiscalant); increased water quality (better membranes); lowered power consumption (energy recovery devices)
- for TD: development of the Multiple Effect Distillation (MED) for large-scale units thereby bringing about major power and cost reduction as compared to the Multi-Stage Flash ; optimal use of steam by integrating thermo-compressing units; increased flexibility for matching power and water demand through hybrid RO/MED facilities.

In addition to technology improvements, the desalination industry has also developed robust practices to assess and control the potential environmental impacts of desalination facilities. As example, the impacts on fauna and flora in coastal areas can now fully be mitigated both at the seawater intake (well-designed intake to minimize fish entrapment) and at the discharge outfall (dispersion system providing a fast and efficient mixing of the brine). The Authors will present these technology and engineering developments along with other breakthroughs to expect within the field of desalination (biomimetic membranes, carbon nanotubes, integration of renewable energies...), which could make desalination a very cost-effective and a sustainable alternative for freshwater production to industries worldwide.

THE PRETREATMENT IN THE REVERSE OSMOSIS PLANT

DT3

Manuel Rubio Visiers
AEDyR, Spain

The pretreatment is a basic process in the reverse osmosis plant, because the quality of water is critical in the RO membrane efficiency. In this presentation we are going to review the evolution of the pretreatment along last 25 years according to three criteria: RO membranes technology, size of the RO plant, and new UF membranes technology. As



a result of this evolution, the energy cost in desalination can be optimized as well as the availability of the installation.

Otherwise, the stable operation of the plant can be considered in the projection of the CAPEX and OPEX costs.



OPTIMIZING PROCESS DESIGNS WITH ENERGY RECOVERY DEVICES

DT4

Borja Blanco

Desalination, Energy Recovery Inc., USA

Reverse osmosis (RO) membrane desalination is a pressure-driven process. The osmotic pressure of a salt water or brackish water solution is overcome with hydraulic pressure, forcing nearly pure water through a semi-permeable membrane while leaving concentrated reject behind. During the RO process a significant amount of the energy imparted into the feedwater flowing to the RO membranes leaves the membranes in the concentrated reject water. Energy-recovery devices (ERDs) recover and recycle this energy returning it to the process, and have become a key element of a desalination plant design, as well as the “operating system” in many of these facilities.

These devices together with improved RO membranes and advanced system designs have made desalination a reliable, affordable and widely-accepted technology deployed around the world. The challenge is selecting the proper energy recovery device for a specific application. There are many factors to consider in selecting the energy recovery device but the deciding factors are typically a combination of the capital and operational benefits.

This technical paper and presentation cover an overview of different energy recovery technologies for Sea Water RO and Brackish Water RO applications, pros and cons of the various ERDs available for a specific application and their operational flexibility. It will also review the latest developments in this field and provide examples and details of successful desalination operations.



ADVANCED PRETREATMENTS IN LARGE DESALINATION PLANTS

DT6

Manuel Fariñas

Acciona Agua, Spain

Although, when the waters are not very loaded, the advanced pretreatments still are more expensive than the conventional ones, reality is revealing that the number of large-sized desalination plants fitted with an advanced pretreatment is growing.

The reasons for the increase of this type of pretreatments are multiple. Amongst the most important ones we can mention:

- The complexity and difficulty of raw water treatment
- The environmental limitations imposed on the reject discharge



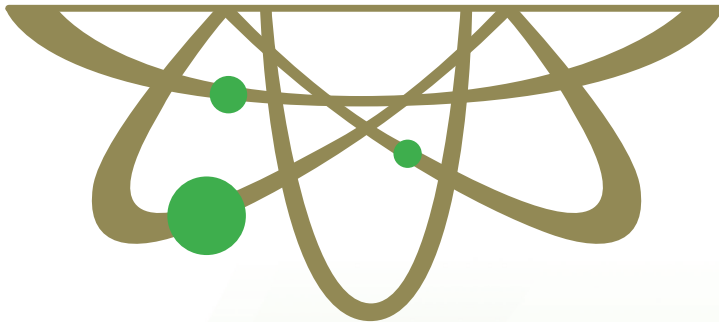
- The requirements demanded by the regulations related to public health
- The high price of electric energy in the region
- The high cost of the land or the lack of available space
- Etc.

Throughout the present conference two large desalination plants (Beckton and Adelaide) fitted with advanced pretreatments are shown, as well as the reasons that led to opt for such pretreatments.





Phosphoric Acid Production





THE USE OF AUTOMATIC CONTROLS IN A PHOSPHORIC ACID REACTOR

PAP1

Vaughn Astley
Dr. Phosphate, USA

Computer controls systems have been in use in Florida phosphoric acid plants since the 1990's. The systems control the sulfate, P_2O_5 strength, filter feed and rock rate. Productions improvements of over 20% in throughput and 8% in recovery have been reported. While these systems are still in operation, new control systems have been developed that should provide even better control. The systems will be described as well as the cost of implementation.



NEW EFFECTIVE METHOD TO REDUCE SULFATE IN PHOSPHORIC ACID NISSAN PROCESS

PAP2

A.MAHROU, A. BEN EL BOU, M. LOUHZ
OCP Group, Maroc

This paper is an abstract of many tests conducted by our process engineers to find out the best way of reducing sulfate in a phosphoric acid Nissan Process. The first method used phosphate as an additive to the slurry coming from the 4th crystallizer in order to reduce sulfate in the output of the process and make it fit with the requirements. However, this method generated a lot of side effects impacting both productivity and P_2O_5 yield. Phosphate added at the last stage hasn't enough time to react and crystals haven't enough time to grow and offer a better filterability. These resulted in P_2O_5 losses and a decreasing filterability limiting the capacity by more than 5%.

In order to overcome this problem, many tests have been carried out in MP1 Lines. Some of them were unsuccessful but gave more insights about how to tackle this problem. One of the best solutions was found out, improved progressively and implemented in a large scale. The new method now is carried out outside the process. The phosphoric acid produced by NISSAN Process is taken outside the process, treated with phosphate and clarified. The finished product is sent to concentration, however the slurry resulted from the clarification process is recycled to NISSAN Process to be mixed with sulfuric acid and phosphate and undertakes the whole stages.



MERSEN MIXERS: AN INNOVATIVE DESIGN COMBINING PROCESS OPTIMISATION AND ENERGY EFFICIENCY

PAP3

Erik LOISEAU
Mersen, France

Mersen is a leading multinational industrial group. With its extensive expertise in high-grade materials and electrical installation reliability and security, Mersen designs innovative solutions tailored to customer requirements to improve their industrial performance in sectors such as energy, transport, electronics, chemical/pharmaceuticals and process industries.

Its Process Equipment Division is internationally recognised for its expertise in the design and manufacture of equipment made from high-grade materials for use in corrosive and hot environments.

For over 50 years, Mersen has been designing and manufacturing mixers for water, chemical and hydrometallurgy processing.

With its solution-oriented approach, it has developed a range of mixers specially designed for the phosphoric acid and fertiliser market.

Our 30 years of experience in this field have enabled our research and development teams to create a range of mixers that improve process performance and energy efficiency. Their innovation essentially focuses on the hydraulic and mechanic design and their development is based on calculations and simulations generated by our in-house software.

The know-how of our engineering department and our expertise in noble materials make Mersen a key player in the design and manufacture of mixers for use in extreme environments. Its industrial plants in Morocco (2,500m²), France (8,000m²) and China (150,000m²) confirm our international position as the leading supplier of process equipment for the phosphoric acid and fertiliser market.



FROM LAB TO PLANT: FIRST INDUSTRIAL EXPERIENCE OF THE NEW HIGH EFFICIENCY DIHYDRATE HEMIHYDRATE PROCESS (DA-HF) FOR PHOSPHORIC ACID PRODUCTION

PAP4

**Tibaut Theys^a, Dorina Fatia^b, Olivier Schrevens^{a,b}, Agata Tarnowska^b,
Monika Zienkiewicz^b**

^aPRAYON, Belgium

^bGRUPO AZOTY, Poland

During the first edition of Symphos, Prayon presented a newcomer in the family of dihydrate – hemihydrate processes used to produce phosphoric acid: the Prayon Dihydrate Attack – Hemi Filtration process (DA-HF).

In this process all the dihydrate slurry from attack tank is converted into hemihydrate before filtration. Process conditions have been found such as to make possible phosphoric acid production directly from hemihydrate conversion tank. With this process P2O5 recovery gains of about 1,5% - 2% can be expected with respect to a dihydrate process. Slurry filterability is also improved by about 10% - 20% and P2O5 content of the produced acid is increased by more than 6% compared to a Dihydrate process.

Based on the promising results obtained during several pilot tests where more than 6 different phosphate were tested, Grupa Azoty and Prayon Technologies decided to join their forces to run two industrial tests in Grupa Azoty plants.

One of the Dihydrate production plant was converted into DA-HF process by simple modifications, including piping modifications, pump addition, steam and sulphuric acid injection pipes installation. During the tests, Egyptian and Moroccan rocks were processed successfully. The conjoin team shows that the process is stable; it can be stopped and started easily. The efficiency obtained is about 97,5% with Morocco rock and the P2O5 produced above 33 %.

The results obtained being very promising, Grupa Azoty and Prayon Technologies have agreed to move forward studying the conversion of one Grupa Azoty production plant into this new technology.



FILTRATION TECHNOLOGIES IN PHOSPHORIC ACID PLANTS

PAP5

Mohamed BELGHITI ALAOUI
OCP, Morocco

Achieving high performances has always been the major concern of Fertilizer and phosphoric acid plants managers and operators. One of the most important processing step that impact these performances is phosphoric acid filtration. Technologies of filtration are available with multiple suppliers which propose different solutions. The purpose of this paper is to make a comparison between the different technologies. We do not intend to conclude which one is better than the others, but our aim is to develop a methodology of selection of the most appropriate solution for each case. We will highlight the main and



recent developments in the field. We will also open some ways to improvements not fully explored. In these paper we will present some practical methods regarding process and maintenance operations.



OPTIMIZATION FOR TILTING PAN FILTERS

PAP6

Scott Yeo

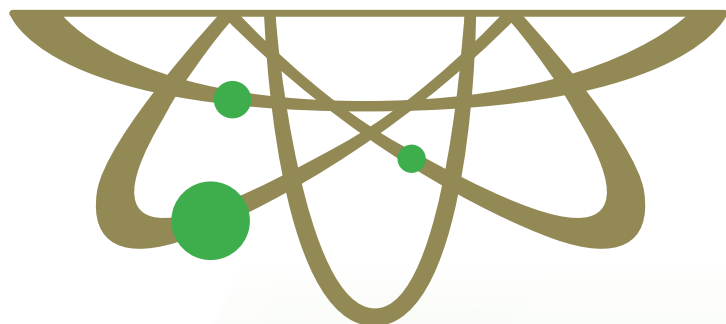
Metalcraft Services of Tampa, USA

Combining more than 40 years of experience with innovative designs, Metalcraft Services has become the leading manufacture of improved filter components for existing Tilting Pan Filters in the United States. Metalcraft has specialized in improving the reliability of existing tilting pan filters by providing filter components that increase filtration area, improve flow characteristics, increase structural integrity, and reduce maintenance cost. The optimization process involves diligent onsite technological study, mapping and modeling of an existing filter. Benchmarks are established as to the operational and maintenance condition of the filter, and mechanical deficiencies can be addressed. Filter measurements and data are integrated into the modeling software to reveal accurate real time conditions, which then can be compared with corrected or improved modeling of all filter components. The extent of improvements and optimization are discussed with the client and further steps are planned in harmony with the customer's goals. Continuation of the optimization process allows for implementing improved cloth spray header system matched with a turnover track that is properly timed in relationship to the sprays and dumping cycle. Applying these technologies will result in improved losses, better cloth cleaning efficiencies, extended run time between cloth changes, and lower maintenance cost. By implementing the Filter Optimization process, with enhanced equipment designs and reliability centered maintenance practice, significant returns on investment will be achieved.





Geology





RECONNAISSANCE GÉOLOGIQUE DES PHOSPHATES DU MAROC

GEO1

M'barek AMAGHZAZ, Es-said JOURANI

OCP-S.A., Maroc

Depuis sa création en 1920, l'OCP s'est investi dans l'exploration des bassins phosphatés d'Oulad Abdoun, Gantour, Meskala et Oued Eddahab. L'approche de reconnaissance géologique suivie consiste en :

- la localisation des périodes géologiques favorables à la formation des dépôts phosphatés (Crétacé - Eocène),
- la délimitation des zones présumées phosphatées;
- la cartographie et l'échantillonnage des affleurements;
- les levés géologiques des puits d'eau des tiers;
- l'évaluation préliminaire du potentiel des zones explorées. La reconnaissance géologique d'un gisement passe généralement par les étapes suivantes:
- Etape 1 : Maille lâche $\geq 4\ 000\text{m}$
- Etape 2 : Maille intermédiaire 800-2000m
- Etape 3 : Maille Ultime $\leq 500\text{m}$

Le passage de l'étape n à l'étape n+1 ne se fait qu'après évaluation des résultats de l'étape n.

Aujourd'hui, le nombre d'ouvrages (puits et sondages) réalisés sur les quatre bassins phosphatés s'élève à plus de 25 000. Malgré l'effort réalisé, la surface reconnue ne représente qu'un peu plus de 53% de la surface probable de l'extension de la série phosphatée, seul le bassin de Meskala est reconnu dans sa totalité.

Le traitement des informations recueillies des ouvrages réalisés a abouti à la caractérisation des ressources et réserves des gisements reconnus dans le cadre de plus de 440 rapports d'études géo-minières et hydrogéologiques et de 160 notes techniques sont élaborés et diffusés en interne à l'OCP. Les résultats de ces études servent de support pour la planification de l'exploitation des gisements.

En complément aux méthodes exploratoires classiques (Puits et sondages), la R&D OCP a introduit en collaboration avec les universités marocaines les méthodes d'investigation géophysique. Ces méthodes ont donné des résultats concluants pour :

- les phénomènes géologiques particuliers de « dérangements » affectant la série phosphatée du bassin d'Oulad Abdoun (gisement de Sidi Chennane),
- la caractérisation hydrogéologique des nappes souterraines.

La recherche géologique fondamentale sur les phosphates a été également traitée dans le cadre de collaborations avec les Universités nationales et étrangères. Les travaux de recherche réalisés portent notamment sur la sédimentologie, la paléontologie, la stratigraphie, la pétrographie et la géochimie des phosphates, dont les résultats sont d'une grande utilité pour la recherche minière.

En perspective, la reconnaissance géologique se poursuivra par :

- La reconnaissance à maille ultime des gisements de relève,
- L'exploration des domaines non encore reconnus pour les bassins phosphatés, tels les extensions Sud d'Oulad Abdoun, des Gantour et d'Oued Eddahab;
- La généralisation de l'investigation géophysique
- La reconnaissance hydrogéologique des aquifères des bassins phosphatés
- La numérisation des données topographiques.

Mots clés : Reconnaissance, maille, puits, sondages, rapports, sédimentologie, paléontologie, dérangement, décarbonatation, géophysique, numérisation.

Youssef DAAFI, Ahmed CHAKIR, Essaid JOURANI, Sidi Mohammed OUABBA
OCP-S.A., Maroc

La reconnaissance géologique des gisements aboutit à leur modélisation géologique avec une estimation des ressources et des réserves de phosphate en fonction de divers critères miniers. Cette modélisation sert à la planification de la production à différentes échelles :

- le Projet d'Épuisement (PE) qui s'étale sur plusieurs dizaines d'années et à partir des études géologiques régionales ;
- le Projet à Long Terme (PLT) qui s'étale sur une durée de plus de 20 ans à partir des études géologiques sectorielles ;
- le Projet Stratégique Actualisé (PSA) qui donne la planification de la production sur 5 ans à partir des études géologiques des panneaux d'exploitation ;
- le Business Stearing (BS) qui donne la planification de la production sur une année, actualisée chaque trimestre en fonction des commandes des clients donnant lieu à 4 BST (BST1, BST2, BST3 et BST4) à partir du listing case.

L'exploitation à ciel ouvert des gisements de phosphate à l'OCP consiste en le découpage du gisement en panneaux, le panneau est découpé en tranchées de 40m de largeur et les tranchées sont découpées en case d'exploitation de dimension 40x100m. Afin de permettre à l'exploitant une flexibilité de la planification minière, le géologue procède à des caractérisations chimique et physique de chaque case avec une estimation de ces volumes de phosphate et du stérile.

Au début, la caractérisation des cases se faisait par la méthode manuelle en se basant sur les cartes d'iso valeurs. Dans le cadre de ses recherches visant à modéliser les blocs d'exploitation minière avec une grande précision, la Direction Recherche et Développement de l'OCP a procédé à la modélisation des gisements et a mis au point une procédure de traitement des données permettant de répondre aux besoins de l'exploitant pour la planification de sa production.

Mots clés : OCP, listing case, krigeage, gisement, panneau, blocs d'exploitation, R&D, géologie, planification minière

→ GISEMENTS DE PHOSPHATE D'AFRIQUE DE L'OUEST : ANALOGIES GÉOLOGIQUES ET PRÉ-ENRICHISSEMENT NATUREL DES PHOSPHATES ÉOCÈNES DE TAÏBA-TOBÈNE (SÉNÉGAL) ET SALIQUINHÉ-FARIM (GUINÉE BISSAU).

GEO3

Jean-Pierre Prian^a

^aBRGM, France

Les gisements de phosphate du bassin sénégal-mauritano-guinéen, bien que de tonnages modestes par rapport aux géants d'Afrique du Nord et de Méditerranée orientale, se singularisent par des minerais particuliers valorisés par leurs caractéristiques pétrochimiques qui témoignent de conditions spécifiques de phosphatogenèse et d'enrichissement par altération.

Quatre gisements cachés de phosphate de calcium sont connus dans des environnements marins peu profonds de l'Eocène du vaste bassin sédimentaire.

Les deux gisements orientaux, N'Diendouri - Ouali-Diala (Matam), au Sénégal, et Bofal-Louboïra, en Mauritanie, distants de 140 km, se sont déposés à l'Eocène inférieur sur la bordure du bassin. Ils renferment respectivement des ressources en phosphate tout-venant de 40 Mt à 28,7 % P_2O_5 et 94 Mt à 20 % P_2O_5 . Seul le gisement de N'Diendouri fait l'objet d'une petite exploitation depuis 2008, pour granulation et amendement direct.

Les deux gisements occidentaux (Taïba-Tobène, au Sénégal, et Saliquinhé-Farim, dans le Nord de la Guinée Bissau), distants de 340 km, sont situés dans des zones de hauts-fonds à l'entrée de la plate-forme continentale, respectivement sur le flanc nord-ouest du haut-fond de N'Diass et sur la bordure sud du golfe éocène de Casamance (zone haute de Farim-Vélingara). Le gisement de Taïba (Keur Mor Fall et N'Domor Diop) a été exploité de 1960 à 2003. Ses réserves étaient de 80 Mt à 25 % P_2O_5 . Son exploitation a été relayée par celle, en cours, du gisement de Tobène (superficie d'environ 12 km²) dont les réserves s'élèvent à 50 Mt à 27 % P_2O_5 . Le gisement de Saliquinhé-Farim (superficie d'environ 35 km²) est en cours de développement par GB Minerals. La caractérisation du gisement par le BRGM, entre 1981 et 1983, avait démontré la présence d'au minimum 100 Mt de phosphate à 30% P_2O_5 .

Les deux gisements de Taïba et Saliquinhé présentent des caractères communs qui concernent, notamment, leurs caractéristiques lithostratigraphiques, leur environnement marin initial et leur paléogéographie, les types de grains phosphatés des minerais, la structure des pièges des minéralisations de phosphate en grains, les processus de remaniement synsédimentaire et de vannage des grains, la composition chimique des minerais, l'évolution des minéralisations en environnement marin puis continental, les relations entre phosphate carbonaté et phosphate décarbonaté, les altérations superficielles dans leur site de concentration final ayant entraîné le lessivage total de la calcite et l'enrichissement en phosphate (pré-enrichissement naturel des minerais).

L'exposé illustre les caractéristiques de ces quatre gisements d'Afrique de l'Ouest et met plus particulièrement en exergue les similitudes des gisements de Taïba et de Saliquinhé, ainsi que la succession des processus géologiques complexes ayant permis leur formation.

GESTION DES RISQUES POST-MINIERS : OPÉRATION « SCANNING MOUVEMENT DE TERRAIN »

GEO4

Frédéric Poulard¹ et Christian Franck²

¹INERIS, France

²GEODERIS, France

Les effets et les impacts des «anciennes exploitations minières» font partie, avec les dangers technologiques et les inondations, des aléas les plus intégrés à la politique nationale de gestion des risques. Les nuisances minières potentielles sont variées (inondations, émission de gaz de mines, échauffements/feux, pollutions des eaux et des sols..) mais la problématique majeure en France est celle liée aux mouvements de terrains (affaissements, effondrements ou glissements miniers).

En matière de gestion de l'aménagement du territoire, l'Administration française s'attache à évaluer et à prévenir les risques, le plus en amont possible. Ainsi, la prévention des risques miniers est fondée sur une démarche transversale menée à différentes étapes de la vie d'un site minier par divers acteurs:

1. Délivrance des permis miniers (exploitant et Administration Centrale);
2. Ouverture de travaux miniers et réalisation du dossier d'ouverture (exploitant, bureaux d'études et Administration décentralisée);
3. Suivi de l'exploitation au cours des travaux miniers (exploitant et Administration décentralisée);
4. Arrêt des travaux et réalisation du dossier d'arrêt définitif des travaux -DADT (exploitant et Administration décentralisée);
5. Gestion à long terme des risques post-miniers (Administration centrale et décentralisée, experts miniers, collectivités territoriales et Public) et notamment réalisation de Plan de Prévention des Risques Miniers (PPRM).

La France métropolitaine comptant près de 4500 titres miniers, en grande majorité arrêtés, la phase 5 s'est révélée complexe, lourde et difficilement planifiable. En 2006, afin d'optimiser cette gestion et de répondre aux pressions locales de plus en plus fortes, le Ministère de l'Économie, des Finances et de l'Emploi a demandé au Groupement d'Intérêt Public GEODERIS, de:

- classer l'ensemble des sites miniers français en fonction de leur niveau de risque, actuel ou futur, inhérent à l'instabilité des terrains (dans un délai court de 3 ans);
- sélectionner les sites présentant les niveaux de risque les plus préoccupants et de les soumettre à une qualification rapide de l'aléa mouvement de terrain;
- identifier les situations qui nécessitent un traitement prioritaire (travaux de mise en sécurité notamment).

Ce processus intitulé « Scanning mouvement de terrains » se devait d'être bâti sur une méthodologie robuste. Celle-ci, établie par l'INERIS, a comporté une phase importante de mise en place d'un outil de hiérarchisation. Après des mois de réflexions, c'est une analyse de type multicritères qui a finalement été retenue (de la famille des méthodes Electre), basée sur une cotation pondérée de l'aléa de type:

$\sum_i p_i * C_i(x_a)$, avec C_i , critère d'évaluation, de poids p_i , d'un site minier donné x_a .
i Cette définition a nécessité de:

- sélectionner un groupe d'experts appropriés;



- de définir des critères de hiérarchisation adaptés;
- d'utiliser des moyens efficaces;
- de tester et de valider chacune des étapes avant d'envisager la réalisation d'une hiérarchisation sur l'ensemble de sites miniers français.

L'article proposé détaille précisément la démarche complète de cette problématique scientifique : description du problème à résoudre, prise en compte des contraintes à considérer, identification de différentes solutions possibles, sélection, optimisation et validation de la solution retenue et application aux cas concrets.

En 2008, l'outil et le classement de la totalité des sites miniers français étaient terminés. Au cours des années suivantes (2009, 2010, 2011, 2012 et 2013), les résultats de cette hiérarchisation ont efficacement aidé le Ministère de l'Ecologie et du Développement Durable et de la Mer à construire ses budgets et à orienter ses actions

- réalisation d'études détaillées des aléas mouvement de terrain (environ 12 par an);
- portés-à-connaissance des communes concernées;
- décision de mise en place (ou non) de Plan de Prévention des Risques Miniers;
- campagnes d'investigations complémentaires (sondages et géophysique);
- travaux de mise en sécurité (remblayage, confortement, expropriation...).

Cette hiérarchisation multicritères «Scanning Mouvement de terrain» a par ailleurs servi de base à la constitution de la liste des sites français de gestion de déchets de l'industrie extractive «ayant des incidences graves sur l'environnement ou risquant, à court ou à moyen terme, de constituer une menace sérieuse pour la santé humaine ou l'environnement» (Directive 2006/21/ce du Parlement Européen et du Conseil du 15 mars 2006).



MINÉRALOGIE DES FORMES SILICEUSES DE LA SÉRIE PHOSPHATÉE DES OULAD ABDOUN (MAROC)

GEO5

**EL HADDI Hamid^a, BENBOUZIANE Abdelmajid^a, MOUFLIH Mustapha^a,
JOURANI Es-said^b & AMAGHZAZ M'barek^b**

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Le bassin des Oulad Abdoun est marqué par des phénomènes diagénétiques remarquables par leurs formes et aspects. La silicification et les formes siliceuses sont des événements diagénétiques qui font l'objet de notre étude dans ce travail. Ces formes très abondantes incitent non seulement les chercheurs, mais aussi les mineurs à comprendre et expliquer leur formation et origine. Une telle étude a été réalisée sur l'ensemble des séquences de dépôt de la partie centrale de ce bassin (Ghar Étager et El Halassa). Les observations macroscopiques et microscopiques réalisées sur l'ensemble des faciès de la série phosphatée et particulièrement ceux des cortèges siliceux ont permis de distinguer sur le plan minéralogique :

- une silice en grains de quartz clastique ou néoformé, se trouvant dans des proportions et des dimensions variables dans l'ensemble des faciès étudiés (phosphates, carbonates et argiles) ;
- une silice en opale et agate formée de microsphères de silice amorphe ou gel (opale AG) ou isotrope siégeant surtout dans les faciès carbonatés marneux sous forme de concrétion millimétrique à décimétrique ou de complexe à porcelanite centimétrique à métrique;



- une silice en calcédoine constituée par du quartz microcristallin et fibreux formant des silicifications en ciments centripètes et en frange colmatant les espaces intra et inter-granulaires des faciès phosphatés et carbonatés.

Pour apporter plus de précisions sur ces phases minéralogiques, un ensemble d'analyse par diffractomètre aux rayons x ont été réalisées sur des concrétions siliceuses pures (nodules et rognons), des calcaires et phosphates siliceux, des marnes siliceuses et des silexites ou porcelanites, etc. Ces analyses montrent des pics principaux 3,34 Å et 4,26 Å qui s'accordent avec des variétés de minéraux de formes cristallines, quartz clastique et microcristallin ou fibreux. En revanche la silice type opale montre des pics larges et intenses 4,10 Å, 4,33 Å et 2,50 Å. Ces pics sont soit attribuables à une opale CT (opale Cristobalite-Tridyrnite) à structure désordonnée à l'image d'un «interstratifié» soit à une opale T de type Tridymite. Dans les diffractogrammes des silex, le quartz apparaît toujours avec l'opale avec une raie à 4,26 Å qui interfère avec celui-ci à 4,33 Å. Le quartz microcristallin, la calcédoine et l'opale CT sont les principaux constituants des silex et de leur patine. Les phases minérales dominantes des porcelanites et des marnes siliceuses sont l'opale CT/AG et la calcite. On note également que le quartz de la recristallisation de l'opale est plus abondant dans les porcelanites que dans les marnes siliceuses où la calcite non encore opalisée est plus fréquente. L'origine diagénétique et la mise en place de ces formes siliceuses seront discutées et mis valeur en rapport avec la dynamique de la mise en place des cortèges phosphatés transgressifs et les cortèges marneux de comblement.

Mot clés : Phosphate, Oulad Abdoun, Diagenèse, Silicification, Opale, Silex.



GEOLOGICAL MODELING AND ESTIMATION TECHNIQUES OF PHOSPHATE DEPOSITS

GEO6

Schadrac Ibrango
Met-Chem Canada Inc

Subject: Review of geological modeling and estimation techniques applicable to typical tabular phosphate deposits.

Keywords: 3d Block model, Gridded seam, implicit modeling, kriging, conditional simulation, geostatistics, phosphate deposits

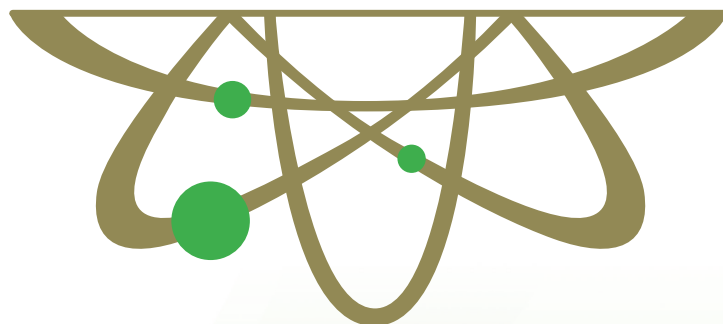
Met-Chem Canada Inc. is an engineering consulting firm serving the mining industry since 1969 and based in Montreal Canada. Met-Chem is a wholly owned subsidiary of UEC Technologies LLC which is part of United States Steel Corporation. Met-Chem's geologists have been involved in geological modelling of various commodities around the world, including Northern Africa and Magreb.

This technical paper will review the different geological modelling and estimation techniques applicable to typical tabular phosphate deposits such as OCP's. Modelling techniques reviewed include gridded seam (GSM), 3D block modelling, and implicit modelling. Estimation techniques reviewed include inverse distance, nearest neighbour, the various kriging methods, and conditional simulation among others.





Environment





GLOBALIZATION OF PHOSPHOGYPSUM REGULATIONS

ENV1

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Ardaman & Associates Inc., U.S.A

This state-of-the art keynote paper reviews regulations relating to disposal and on-land stacking of the phosphogypsum produced at phosphoric acid plants, including environmental protection and health-related criteria, as well as guidelines dealing with beneficial use of the phosphogypsum by-product. Whereas the discharge of phosphogypsum into the ocean is currently banned in the U.S.A. and in Canada based on environmental considerations, disposal into the ocean is still deemed to be environmentally acceptable in some countries as long as the discharge is diffused artificially over a sufficiently wide area or is subjected to natural dispersion by vigorous currents and wave action. A brief historic overview is presented of why and how the regulations for on-land disposal and safe operation of stack systems were first developed in the U.S.A. which has led globally on this topic; followed by how these regulations are now being successfully exported worldwide to other countries, with some local variations to address local issues.

On the other hand, beneficial use of phosphogypsum is flourishing in developing countries while the U.S. is lagging far behind. There is an erroneous perception by some environmental groups in the U.S.A that the use of phosphogypsum even in an open air environment would cause adverse health related effects: this conclusion is based on an unrealistically conservative EPA model which raised unfounded radiological concerns. It is unlikely, therefore, that globalization of guidelines pertaining to beneficial use of the phosphogypsum would move to the forefront in the near term, and the U.S. is likely to remain far behind most other countries in developing safe beneficial uses of this resource. Nevertheless, it is the author's opinion that there is a need for developing guidelines for safe handling of the phosphogypsum being exported for various beneficial uses in many countries throughout the world, as well as criteria for the safe use of this by-product in a closed environment.



DÉPOLLUTION DES EAUX CONTENANT LE CADMIUM PAR LES PHOSPHATES MAROCAINS

ENV2

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Partout dans le monde et plus particulièrement au Maroc, la pollution des eaux par certains produits chimiques biodégradables ou non d'origine industrielle (métallurgie, hydrocarbures, colorants, phénols, ...) ou agricole (pesticides, engrais, ...) menace notre environnement. L'élimination de ces produits est devenue une préoccupation importante dans tous les pays, afin de protéger les milieux naturels et améliorer la qualité des eaux.

Plusieurs techniques sont utilisées pour réduire l'impact de cette pollution, telles que la précipitation, l'échange d'ions, la distillation, l'oxydation, la réduction, la filtration, le traitement électrochimique, l'évaporation, ...etc. Ces processus ayant cependant un coût

de plus en plus élevé, il est donc intéressant de développer des méthodes plus efficaces et peu onéreuses de traitement et de dépollution.

Parmi ces polluants, on trouve le cadmium qui est un métal lourd que l'on rencontre en milieu aqueux sous diverses formes physiques (dissoutes, colloïdales, particulaire) et sous différentes formes chimiques (minérale et organique). Cet élément, est hautement toxique pour la plupart des organismes car il est cancérigène, mutagène et il facilite le transfert des autres métaux lourds dans les cellules du corps. Plusieurs adsorbants ont été utilisés pour l'élimination du cadmium présent dans l'eau tels que les argiles, la biomasse, les zéolithes naturels et synthétiques ...etc.

Dans le cadre de la valorisation des ressources minières marocaines et la protection de l'environnement, nous avons étudié les possibilités d'utilisation du phosphate sédimentaire marocain comme adsorbant des ions métalliques. Pour cela, nous avons procédé à l'évaluation de la rétention du cadmium par un phosphate naturel du bassin d'Oulad Abdoun. Nous avons étudié l'influence de la concentration du soluté et la masse du support ainsi que la modélisation du mode d'interaction métal-phosphate par les isothermes d'adsorption.

Les résultats expérimentaux montrent une interaction entre le cadmium et le phosphate naturel influencée par la masse du support ainsi que la concentration en métal dans la solution étudiée.

Les isothermes d'adsorption à l'équilibre sont capitales dans la détermination de la capacité de l'adsorbant, la définition de la nature du phénomène de l'adsorption et le calcul des coefficients de transfert de matière. Les modèles les plus utilisés pour décrire la distribution d'un adsorbant entre l'adsorbant et la solution sont ceux de Langmuir et Freundlich. Nous avons étudié l'équilibre en mettant en contact 0,05 g de phosphate lavé et broyé de fraction 125 μm avec 50 mL d'une solution contenant les ions de cadmium, à des concentrations de 10 à 300 mg/L. L'agitation est maintenue pendant un temps suffisant pour atteindre l'équilibre.

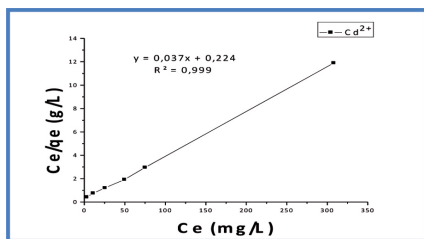


Figure 1 : Isotherme de Langmuir de la sorption des ions Cd^{2+} par le PN

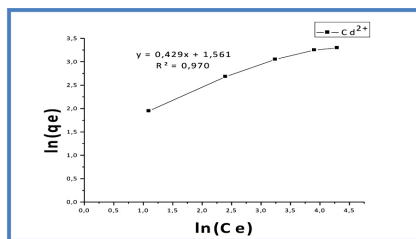


Figure 2 : Isotherme de Freundlich de la sorption des ions Cd^{2+} par le PN

Les figures 1 et 2 représentent les isothermes d'équilibre de sorption des ions Cd^{2+} par le phosphate naturel (PN).

Les coefficients de corrélations déduits de ces deux modèles montrent une dominance de l'adsorption en monocouche sur celle d'intra-granulaire.

Ces résultats sont concordants avec nos anciens travaux et prouvent que l'utilisation du phosphate marocain est très prometteuse pour la dépollution des eaux contaminées par des ions métalliques.

EFFECT OF CHEMICAL AND THERMAL TREATMENT ON THE POLLUTION AND GEOTECHNICAL PROPERTIES OF DREDGED SEDIMENT

ENV3

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Dredging of sediments is necessary in order to maintain maritime activities and for flood prevention. However the increased industrial activities are causing accumulation of pollutants in the sediments. The main contaminants are heavy metals and organic compounds. Because of the cost of storage, treatment and valorization can be economically sound. This study focuses on the technology to treat heavy metals from dredged sediments using phosphoric acid (H₃PO₄) (the Novosol® process developed by Solvay company) with a goal to stabilize heavy metals by capturing them in calcium phosphate matrix and to destroy organic matter by calcination at 650°C. Several studies have been conducted in this field. The stabilized materials obtained have been used in civil engineering. However these studies have never assessed the effect of the composition of the phosphoric acid on the treatment. In this paper the effect of two types of phosphoric acids with various composition and origins were compared. The investigation focuses on the effect of the phosphoric acids on the environmental behavior of metals and on the geotechnical properties of the dredged sediment.

APATITIC CALCIUM PHOSPHATE BASED HEAVY-METAL ACCUMULATORS: TREATMENT OF GAS PHASE POLLUTIONS

ENV4

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Landfill and incineration are the most used techniques for the management of municipal and industrial wastes. But with the limit in landfill sites and the growing amount of wastes, incineration is becoming more advantageous, because it allows a high reduction of waste's volume up to 90%. However, emissions of pollutants from incinerator flue gases are currently of great environmental concern because of their toxicity. The emission of heavy metals takes place during the combustion of wastes, wherein heavy metals are vaporized by the thermal effect of combustion and then emitted with exhaust gases despite filtration of smoke particles [1]. Thus, the control of incinerator's emission gas, in particular heavy metal emission, is an important factor for the improvement of the efficiency and acceptability of the incineration technology.

This work aims to investigate the transformation of calcium hydroxyapatite powder into accumulators having a controlled porosity and activity for metal sequestration. Different physico-chemical characterizations (SEM-EDX, XRD, BET, adsorption-desorption isotherm, ICP-AES...) were used for the analysis of accumulators obtained. Then, they were tested

for the removal of heavy metals (Pb, Cd, Zn) from gas emissions at both laboratory and industrial pilot scales. The first results showed that high portions of vaporized heavy metals were accumulated at the surface of the solids. Smaller portion of metals were also found in the whole porous structure of the solids, indicating that diffusion might be a limit of the process. The results obtained were interesting from the viewpoint of future industrial application. Under severe experiment conditions (high temperature, high acidity and high humidity), calcium hydroxyapatite based accumulators were chemically and thermally stable and showed high reactivity for the removal of gaseous heavy metals.

Keywords: Apatitic calcium phosphate, accumulator, heavy metal, gas treatment



Fig. 1. Example of Ca-HA samples at macro and micro scales

Reference:

- [1] Rio S., Verwilghen C., Ramaroson J., Nzihou A., Sharrock P., Heavy metal vaporization and abatement during thermal treatment of modified wastes. *Journal of Hazardous Materials*, 2007, 148, 521-528.



HYDROXYAPATITE AND ALIZARIN SULFONATE ARS MODELING INTERACTIONS FOR TEXTILE DYES REMOVAL FROM WASTEWATERS

ENV5

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Huge amounts of dyes-containing wastewaters are discharged into the environment sometimes without any remediation or land filled as sludges which are difficult to handle and eliminate whatever the method of treatment used.

Due to the lack of reliable data on the structural diversity of these harmful compounds, further information is needed about the retention mechanisms especially on synthetic or natural mineral adsorbents like hydroxyapatite HA, a friendly ecological compound commonly found in soils as phosphate rock.

We already showed the potential use of hydroxyapatite HA to remove textile dyes from various industrial waste water by coprecipitation with HA which could be thereafter regenerated and reused following repeated dye removal by thermal treatment.

As the dihydroxyanthraquinone Alizarin or its salt (ARS) is regarded as a model compound for more complex dyes, this led us to investigate the way calcium ions interact simultaneously with phosphate and ARS. The interaction of ARS with hydroxyapatite (HA) was shown to proceed by formation of whether catecholate salt formation or akin to chelate formation with a phenolic hydroxyl group and adjacent quinone oxygen as already mentioned in the literature. However important details point to a situation more complex than simple adsorption. To clarify the mode of action of HA on the removal of dyes or

organic matter in general, we investigated the interactions of alizarinsulfonate ARS with calcium and phosphate ions in solution as a function of pH and dye/adsorbent ratio.

The possibility of the formation of mixed complexes of the type phosphate-calcium-dye which reveals the competition for calcium ions between phosphate and organic ligands is emphasized and reported herein.

→ CALCIUM PHOSPHATE SORBENT FOR ENVIRONMENTAL APPLICATION

ENV6

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Heavy metal pollution in soils, wastewater or fly ashes is a persistent environmental problem. This pollution in water or wastewater is an ongoing environmental problem and the rules to control and decrease this pollution are increasingly strict. The extreme toxicity of heavy metals even at low concentration and their bio-accumulation cause a lot of environmental problems. Minerals such as the calcium phosphate of general formula $M_{10}(XO_4)_6 Y_2$ with M a divalent cation, $(XO_4)^{3-}$ a trivalent anion and Y- a monovalent anion are well known for trapping metal ions. The retention of heavy metals by calcium phosphate has been already widely studied in aqueous solutions.

In this study, a low cost calcium phosphate gel (Ca-HA) synthesized from a calcium carbonate industrial waste was used as a sorbent for wastewater treatment. We have characterized this sorbent before and after use. The physical characterization showed a decrease of the specific surface area and density. The granulometry measurements showed an increase of the particles diameter explained by the sorption of pollutants (organic molecules). The presence of these molecules was confirmed by total and organic carbon measurement and thermal analysis. The elemental measurements confirmed also the heavy metal sorption by the Ca-HA. A calcination of the contaminated Ca-HA was carried out at different temperatures. After calcination the solid contained less organic molecules and heavy metals were concentrated in the matrix. This solid dried or calcined was dissolved in acid solutions (HCl or HNO_3). We obtained a solid phase (solid not dissolved) and a liquid phase. The majority of Ca and P passes in solution. The solid not dissolved was characterized by different methods (CHNS, DRX, ICP-AES) to compare with the initial solid. The liquid phase obtained during the stage of acid dissolution was neutralized with added KOH to increase the pH and regenerated a solid. This new solid was characterized to determine its composition. An amorphous calcium phosphate was obtained. Some experiments to determine its ability to retain heavy metals and/or organic molecules will be made.

COMPOSITE MATERIAL WITH CALCIUM SULFATE AND CALCIUM PHOSPHATE FOR HEAVY METALS RETENTION

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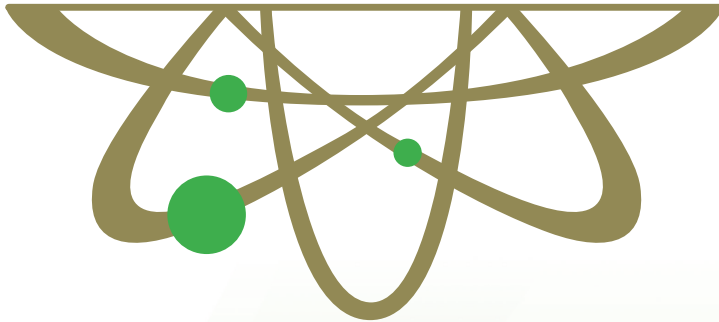
²Université de Toulouse, Mines Albi, CNRS, Centre RAPSODEE, Campus Jarlard, France.

Porous composite materials containing calcium phosphate and calcium sulphate were elaborated by mixing various hydroxyapatites with calcium sulphate hemihydrate, adding water and moulding the paste into shape. The composite material was broken into small granules of 5 mm size to test for heavy metal retention in a column configuration. It was found that the amount of zinc ions retained depended on the contents in apatites present in the composite, and that results were similar to the results obtained for equivalent amounts of pure apatite put in the same column. These results are interesting because previous work on pure apatites showed release of small sub-micrometer sized metal phosphates when the apatite particles were contacted with heavy metals in a flow-through experiment. Thus, the plaster matrix does not prevent metal uptake from aqueous solutions and helps minimize release of fines from the used apatite. The breakthrough curves and zinc retention capacities will be presented for various composite compositions, flow rates and zinc concentrations.





OCP Industrial Management





OCF PRODUCTION SYSTEM

OIM1

Hassan Chadli & Amine Louali
OCF SA, Maroc

OCF Group has been through a global transformation process that enables him to reach a high level of performance in the existing operation. The first step of the industrial transformation was named IQLAA and last more than 2 years. It enabled OCF to increase its global production capacity by close to 25% without any investment. The next stage is about the implementation of OCF Production System, the OCF Way of producing and improving productivity and cost in a large Industrial Group of more than 20 000 people. This session is about sharing this incredible experience that enabled OCF Group to initiate cultural transformation of the workforce and will last for the coming years. Taking its origins in the Industrial Strategy, we will go through the initial movement initiated through IQLAA program and the key lessons learnt from this initial experience and how it was improved through OCF Production System to sustain performance over years.



TRANSFORMATION DU MANAGEMENT HSE À OCF

OIM3

Ahmed fouad BAHBOUHI
OCF SA, Maroc

Pour accompagner le déploiement de sa nouvelle stratégie industrielle, en particulier la transformation opérationnelle et les projets de développement industriels et immobilier, OCF a ouvert un chantier de transformation du management HSE avec une ambition d'excellence dans ce domaine. La présente présentation donne une idée sur la genèse de ce chantier, la démarche suivie, les différents éléments mis en place durant l'année 2012 ainsi que le programme prévu pour l'année 2013.



THE ECOSYSTEM INITIATIVE OF OCF GROUP

OIM5

Youssef El Bari
OCF SA, Morocco

OCF group launched in 2012 the industrial ecosystem initiative. The objectives are to increase the sustainability and the global competitiveness of the industrial ecosystem and to increase the local content of OCF purchases. Through a deep change in the purchasing processes of the company, OCF Group promotes the development of its ecosystem. On one side, OCF encourage the installations of its international best in class suppliers in Morocco to make it a platform to serve the region. For this purpose, it is ready to bring the supplier with a visibility on its ambitious investment program and its growth. Services, as well as manufacturing capabilities are targeted. On the other side, OCF work with Moroccan SME and share with them its capabilities in order to improve their skills and facilitate their financing.



OCP ADVANCED PHOSPHATES TRAINING

Amine Louali¹, Robert Beauchemin²

OIM6

¹ OCP SA, ² SNC LAVALIN

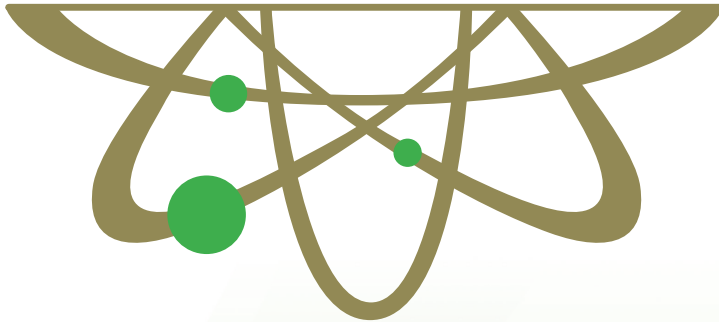
OCP will be inaugurating this summer the largest and most advanced phosphates training campus worldwide. With a planned capacity of 6,000 simultaneous learners and 300 instructors across four separate centers (Khouribga, Benguerir, Jorf Lasfar, Safi), the campus will offer innovative pedagogical strategies and training accelerators. These include thousands of hours of computer-based training (instructor-led and autonomous), five process plant simulators (washing, sulfuric acid, phosphoric acid and two granulation lines), advanced maintenance training workshops and heavy equipment simulators (mining truck, electric rope shovels and bulldozers). Learners will be put through rich learning experiences which include, basic and advanced e-Learning programs, a number of practice opportunities, in workshops, simulators and through “on-the-job” periods. In addition to being the main provider of qualified technical personnel to OCP mining and chemical processing facilities, this training campus will also fulfill a social development role in the region as an employability improvement platform.

This presentation will explain the main objectives of the OCP training campus, some of the challenges involved in getting this project completed and the expected benefits for the industry.





Phosphate Beneficiation





LE DÉVELOPPEMENT DES PROCÉDÉS ET DES TECHNIQUES D'ENRICHISSEMENT ET DE TRAITEMENT DES PHOSPHATES À L'OCP. UN CHEMIN VERS L'EXCELLENCE POUR ASSURER L'EXPLOITATION RATIONNELLE EST ÉQUILIBRÉ DES GISEMENTS DE PHOSPHATES: CAS DU SITE DE KHOURIBGA

PB1

ALOUANI ABDELKADER et ZNIBAR AHMED¹

OCP S.A., Maroc

L'exploitation des phosphates dans la zone minière de Khouribga 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 chaîne de production et utiliser les techniques les plus adaptées pour l'enrichissement des phosphates.

Le contrôle qualité des produits est assuré par la surveillance et la mesure des éléments de pilotage le long des circuits de production. Cette reconnaissance permet d'identifier les caractéristiques des échantillons des qualités sources et marchandes des phosphates prélevés au niveau des différents stades opératoires. Les processus de manutention, d'enrichissement et de fabrication des qualités marchandes sont certifiées ISO 9001 et ISO 14001.

Pour améliorer davantage la qualité des produits, l'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 permet de :

- Améliorer le taux de récupération des phosphates ;
- Rationaliser l'exploitation des gisements et augmenter leurs durées de vie ;
- Intégrer l'exploitation des différentes couches des gisements de phosphate dans les projets de développement stratégique de l'OCP ;
- Produire des qualités marchandes de phosphate à haute valeur ajoutée.



NEW TECHNOLOGY FOR DISAGGLOMERATION AND SLURRYING OF FLORIDA PHOSPHATE MATRIX

PB2

Hagen Müller

Haver Engineering, Germany

The phosphate mining represents a significant and important industry in the state of Florida. Due to the great demand of resources the industry is in a strong public focus. Only the mining process of the phosphate ore is responsible for about 45% of total energy consumption during its mining and processing. Slurry pumping to the processing plant accounts for one third of the energy consumption during mining. Various studies have shown that the optimum solid-water ratio for slurry pumping is at approximately 60%. It is difficult to set this value with the currently applied technology of hydraulic monitor



operations. For operational reasons more precise control of the solids content is almost impossible. Therefore the Florida Industrial and Phosphate Research Institute was funding this research project.

The main problem is the dis-agglomeration and slurrying of phosphate matrix for slurry pumping. State of the art is still the use of draglines for phosphate ore mining. The dragline dumps the phosphate matrix to the pit. Here it is slurried with the help of hydraulic monitors and conveyed to a static grizzly. The grizzly is used to scalp larger rocks and roots. It is need to be cleaned at regular intervals. Behind the grizzly a suction pump is situated which is pumping the slurry to the processing plant. The average solids content of the slurry is only about 25-35%, and varies widely depending on the material properties.

Overall four different types of phosphate ore were examined. In the first step the phosphate ores are analysed and characterised. Then two different ways were evaluated to improve the current used slurrying process. On one hand tests with high pressure water jets up to 200 bars (2900 psi) for disaggregation the phosphate matrix were performed. The disaggregation and slurrying is principle possible with this technology, but the necessary throughput can't be reached due to the long retention time required. On the other hand selective crushing tests with a wet hammer mill were executed. Using this technology it has been possible to achieve a solids content of 60 wt.-%, while achieving a high degree of disaggregation of the clay agglomerates, without destroying the valuable material. Based on the test results a preliminary design for a mobile dis-agglomeration and slurrying unit was developed. The advantages obtained by the new technology are a reduction of water demand from 2,16 m³/t to only 0,1 m³/t and energy consumption from 1,32 kWh/t to 0,36 kWh/t.



SYNERGISTIC EFFECTS OF ENVIRONMENTALLY FRIENDLY COLLECTORS IN PRECONCENTRATION STEP OF DOUBLE FLOAT PROCESS ON SEDIMENTARY PHOSPHATE ORE

PB3

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¹Clariant Produkte, Germany

Sedimentary phosphate rock like apatite is a precious source for phosphoric acid and fertilizers like NPK. During beneficiation of the ore, typically flotation is applied for purification of the ore from gangue material like carbonates and silicates. A double float process using direct flotation with anionic collectors in the first stage and reverse flotation with cationic collectors in the second stage serves this purpose well. Carbonates, like dolomite or calcite and silicates, are removed from the ore. This study outlines the investigation of the direct flotation of a sedimentary phosphate ore as the first step of purification. The target was to increase the P₂O₅ recovery to >90% at a constant P₂O₅ grade while separating as much carbonate as possible. Several anionic collectors and combinations, thereof, were tested.

Achieving P₂O₅ recoveries of up to 95% by using an environmentally friendly collector blend showed the best result while the MgO grade was lowered from 5.1 to 4.1%.

PROCÉDÉS DE LA FLOTTATION DES PHOSPHATES CARBONATES ET SILICO-CARBONATES : ETAT DE L'ART ET PERSPECTIVES

PB4

**Moulay Brahim Jouti, Chakour Mountassir, Hafid Zouhair et Etahiri
Abderahman**
OCP SA, Morocco

L'enrichissement des minerais de phosphate sédimentaire à gangue carbonatée ou silico-carbonatée connaît un grand développement et suscite un intérêt particulier du fait de la demande croissante de la fertilisation et l'évolution des exploitations minières vers des phosphates de qualité moindre marquée par la baisse des teneurs en BPL et l'accroissement des teneurs en impuretés.

Des efforts considérables de recherche ont été déployés ces dernières années pour séparer les carbonates et les silicates des apatites par flottation. Les travaux réalisés ont porté entre autre sur l'analyse physico-chimique et minéralogique de la surface, le contrôle de l'environnement de la pulpe et la recherche de nouveaux réactifs plus sélectifs. Ces travaux ont abouti à divers procédés de flottation des phosphates, directe et inverse, développés à l'échelle laboratoire et pilote et dont certains ont été industrialisés.

La plus part des procédés de flottation inverse font appel à la flottation de pulpe deschlammée consistant en une flottation des carbonates par un collecteur anionique, associée à la dépression sélective des particules phosphatées généralement par un électrolyte. La silice présente dans le minerai est généralement flottée dans une seconde étape à l'aide d'un collecteur cationique type amines. Les collecteurs anioniques des carbonates les plus utilisés sont les acides gras, acides gras sulfonés, phosphoriques esters et ethoxylated phosphoriques esters, tandis que pour les déprimants du phosphate, les acide phosphorique, sulfurique, fluosilicique, diphosphonique, tripolyphosphate de sodium, starch sont les plus connus.

La flottation directe du phosphate utilise un collecteur anionique ou cationique associée soit à la dépression de la gangue ou l'activation de l'apatite. Les déprimants, silicates de sodium, gum arabic, starch, acide citrique, sont les plus connus.

Consciente de l'importance de développer un procédé techniquement et économiquement viable pour enrichir les phosphates pauvres, la R&D OCP a lancé un important programme de recherche pour mettre au point un procédé pour enrichir ces phosphates par flottation. Ce programme a abouti à la mise au point d'un procédé qui permet de séparer les carbonates et les silicates de l'apatite en une seule étape de flottation en utilisant les esters phosphoriques comme collecteurs des carbonates et les amines comme collecteurs de la silice avec une dépression du phosphate par l'acide phosphorique.

Aujourd'hui, la Recherche et Développement de l'OCP est en face d'un défi majeur car elle a le devoir d'améliorer l'existant par l'introduction de technologies innovantes et le développement de nouveaux collecteurs de flottation plus efficaces et de repenser les procédés de traitement actuels par la mise au point de nouveaux procédés de flottation pour les phosphates très pauvres en P_2O_5 .

Keywords : minerai de phosphate, procédé de flottation, réactifs de la flottation.



INNOVATIVE RTS TECHNOLOGY FOR DRY BENEFICIATION OF PHOSPHATE

PB5

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The Crago double flotation process is widely used for upgrading raw phosphate in Florida. However, it is a water-based physico-chemical process and consumes a huge amount of water and chemicals and is not efficient to remove dolomite from phosphate. In addition, the final phosphate flotation concentrate often has a grade of 30-31% P₂O₅, which is below the BPL content of 75% (or 34.3% P₂O₅) required for making the animal feed grade phosphate.

This study is performed to evaluate the potential and feasibility of the innovative rotary triboelectrostatic separator (RTS) as a dry phosphate beneficiation process. The RTS technology is characterized by an innovative high efficiency rotary charger, charger electrification, laminar air flow, independent control of charging and separation condition, low energy consumption, etc. Compared to conventional triboelectrostatic separators, the unique RTS technology offers multiple technical advantages: 1) increase particle charge density 4-6 times; 2) improve solids throughput by an order of magnitude; 3) enhance process efficiency by up to 70%; 4) reduce overall energy consumption by more than 80%.

A laboratory scale prototype RTS unit has been used to investigate the effects of major process parameters on separation efficiency and identify optimum conditions for Florida phosphate samples. Experimental results have shown that the RTS technology upgraded a 10% P₂O₅ feed (16-35 mesh) to a 30% P₂O₅ concentrate with a P₂O₅ recovery of more than 85% and acid insoluble rejection of almost 90%; it also purified a flotation concentrate with 31% P₂O₅ to nearly 35% P₂O₅.



TRIBOELECTRIC BELT SEPARATOR FOR BENEFICIATION OF MINERALS

PB6

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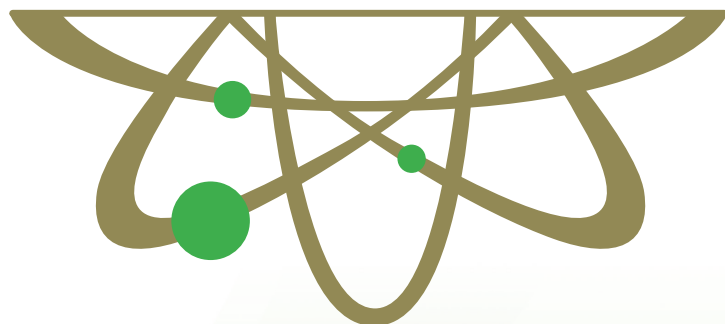
Separation Technologies, LLC (ST) has developed a processing system based on triboelectric charging and electrostatic separation that provides the mineral processing industry a means to beneficiate fine materials with an entirely dry technology. The environmentally friendly process can eliminate wet processing and required drying of the final material. The process requires little if any pre-treatment of the material other than grinding and operates at high capacity - up to 40 tonnes per hour by a compact machine. Energy consumption is low, approximately 1 kWh/tonnes of material processed. Since the only potential emission of the process is dust, permitting is typically relatively easy. In contrast to the other available electrostatic separation processes that are typically limited to particles greater than 75 μm in size, the ST belt separator is ideally suited for separation of very fine (<1 μm) to moderately coarse (300 μm) materials with very high throughputs. The triboelectric particle charging is effective for a wide range of



materials and only requires particle - particle contact. The small gap, high electric field, counter current flow, vigorous particle-particle agitation and self-cleaning action of the belt on the electrodes are the critical features of the ST separator. The high efficiency multi-stage separation through charging / recharging and internal recycle results in far superior separations and is effective on fine materials that cannot be separated at all by the conventional electrostatic techniques. Since 1995, this triboelectric process has been extensively used for the beneficiation of coal fly ash with eighteen separators in place and over 130 machine-years of operation at locations in North America and Europe. The technology has been also successfully applied to the beneficiation of a variety of minerals including calcium carbonates, talc, and potash. Recently, dry electrostatic separation has been successfully demonstrated for beneficiation of phosphate ores.



Agronomy & Fertilization



RESPONSIVENESS OF DIFFERENT POTATO VARIETIES (SOLANUM TUBEROSUM) TO PHOSPHORUS APPLICATION

AF1

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A better understanding of mineral application and use by crops is one way for enhancing crop yields with a minimum negative impact on environment and a reduced cost of the production achieved. Genetic variability of crops may be used directly (by choosing efficient genotypes) or not (by introducing interesting genotype in breeding programs) to achieve this goal.

The objective of this study is to assess responsiveness of different potato varieties to mineral phosphorus application.

A field trial was conducted at El Annaceur (experimental station of the National Institute for Agronomic Research (INRA, Morocco)) on soil with the following characteristics: clay (27%), silt (53%) and sand (20%), pH water (8,4), NO₃⁻ (11,6 mg/kg), OM (2,80 %), P₂O₅ (Olsen) (67 mg/kg) and K₂Oexchangeable (520 mg/kg).

Seven potato varieties (V) (Desirée, Nicola, Barna, Pamela, Daifla, Labella and Marguerita) were combined with two phosphorus (P) treatments (P₀: without any P application and P+: 100kg P₂O₅/ha as super triple phosphate (45%)). The experimental design was a split plot with three replications, P on main plots and varieties on subplots.

Every subplot consists of one line 3m long of each variety separated on both sides by the check one (variety: Desirée) at distance of 0.70m. Ten tubers were planted on each line by variety. Nitrogen was added at the rate of 50kg N/ha at planting and another 50 kg N/ha at tuber formation as ammonium nitrate.

The variety Désirée showed the most important response to P application with an average of 46 % of increase compared to control. The variety Nicola comes in second position with 18 % of response to P application while varieties Labela, Pamela and Daifla showed similar improvements with approximately 10 % of improvement comparatively to control.

Results show a significant effect of variety. No effect of P or (P*V) were recorded. Pamela gives the best tuber main yield of 34 t/ha followed by Daifla and Margerite that gave a main yield of about 28 t/ha. The other varieties give yields variant between 19 and 22 t/ha.

Within the framework of this experiment, the variety Pamella gave the best yield in both situations of phosphate nutrition. While the control variety Désirée required an additional application of P to express her potential of yield so marking a 46 % improvement compared with the treatment without any P application.

ETUDE DU MÉLANGE PHOSPHOGYPSE/PHOSPHATE NATUREL POUR APPLICATION EN AGRICULTURE

AF2

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Cette étude a porté sur la biodisponibilité du phosphore contenu dans des phosphates naturels du MAROC. Les traitements des minerais de phosphates et leurs valorisations font rarement appel aux opérations unitaires de broyage poussé en raison du coût énergétique et de leurs propriétés de friabilité. Dans ce travail, nous avons examiné la possibilité d'introduire des opérations de broyage poussé dans le cadre d'une filière courte de valorisation pour améliorer l'efficacité agronomique des phosphates naturels (PN) grâce à une transformation structurelle ou une attaque ménagée plus efficace par l'acidité libre résiduelle dans le phosphogypse (PG) résidu industriel de la production d'acide phosphorique.

Le PN utilisé dans ce travail provient de la région de Khouribga «MAROC» et le PG de Jorf Lasfar.

Les fractions fines de phosphates ont été obtenues à l'aide des opérations de broyage étagées et ménagées.

Les fractions granulométriques ont été caractérisées par plusieurs techniques : DRX, BET, Granulométrie LASER, MEB, ... L'ensemble des analyses a mis en évidence un certain nombre de phénomènes essentiellement l'amorphisation et l'agglomération.

Les mélanges PG/PN ont été aussi ciblés afin d'exploiter l'apport bénéfique du PG sur le PN. Ensuite, leurs aptitudes agronomiques en vases de végétation ont été étudiées dans ce travail.

Mots clés : Phosphate naturel, Broyage, Surface spécifique, Phosphogypse, Biodisponibilité, Application directe.



4R NUTRIENT STEWARDSHIP FOR IMPROVED NUTRIENT USE EFFICIENCY

AF3

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Fertilizers play a significant role in securing the production of food crops around the world. In fact, it is estimated that fertilizers currently support 40-60% of all crop production currently. Meeting future food security targets requires the responsible use of fertilizer nutrients. The 4R Nutrient Stewardship guidelines were developed by the fertilizer industry as a process to guide fertilizer Best Management Practices (BMP) in all regions of the world. This approach was required to address the growing concern that fertilizers are applied indiscriminately to the detriment of the environment. Given that farmers purchase fertilizers at world prices in most regions, and these prices have been steadily increasing over time, most users are very cautious about the rates of nutrients they apply. To avoid unnecessary policy intervention by governments, the fertilizer industry needs to be unified in their promotion of BMPs that support improved nutrient use efficiency and environmental sustainability, while supporting the farmer's profitability. This ultimately comes down to developing appropriate recommendations that match crop nutrient requirements fertilizer additions and minimize nutrient losses from fields. This led to the 4R Nutrient Stewardship concept, applying the Right Source of nutrients, at the Right Rate, at the Right Time and in the Right Place.

Right source means matching the fertilizer to the crop need and soil properties. A major part of source is balance between the various nutrients, a major challenge globally in improving nutrient use efficiency. Finally, some fertilizer products are preferred to others based on the soil properties, like pH.

Right rate means matching the fertilizer applied to the crop need – simple as that. However, this is far from being a simple concept when you consider the variations in yield goals, previous crop management, crop residue management, influence of legume crops in rotation, etc. Adding too much fertilizer leads to residual nutrients in the soil and losses to the environment. Ultimately, striking a balance between the crop needs, environmental conditions and the farmers economic situation is required.

Right time means making fertilizer nutrients available to the crop when they are needed. Nutrient use efficiency can be increased significantly when their availability is synchronized with crop demand. Split time of application, slow and controlled release fertilizer technology, stabilizers and inhibitors are just a few examples of how fertilizer nutrients can be better timed for efficient crop uptake.

Right place means making every effort to keep nutrients where crops can use them. This is an issue which poses the greatest challenge in small holder agricultural systems, where most fertilizer is broadcast applied, and in many cases without incorporation. Research indicates that fertilizer placement can not only improve crop response, but also improve fertilizer use efficiency significantly by lowering nutrient application rates. Adaptation to non-mechanized agriculture have been made in certain regions which clearly support efforts to modify fertilizer placement as a BMP.



NUTRITIVE SOLUTIONS: INNOVATIVE FERTILISERS TO HELP GROWERS MEET GLOBAL FOOD CHALLENGE

AF4

Valérie Renard
Prayon, Belgium

Food, health and nutrition are enormous challenges for the 21st century. A major concern is to give all people of the planet access to sufficient, safe and nutritious food. Prayon can help meet these challenges by providing innovative phosphate solutions. These solutions are directly devoted to the food sector as well as playing their role as fertilisers. By contributing to both the quantity and the quality of the crops, they have a big impact on the produced food.

Fertilisers' role will become more and more important in the next decades to meet the global food challenge. At Prayon, it has become a strategic priority. Based on its long experience of fertiliser production, the company today focuses on developing, producing and marketing creative nutritive solutions that will help meeting food needs by providing horticultural and agricultural industries with the best products.

For these industries, the challenge is to apply the right source of fertiliser at the right rate, right time, right place and on the right crop. Our products and experience can greatly help them.

Our Hortipray® brand is already well known on the market. Hortipray® is a complete range of 100% water soluble fertiliser products, developed to fulfill the requirements of the most demanding producers and consumers. These products supply vegetables, fruits and flowers with optimum nutrient levels so that both crop yields and quality are optimised.

Over the last few years, Prayon has been very actively working on the development of new functionalities for fertigation customers. Innovation is part of our everyday focus. Our innovations are the combined outcome of our researchers' creativity, customer requirements and studies made by our academic and research partners worldwide. Based on their knowledge of phosphate applications (in fertigation but also in detergency, food applications, water treatment, etc.), Prayon's technicians have identified several synergies that help enhance the functionalities of our Hortipray® products.

In combining phosphate (P) benefits with other important functions for the growers, Prayon is developing 'several in 1' (2 in 1, 3 in 1 and more) nutritive solutions that facilitate growers work and offer adequate response to their daily problems.

Already available on the market, Hortipray® anticalc is part of these major innovative products developed for fertigation use. This new range combines the benefits of phosphate, nitrogen and/or potassium fertilisers with anti-sediment effect. It was shaped to prevent the deposit of limescale and other chemicals in irrigation pipes. This reduces the risk of blockage and uneven irrigation as well as prevents the growth of bacteria. It also extends the lifespan of the pipes.

By preventing clogging and scaling in the irrigation system, Hortipray® anticalc prevents losses of water and nutrients, which is essential for the plant growth but also for the environment.

This "2 in 1" solution allows to reduce the use of other anti-clogging additives or cleaning chemicals and offers thereby a cost and time effective solution for growers.



Prayon has recently entered into a collaborative agreement with a Dutch company to use its intelligent and user-friendly turnkey solution that defines precisely how much water the plant receives. It will help demonstrate the efficiency of Hortipray® anticalc with sharp figures.

Another range of 'several in 1' products is currently being developed and tested in greenhouses. These patented products combine the supply of essential macro and micro-nutrients to the plant. The advantage is a more complete, more economic and environment friendly solution which makes growers' work easier. The first product of this range will be launched in the very near future. It will be presented in detail during the conference.

Prayon is convinced that fertilisers' role will steadily increase in the coming years given their crucial role in promoting food and nutrition security. Investing in R&D aimed at optimising benefits associated with the use of fertilisers is therefore a priority. The company's ambition is to contribute to this process by creating innovative products for fertigation which will care for both nutritive needs and sustainable development.

DEFICIENCY AND MANAGEMENT OPTIONS FOR PHOSPHORUS IN MAIZE PRODUCTION IN EAST AND SOUTHERN AFRICA

AF5

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Soil phosphorus deficiency is recognized as a major factor limiting maize production East and Southern Africa. This paper reviews the severity and occurrence of P deficiency in the maize-based farming system in the region and presents an overview of available P nutrient resources and their impact on maize productivity. P deficiency is particular acute in the highly weathered and acidic tropical soils in East Africa, that have a high P-fixing capacity. The amount of P adsorbed by the soils is associated with high exchangeable aluminum and total iron contents, as well as low pH. In much of sub-tropical soils in Southern Africa, the predominant soils are sandy with low P fixing potential, and P deficiency is mainly associated with low soil organic matter contents. The deficiency of P in the soils in southern Africa is often obscured by nitrogen deficiency. Improving the yields of the main cereal crop, maize, requires judicious management of limited fertilizer resources available to farmers. In Southern Africa maize yields can readily be increased by 2-6 t/ha when moderate rates of mineral P fertilizer or animal manures are used in combination with mineral N fertilizer. However, large investments in P and lime are often required to recapitalize P and reverse soil acidity in the P-fixing soils in East Africa. Experimental results show that mineral P fertilizers offer the best option to reduce P deficiency but their use restricted by poor accessibility and low affordability to farmers. Options adapted to the conditions of smallholder farmers include direct use of reactive P rocks, partial acidification of low reactive P rock and the application of various organic matter sources. A major challenge for improving management of P in East Africa is the development of reliable analytical methods adapted to P-fixing soils.



TERACTIV CACAO AS A NEW FERTILIZER BASED REACTIVE PHOSPHATE ROCK FOR COCOA PRODUCTIVITY IN CÔTE D'IVOIRE: A PARTICIPATORY APPROACH TO UPDATE FERTILIZATION RECOMMENDATION

AF6

KOKO L. K.

CNRA, Programme cacao, Ivory Coast

Cocoa (*Theobroma cacao* L.) is a strategic product for Côte d'Ivoire. This country is the world leader producer with aver 40 % of world volume production. This production is obtained on 6 % of the country's area by the work of 5 million farmers and the members of their family. Cocoa contributes to 30 % of export earnings and 15 % of the Gross Domestic Product (GDP). These economic parameters show the importance of cocoa for Côte d'Ivoire. Despite some remarkable performance, in cocoa growing systems, there are many constraints for cocoa productivity and sustainability. Particularly, in acid strongly P-sorbing soils of Côte d'Ivoire, P is among the nutrients that most limits cocoa production.

For the success of cocoa planting, application of P to soils is one solution to ensure cacao growth and productivity. However, the current recommendations of fertilization based on the use of the fertilizer 0 N. 23 P2O5.19 K2O + 10 CaO + 5MgO is not adapted in a context of deteriorating soil fertility. Improving the productivity of cocoa in Côte d'Ivoire therefore requires to update the fertilizer recommendations. In this context, the National Agronomic Research Center (CNRA, Côte d'Ivoire) conducts research-development in collaboration with the company Mars Inc. and Office Chérifien of Phosphates (OCP, Morocco), in order to test and validate a new fertilizer called Teractiv Cacao (0 % N . 15 % P2O5. 14 % K2O + 28 % CaO + 5,5 % S + 2,5 % MgO + 0,9 % Zn + 0,24 % B2O3). This new fertilizer includes natural tender phosphate (Reactive Phosphate Rock, RPR) in its composition, which makes it reduces the cost of purchase for cocoa producers and optimizes phosphate fertility of soils in cocoa growing systems. In its implementation, the research-development project adopted a participatory approach. Trials are conducted in three main cocoa regions in Côte d'Ivoire, including CNRA research stations Divo (Central - West) and Abengourou (East), as well as cocoa farmers areas in Soubré (South West). Ultimately, this project will contribute to the updating of fertilizer forms and doses in order to improve cocoa productivity in Côte d'Ivoire.

Keywords: Teractiv cocoa, Reactive Phosphate Rock, soil fertility, Côte d'Ivoire



IMPROVEMENT OF SOIL FERTILITY AND CROP PRODUCTION THROUGH DIRECT APPLICATION OF ROCK PHOSPHATE ON MAIZE IN INDONESIA

AF7

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*ISRI: Indonesian Soil Research Institute, Indonesia

Most of Indonesian agricultural soils are acidic and low in both total and available phosphorus. According to Mulyani (2004), about 104 million ha (68%) from total 148 million ha are acidic and mostly found in Sumatra, Kalimantan and Papua Island. The



expanding newly developed program of agricultural area is addressed to these islands. Approximately 47.1 million ha are available as new agricultural land (with slopes of 0-3%, 3-8%, and 8-15%). In addition, 15-20 million ha are potentially suitable for the cultivation of tree crops or estate crops (Adiningsih and Karama, 1992).

The major nutrient constraint in these soils is P and responses to both N and K are poor unless P deficiency has first been corrected. Correction of P deficiency therefore constitutes a major part of improving fertility of acid soils. Problems related to the acidic soil could be corrected by applying ameliorant such as phosphate rock (PR) and lime. Phosphate rock is recommended for application to acid soils where phosphorus is an important limiting nutrient on plant growth. This problem face most acid soils in Sumatra and Kalimantan. Maize is one important food crops in Indonesia. Studies of application of rock phosphate for Maize in Indonesia were reported. Rock phosphate was shown to improve soil fertility and maize crop productivity. In addition, residue of rock phosphate supplying plant for at least up to 4 cultivation times.

Through collaboration research between The OCP and ISRI (Indonesian Soil Research Institute), a study on the potential effect of direct application of, Reactive Rock Phosphate from OCP MOROCCO, in Maize is being conducted.

The overall objectives are to evaluate direct application of Reactive Rock Phosphate for Maize and find out the best rate and application method of Rock Phosphate for Maize.

EFFICACY OF TWO MOROCCAN SULPHUR-ENRICHED FERTILIZERS ON TEA AND SOME IMPORTANT STAPLE CROPS IN SMALLHOLDER FARMING IN KENYA

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Agriculture is the major economic sector in Kenya, employing over 70% of the population and contributing 25% of GDP. Kenya vision 2030, the long-term national development blueprint has identified agriculture as one of the key sectors to deliver 10% annual economic growth rate.

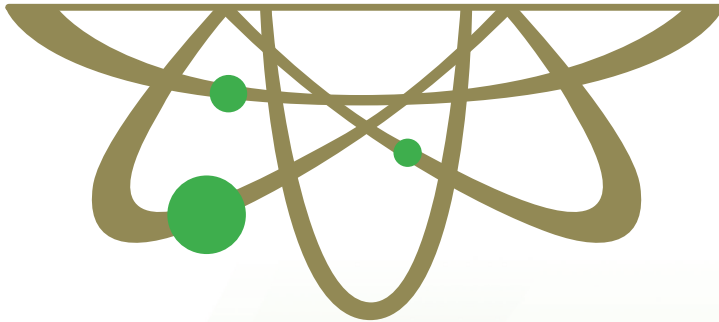
In Kenya, smallholder farmer's production accounts for 75% of total agricultural output and 70% of marketed agricultural produce. However, productivity in the smallholder farms is still below potential, due to continuous cropping coupled with low and inefficient use of agricultural inputs particularly fertilizers.

Yields and fertilizer efficiency of high sulphur requiring crops such as tea, maize and pulses could be improved by the use of appropriate sulphur fertilizers. Consequently, Kenya Agricultural Research Institute (KARI) in collaboration with Group Office Chérifien des Phosphates (OCP-Morocco) initiated a three year multi-location trials to evaluate the efficacy of two Moroccan sulphur-enriched fertilizer, which are NPS:19:38:0:7S and NPS: 12:46:0:7S on tea, maize, soybean and climbing beans.

The experiment was commenced in October 2012 and is being conducted in 80 farms across four counties in Central Kenya. The experimental design is typical on-farm trials with farms in one cluster acting as replicates. The plot sizes are 10x10 m² and five treatments including the sulphur-enriched fertilizers and the recommended fertilizers for the selected crops, in presence and absence of lime, were tested against the farmer's practice.



Industrial Management



ON-LINE XRF ANALYSIS OF PHOSPHATE MATERIALS AT VARIOUS STAGES OF PROCESSING

IM1

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Using several types of ground phosphate rock, phosphate fertilizers and intermediates, potential applicability of X-ray fluorescence conveyor analyzer CON-X [1] was demonstrated for quantitative on-line measurement of P, S, Cl, K and Ca at various stages of phosphate processing. In addition to the physical components required to perform on-line XRF measurements, analyzer is equipped with special evacuated mini-chamber. Design of bypass line consistent to analyzer configuration is proposed. Assessment of calibration quality for P, S, Cl, K and Ca was demonstrated on the basis of control samples and synthetic mixtures. The dynamic simulation of on-line measurements on grounded N-P-K fertilizer stream indicated a statistically acceptable correlation with laboratory chemical analyses (relative standard deviation for P is 1.5%, for S and Ca 6-7% and for K 10% relative). Application of conveyor XRF analyzer to industrial processing generates real-time feedback of elemental composition and quality of phosphate on conveyor thus enables to automate control of the production processes.

POTENTIELS DE DÉVELOPPEMENT ET D'USAGE DES SNCC DANS LES UNITÉS DE FABRICATION D'ACIDE PHOSPHORIQUE ET DES FERTILISANTS: EXPÉRIENCE DE OCP JORF LASFAR

IM2

EHLALI Mounsif & EL ASRI Said

OCP Group, Morocco

Actuellement, les SNCC ne constituent plus de simples outils techniques de contrôle commande des unités de production, mais ils se sont développés pour se placer au cœur du procédé comme outils incontournables de la conduite et de la gestion des unités de production. Actuellement les SNCC sont utilisés comme plate-forme centrale permettant (en plus des fonctionnalités basiques de conduite du procédé) la maîtrise et la gestion du procédé par des outils de contrôle avancé, l'archivage et l'historisation des événements et des paramètres de marche d'un grand nombre de données pour une durée très longue et avec une précision très fine. On peut citer aussi l'utilisation des SNCC comme outil d'aide à la décision, outil de la maintenance, moyen de communication, de transfert et de partage de données, le reporting, la comptabilisation des bilans, la modélisation et l'optimisation des procédés, etc..

Ces avancées technologiques transforment les SNCC en équipement névralgique et stratégique dans les usines et les entreprises en général. Ainsi et même si la majorité des fabricants confirmés annoncent un taux de disponibilité de 99,99%, il est nécessaire de bien mettre au point et ressortir les exigences minimales à imposer lors d'un choix d'un SNCC, surtout pour les unités de fabrication des dérivés de phosphates ayant des spécificités et des contraintes particulières, afin d'atteindre les performances requises et tenir compte des exigences des procédés exploités.

OCP a introduit les SNCC et leurs nouvelles technologies, depuis 1997 dans les unités de



production d'Acide Phosphorique et des Fertilisants. A ce stade, une maîtrise parfaite de l'élaboration des cahiers de charge et une connaissance confirmée sur le fonctionnement des SNCC sont assurément acquises par les compétences locales de OCP. En guise de conséquence, le besoin de tirer profit et d'exploiter davantage les ressources et les nouvelles fonctionnalités des SNCC a logiquement émergé. Cette situation a donné lieu au développement croissant d'autres axes d'amélioration au niveau de nos unités de production. Nous citons deux principaux volets, le premier est l'ouverture des SNCC vers les autres réseaux de l'Entreprise pour la communication directe, transparente et sécurisée des bilans de production, le reporting, les paramètres de marche en temps réel,... et le deuxième volet est le pilotage complètement automatique et intelligent des unités de production par l'usage des contrôles avancés, tels que la commande prédictive, optimale, neurones, ...



GESTION ET PRÉVENTION DES RISQUES

IM3

Thierry VERDEL

Ecole des Mines de Nancy, Laboratoire Georessources, France

La prévention des risques est aujourd'hui une obligation et une préoccupation fondamentale des entreprises industrielles, encadrée par la loi et par des normes. Néanmoins, la réglementation est un cadre parfois trop rigide pour faire face aux nouvelles menaces qui pèsent sur les activités économiques du fait des innovations technologiques, des changements sociétaux et des incertitudes qui en découlent. Dans notre intervention, nous proposons tout d'abord un bref rappel historique de la notion de risque et de la prévention des catastrophes à travers lequel nous verrons que co-existent aujourd'hui des stratégies de prévention variées dont certaines trouvent leur origine dans l'antiquité. Nous abordons ensuite les inconvénients techniques et culturels de la réglementation en matière de prévention des risques pour montrer l'importance qu'il y a dans les entreprises à développer une véritable politique de prévention et une culture de sécurité. Nous évoquons alors la nécessité pour les entreprises et les organisations, non seulement de prévenir les risques, mais aussi de se préparer à gérer des situations accidentelles et à affronter des situations de crises. Dans ce dernier cas, nous montrons qu'au-delà des compétences techniques, ce sont les capacités des organisations et des individus à affronter l'incertain et la complexité, le doute et le stress qui doivent être mobilisées, telles que les capacités de communication, de leadership, de flexibilité et de créativité. Des outils existent pour s'entraîner à faire face à ces situations et révéler ces capacités. Il s'agit par exemple des dispositifs de simulations virtuelles, des serious-game comme c'est le cas du dispositif iCrisis, développé à l'Ecole des Mines dont nous présenterons les principes.



OPTIMIZING VALUE EXTRACTION FROM TURNAROUNDS

IM5

Johan van der Westhyzen

^aDuPont Products S.A., United Arab Emirates

Many leading companies believe that they face a conflict between social, environmental and economic interests. This is not, however, the reality. By taking a holistic, yet pragmatic approach to sustainability by fully incorporating it into business strategy, it is possible to accelerate progress towards business and environmental goals, as DuPont's own experience will demonstrate.

At present, many companies are adjusting their attitude and approach to sustainability. One strong influence for this change is rising pressure from investors and stakeholders to become more "green". And yet, increasingly, companies are realizing that improved sustainability can augment their bottom line. Nonetheless, the drive to maximize shareholder return and increase productivity has traditionally overshadowed the need to husband resources, manage waste, reduce pollution and increase biodiversity. As a result many companies find it difficult to change the corporate mindset and give sustainability the same priority as return on investment.

Methods such as sustainable sourcing and manufacture, sustainability strategy development, accountability delineation and progress measurement can be maximized by utilizing a strong management system that focuses on cultural elements, visible leadership, appropriate structures and robust processes and actions. This paper will detail specific methodologies to develop such a system, and provide new insights into the means through which companies can analyze and select key opportunities that deliver the most value. Further, it will introduce practical methodologies that oil & gas companies can readily adopt to effect lasting change on both a site and corporate level.

By setting up a sustainability management system that focuses on accelerating value creation and performance, then integrating it fully into business strategy; and implementing it in a way that addresses the cultural changes necessary within the organization, the changes will end up being embraced, lasting and efficacious.



THYSSENKRUPP POLYSIUS PLANT TECHNOLOGIES & SERVICES FOR PHOSPHATE ORE PROCESSING

IM6

Luc Rudowski, Sébastien Fix, Virginie Emkeyes

Polysius SAS, France

ThyssenKrupp Polysius is a leading engineering company specialized in plant technology for the cement and minerals industries.

For the Phosphate ore processing, ThyssenKrupp Polysius offers a comprehensive range of technologies:

- For comminution and separation: ball mills, hammer mills and high efficiency SEPOL® separators. The worldwide success of ThyssenKrupp Polysius ball mills lies in the original features of the design with slide shoe bearings and the Combiflex® reducer. Early 2011,



ThyssenKrupp Polysius was awarded a contract from OCP SA for the engineering and supply of 14 ball mills to be installed in the Khouribga washing plants - Mea, Daoui and El Halassa (Morocco).

- For pyroprocessing: rotary & flash dryers, POLCAL® calciners
- For the quality control: sampling and laboratory automation systems POLAB®.

Whatever is the original manufacturer, ThyssenKrupp is a real service provider for predictive maintenance, at site emergency repair and inspection as well as innovating spare parts dedicated to complex mechanical systems.



PROJECT MANAGEMENT PROCEDURES NEEDED TO DESIGN THE NEWEST FOUR PHOSPHORIC ACID EVAPORATORS IN NORTH AMERICA

IM7

Richard D. Harrison PE-FL
PegasusTSI, USA

This paper presents the project management techniques needed to design the newest four evaporators installed in North America, and any other similar project.

Mustang Tampa Inc., a predecessor company to PegasusTSI, was retained by PCS Phosphates to design four new evaporators as part of an expansion project at the Aurora, North Carolina facility.

The four evaporators were successfully fabricated & erected by the mechanical contractor to the PegasusTSI design by mid 2009. Topics discussed in the paper include:

- Project Objectives
- Project Stages: Feasibility Study, Front End Engineering, Detailed Engineering
- Project Scope Definition
- Project Design Basis
- Codes and Standards
- Technology Selection
- Capital Cost Estimation
- Schedule Development and Control
- Operating Cost Estimation
- Value Improvement Practices
- Equipment Specifications
- Contractor Bid Specifications
- Constructability Reviews using 3D CAD
- Construction Management
- Commissioning

The evaporators are located at the following coordinates: 35o 22' 29.3" North & 76o 46' 54.7" West and can be seen on Google Earth. Similarly, photographs of the evaporators can be seen in the 2010 and 2011 Annual Reports from Potash Corp. of Saskatchewan.

PegasusTSI is an Engineering, Procurement, and Construction Management company with its main office in Tampa, Florida USA with extensive experience in the phosphate industry.

PHOSPHATE PROCESSING USING THE LATEST SENSOR BASED SORTING TECHNOLOGY

IM8

Jens-Michael Bergmann^a

^aTomra Sorting GmbH, Germany.

Dry ore beneficiation is a target in many mines nowadays. Water withdrawal and disposal together with all related environmental aspects are the key issues, even more in dry or arid areas. Obtaining the necessary permissions becomes increasingly difficult and expensive. Therefore idea of a dry ore beneficiation is not new. In Phosphate beneficiation many of the used technologies are waterless, since water is just not present on site. But many of the downstream beneficiation, for instance DMS or flotation, are based on water.

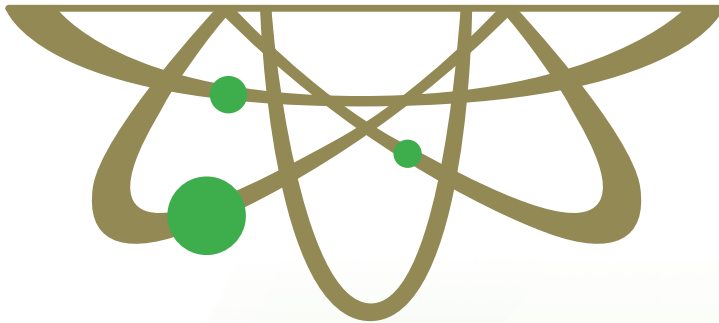
Sensor-Based-Sorting (SBS) can help to pre-concentrate the phosphates and eliminate large shares of calcite or silicon at the very beginning of the processes, in case a deposit shows a reasonable particle size. The X-Ray-Transmission (XRT) technology can be used to separate the flint pebbles for instance. Near Infrared technology (NIR) can detect and separate calcite or limestone particles and eliminate these from the feed stream.

In the recent years these technologies have proven their ability even in industrial scale applications. High efficiencies and recovery rates can be achieved using the latest technologies. Powerful computers and increasingly sensitive X-ray scintillation counters enabled the development of high-performance units. The machines have reached a status of rigid and reliable field stability and can be operated at grain sizes of 8 mm up to 250 mm, depending on the individual ore.

The paper will describe the basics of the XRT and NIR -sorting technology and present latest sorting results.



Materials & Corrosion



CORROSION ET ABRASION DANS L'INDUSTRIE DES PHOSPHATES : PROBLÈMES ET SOLUTIONS

MC1

N. SEMLAL, R. BOULIF, A. KOSSIR
OCP SA, Maroc

La corrosion, plus particulièrement la corrosion-abrasion, est l'un des problèmes majeurs rencontrés lors de la production de l'acide phosphorique par voie humide. Elle est due, d'une part, à la sévérité des conditions de service (température du procédé, vitesse d'agitation et d'écoulement des fluides,...), et d'autre part, aux impuretés corrosives (chlorures, fluorures,...) et abrasives (particules de phosphate, cristaux de gypse,...) contenues dans les différents acides et bouillies. Les équipements les plus touchés étant les cuves d'attaque, les équipements d'agitation, les filtres, les pompes de circulation, les tuyauteries et robinetteries, les échangeurs ...

Il est donc impératif de lutter contre ce phénomène, afin de l'éviter sinon du moins en minimiser l'impact. De ce fait, toute amélioration permettant de prolonger la durée de vie des équipements et de diminuer le nombre d'arrêts nécessaires aux opérations de maintenance est essentielle.

Dans cet exposé, nous nous proposons de présenter les principaux cas de corrosion recensés lors d'une expertise des unités de production d'acide phosphorique du groupe OCP. Pour chaque cas, nous exposerons les types et causes probables de la corrosion rencontrée ainsi que les solutions d'amélioration proposées (matériau, revêtement,...) afin d'augmenter la durée de vie des équipements en question et de limiter l'impact de leurs dégradations en terme de coûts et de temps d'arrêts nécessaires aux opérations de maintenance.

La diversité des types de corrosion relevés, à savoir, mécanique (usure, abrasion,...) et/ou électrochimique (piqûres, uniforme,...) permet de souligner la complexité des problèmes de corrosion liés à la production de l'acide phosphorique par voie humide.

Mots-clé : Corrosion, abrasion, acide phosphorique, industrie des phosphates

MERSEN HEAT EXCHANGERS: INNOVATIONS THAT GUARANTEE RELIABILITY, LIFESPAN AND ENERGY EFFICIENCY

MC2

Laurent TRABLY
Mersen, France

Mersen is a leading multinational industrial group. With its extensive expertise in high-grade materials and electrical installation reliability and security, Mersen designs innovative solutions tailored to customer requirements to improve their industrial performance in sectors such as energy, transport, electronics, chemical/pharmaceuticals and process industries.

Its Process Equipment Division is internationally recognised for its expertise in the design



and manufacture of equipment made from high-grade materials for use in corrosive and hot environments.

Mersen has been designing and manufacturing heat exchangers for over 50 years. With its innovation-oriented approach, Mersen capitalises on its expertise in heat exchange, its mastery of graphite and its wide range of heat exchanger designs to develop solutions to meet the difficult constraints of phosphoric acid.

Graphite heat exchangers are very large devices. Their tubes are 6-metres long with no joints to guarantee better process continuity. Isostatic graphite, a basic component of a heat exchanger, is impregnated with resin to make it more corrosion resistant. To improve equipment lifespan and reliability, amorphous carbon sleeves are used to strengthen the exchanger's tubes and tubular plates.

Mersen affirms its position as a heat exchanger expert with the development of an exchanger with free-flow welded plates; it re-concentrates sulphuric acid used during the mineral attack. The innovation lies in the plate design with variable spacing. The design of the plates and the HXC exchanger also make it more energy efficient.

The Mersen industrial plants in Morocco (2,500m²), France (8,000m²) and China (150,000m²) confirm its international position as the leading supplier of process equipment for the phosphoric acid and fertiliser market.



USE OF STAINLESS STEELS IN THE INDUSTRY: RECENT AND FUTURE DEVELOPMENTS

MC3

Pauline BOILLOT & Jérôme PEULTIER
Industeel, ArcelorMittal Global R&D, France

In a first part, this paper presents the reason why during the last fifteen years the industry move from conventional material to more technically adapted or only more economical solutions. Several examples are described:

- the use of lean duplex UR2304, duplex UR2205 or superduplex UR2507 in the potable water production from seawater,
- the use of superduplex grades UR2507Cu (UR52N+) and superaustenitic UR904 (URB6), UR28 (URB28) and UR31 in the production of phosphoric acid,
- the use of UR2205 for chemical transport or storage,

In a second part, mechanical and corrosion resistance properties of the new Mo free lean duplex UR2202 will be detailed and commented. This material has been recently developed as alternative to 300-series like 304L and in some cases 316L and are less susceptible to nickel and molybdenum price fluctuation. Among others, this new material appears to be a great alternative to austenitics in potable or industrial water applications.

Résumé :

Dans une première partie, cet article présente les raisons qui ont conduit, durant ces quinze dernières années, l'industrie à faire évoluer la sélection des matériaux vers des solutions plus sûres techniquement ou simplement plus économiques. Seront ainsi abordés l'utilisation:



- de la famille duplex (UR2304, UR2205 et UR2507) pour la production d'eau potable à partir d'eau de mer,
- des aciers inoxydables superduplex UR2507Cu (UR52N+) et super austénitiques UR904 (URB6), UR28 (URB28) et UR31 dans la fabrication de l'acide phosphorique,
- des aciers inoxydables duplex UR2205 pour le transport de produits chimiques comme l'acide phosphorique.

Dans une seconde partie, les propriétés mécaniques et de résistance à la corrosion des nuances duplex économiques, c'est à dire à bas nickel et sans addition de molybdène, comme l'UR2202, seront détaillées et commentées. Ces nuances ont été récemment développées afin de proposer une alternative aux nuances de la série 300 (typiquement 304 ou 304L et dans certains cas 316L), car moins sensibles aux fluctuations du cours des éléments d'alliage nickel et molybdène. Parmi les domaines d'application de ces nouveaux matériaux, nous citerons le transport ou le stockage de produits peu corrosifs comme les eaux potables ou industrielles.

→ METALLIC EVAPORATOR IN SANICRO28 FOR 54% PHOSPHORIC ACID

MC4

Khaled Elkayar^a, Vincent PERROT^b,

^aSandvik Materials Technology, UAE

^bACM Company, France

Part 1 : sanicro 28 material

Khaled Elkayar, Sandvik Materials Technology- Sweden- Middle East office, Dubai P.O Box 261216, UAE

The last years the tendency has been getting faster moreover since the Phosphoric Acid plants want more and more to increase their profit and productivity plus decrease their maintenance costs.

Phosphoric acids industry extensively use graphite, which have been juggled in the past the best alternative, despite the inferior mechanical properties of graphite. A better alternative Sandvik Materials Technology Sweden has developed Sanicro 28 a special stainless steel alloy used practically in all critical applications of phosphoric acid plants around the world.

Since 30 years now the interest for the metallic evaporator in Sanicro 28 for phosphoric acid at 54% has been growing. Apart from delivering the semi-finished steel products Sandvik also offers engineering services for phosphoric acid plants, the metallic evaporator in Sanicro 28 manufactured by ACM (Ateliers de Chaudronnerie de Monplaisir).

Thanks to the mechanical characteristics of Sanicro 28 as follows:

- No more planned production stop (metallic tubes can't be broken)
- Life time between 10 and 20 years instead of approx. 3 years for graphite blocks
- Cleaning more easy and without risk thanks to the smooth surface of the tubes
- A very good strength against corrosion in normal use's conditions (approved by Sandvik)



SANDVIK SMT (group of 45 000 employees)

- SANDVIK is the only one, to have an experience of more than 30 years (1977) on the metallic market on 54% phosphoric acid
- SANDVIK has today more than 80 references around the world last was in Tunisia

OUR PROPOSAL

- To change from a block HP 15 (or a HP20) to a evaporator metallic in sanicro 28 would be for you the perfect example to show in real the financial and the production advantages that you could have with such type of evaporator.
- Graphite has an average lifetime of approx 3 years. Evaporator in Sanicro 28 has an average lifetime of 10 to 20 years.
- With a tubular metallic you will have no more risk in production, the worse scenario would be a hole in the tube(of 1mm) which would mean that you would have to fill this hole during a next cleaning cycle. This type of incident will not force you to stop the production

Part 2: metallic phosphoric acid heaters in place of graphite bloc heaters

Vincent PERROT - Thermal Department Manager in ACM Company -
101, rue du dauphine, 69800 Saint-Priest France

Phosphoric acid plants all over the world are using metallic heaters in SANICRO 28 as a replacement of graphite heaters. The metallic heaters are chosen for their excellent robustness, their long-life and their maintenance costs extremely low in comparison with graphite heaters.

Most of the phosphoric acid plants use two technologies of graphite heaters: block heaters for the old units and tubular heaters for more recent units.

Graphite tubular heaters have replaced block heaters which are especially brittle and extremely expensive in terms of maintenance; the average life of the blocks is only two/three years. Nevertheless, the graphite tubular heaters can't solve all the block heaters problems because the tubes remain very brittle and can break easily.

So, the situation is as follows: plants using graphite block heaters have unreasonable maintenance costs and the ones using tubular graphite heaters remain under the threat of a tube which can break, stopping the production.

The solution, now well-known, is to install SANICRO 28 metallic heaters.

One such metallic heater will be soon running in Tunisia.

ACM, which do the thermal and the mechanical design, propose to his clients, at first, to purchase metallic tubular heaters instead of spare part sets of graphite blocks; the purchase budget of a metallic heater is today nearly the same as a graphite block heater. This acquisition will be the perfect demonstration of the metallic heaters advantages in terms of flexibility and financial profit.

The metallic heater design is done to fit exactly in place of a graphite block heater without another investment that the modifications of the steam circuit.

The weekly cleaning of the metallic heaters remain the same as the graphite heaters.



EXPERIENCE WITH TWO HIGH-ALLOYED SUPER AUSTENITIC STAINLESS STEELS IN THE PHOSPHORIC ACID INDUSTRY - ALLOY 31 AND ALLOY 31 PLUS

Helena Alves^a, Nicolas Houlle^b

MC5

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In the fertilizer industry, phosphoric acid, ammonia and their derivatives along with potassium compounds are the major fertilizers providing the necessary soil nutrients for the agricultural industry. Almost 100% of the world's phosphoric acid production used for fertilizers is manufactured by the wet acid process. This manufacturing process appears to be relatively simple involving the reaction of phosphate rock with concentrated sulphuric acid yielding phosphoric acid (26 to 28% P₂O₅) and calcium sulphate slurry, followed by filtration of the acid slurry to remove particulate matter, followed by concentration and purification of the phosphoric acid. However, severe corrosion problems have been encountered making the use of high performance alloys necessary.

Pure phosphoric acid (H₃PO₄) is not particularly corrosive to metals but in the wet process the presence of impurities like chloride, fluorine and silicates arising from the phosphate ores and the free sulfuric acid as well as the hydrofluoric, fluosilicic, and hydrochloric acids lead to complex corrosive conditions. The corrosive attack is further aggravated by abrasion resulting from phosphate rock particles and gypsum crystals, by turbulence and by deposit formation. Wet phosphoric acid producers have been combating corrosion in this process since a very long time. Even though material selection has been continuously optimized not sufficient advantage was being taken from new cost-effective alloys, in particular in the most corrosive production steps like in the acid concentration.

This paper describes the behavior of the well-established super-austenitic high chromium 6% molybdenum Alloy 31 (UNS N08031) in typical conditions of wet phosphoric acid production and introduces a new, further improved version of this alloy - Alloy 31 Plus - characterized by the same good corrosion performance but better fabricability. Results of laboratory tests, field tests and plant experience are presented together with recent case histories. Special emphasis is given to the use of metallic heat exchangers in the concentration units.



EXPERIENCE WITH Nicrofer 3127 HMO - ALLOY 31(UNS8031) IN THE PHOSPHORIC ACID INDUSTRY

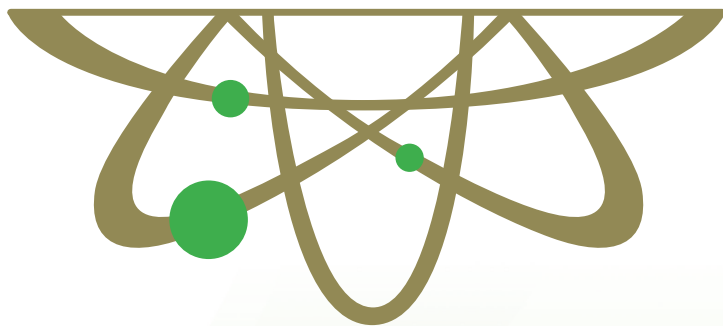
MOUSTAQSSA Abdelhak^a - BOULIF Rachid^b
OCP S.A.

MC6

Nicrofer 3127 HMO- alloy 31 (UNS8031) is a high alloy stainless steel with exceptional resistance in acid solutions of chlorides, fluorides and sulfides. It has also excellent resistance to attack in oxidizing sulfuric acid over a wide range of concentrations. These properties and its high chromium content suggested that it should be optimal material for severe service in wet-process phosphoric acid manufacture. The paper provides the results of a wide series of tests in plant and in the laboratory. Which have resulted in 3127HMO being specified for number of application in several countries, under service conditions which could previously only be handled by the use of more expensive nickel-base alloys.



Fertilizer Manufacture





INDIRECT PLATE HEAT EXCHANGERS OFFER LONG TERM OPERATING PERFORMANCE

FM1

Neville Jordison^a, Jean Marc Reichling^a

^aSolex Thermal Science, Canada

Twenty years ago a new technology was introduced to the fertilizer industry for cooling the final product before storage. The technology is based on indirect heat transfer using water cooled plates, instead of the rotary drum and fluid bed coolers which to that point were the industry standards. By eliminating large volumes of air, indirect plate exchangers offer the benefit of lower installed capital cost, much lower power consumption and reduced emissions. The result is significantly lower cost of ownership. Although the concept of the technology is simple, successful implementation requires a detailed knowledge of the science of indirect heat transfer, mass flow of bulk solids and the thermal characteristics of fertilizers. The technology is proven in more than 100 fertilizer plants worldwide in every type of fertilizer, nitrogen base, phosphates, potash and specialty fertilizers.



DYNAMIC OPERATOR TRAINING SIMULATORS FOR SULPHURIC ACID, PHOSPHORIC ACID, AND DAP PRODUCTION UNITS

FM2

Sergio Joao^a, Coral Siminovich^a

^aSNC-Lavalin, Canada

Dynamic process simulators are widely used in chemical and petrochemical industries for operator training, plant design, and optimization; but there is a lack of rigorous simulators in the phosphate fertilizer industry. Some of the many difficulties encountered in phosphate fertilizer simulation include: lack of knowledge of thermodynamic properties, presence of many phases (gas, liquid and solids), high levels and variation of impurities in phosphate rock producing unknown effects, complexity in modeling particle size distribution, etc. Dynamic simulators for training purposes were successfully developed for sulphuric acid, phosphoric acid, and DAP production units using a commercial simulation platform. A new thermodynamic property package was developed for sulphuric acid and oleum to correctly predict vapor pressure, density, enthalpy and SO₂ solubility. Also, a rotary drum granulator was developed to consider the reaction chemistry of DAP production and the stochastic nature of solids created. The granulator can accurately predict particle size distribution, moisture content, ammonia and dust losses, and gas/solid temperatures. In addition, a rotary drum dryer was developed to predict particle drying, dust losses, and product decomposition. It was shown that the simulators could precisely reproduce control room and field operations to model plant start-ups, emergency or normal shutdowns, process upsets and normal operations.



SCALE-UP AND ON-LINE MONITORING OF GAS-SOLID SYSTEMS USING ADVANCED AND NON-INVASIVE MEASUREMENT TECHNIQUES

FM3

Professor Muthanna Al-Dahhan^a

^aDepartment of Chemical & Biochemical engineering, Department of Nuclear Engineering, Missouri University of Science & Technology, USA

Phosphate and the related processes have wide applications particularly in fertilization of soils and in various chemical productions (potassium phosphate, calcium hydrogen phosphate and diammonium hydrogen phosphate etc.). These processes involve gas-solids systems for drying of the raw materials followed by granulation and chemical formation to obtain the desired products. In addition coating of the particles has also been applied. Drying is very important to the process as effective moisture removal defines the process efficiency and the subsequent unit operations. Therefore, phosphate processes have been researched over the years to improve the processes efficiency and productivity.

Gas-solids systems have been the characteristic of phosphate processes. In order to properly and effectively scale-up, and perform drying, granulation and coating, study of the related gas-solids systems is necessary. The flow dynamics and solids moving and gas-solid interaction need to be quantified and understood. Due to the opacity of these systems and the conditions involved, advanced and non-invasive measurement techniques are needed. Furthermore, non-invasive on-line monitoring technique is essential to ensure proper operation of these systems.

In our laboratory, these techniques have been developed and demonstrated their application in advancing scale-up and operation of various gas-solid systems, which can be of great benefit to phosphate processes in general and for drying, granulation and coating of phosphate particles in particular.

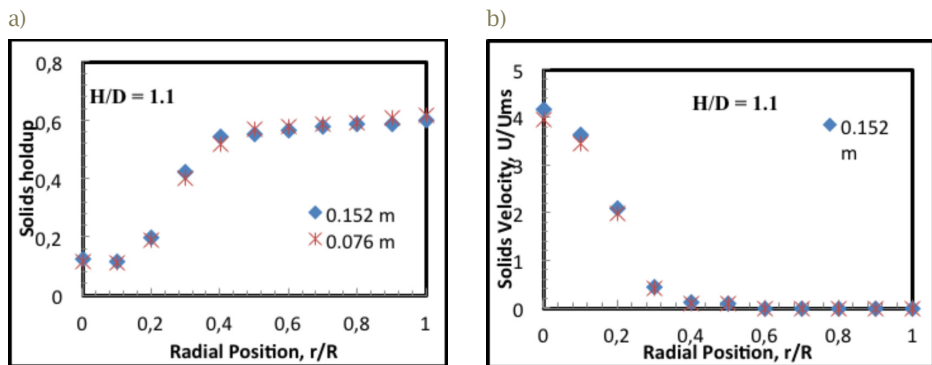
These techniques are:

- Gamma Ray Computed Tomography (DSCT): The DSCT unit is a research setup designed to quantitatively determine the time averaged cross-sectional and radial profile of holdup distribution of the phases in multiphase systems. It has been designed to use a sealed point gamma ray source ¹³⁷Cs (~200 mCi or less) with an array of NaI scintillation detectors.
- Gamma Ray Densitometry (GRD): Gamma ray densitometry (GRD) is a non-invasive radioisotope based technique used in providing information about radial (cross sectional distribution) profiles of solids or gas holdup (volume fraction), flow patterns or regimes and on-line monitoring for various needs including ensuring proper scale-up and performance of multiphase systems that also include gas-solid systems (drying, granulation and coating). GRD consists of a sealed source (Cesium 137 of 250 mCi) in a source holder and a NaI scintillation detector in front of the source.
- Radioactive Particle Tracking (RPT): This technique is based on following the motion of a radioactive particle (also known as radioactive tracer) that mimic the solid particles in 3-D domain using an array of scintillation detectors (Al-Dahhan, 2009). This tracer will be dynamically similar to the tracked phase. Such a study will provide valuable information on solids flow in 3-D, solids velocity and its components, overall residence time distribution, local residence time distribution, stagnant zones, solids occurrence, lagrangian trajectory and other related solids flow dynamic parameters.

In addition to the above-mentioned techniques, sophisticated techniques that complement the results of the above techniques such as optical probes that measure simultaneously solids holdup, velocity and their time series fluctuations and pressure transducers are used.

These techniques have been utilized to develop novel scale-up methods for gas-solids and solids moving systems. To demonstrate such development two gas-solid systems such as gas-solid spouted bed and gas-solid fluidized bed have been used. These systems have been effectively used for drying, granulation and coating. The development can be extrapolated to other gas-solids and solids moving systems encountered in phosphate processes.

The novel new approach is based on matching the solids or gas (void) holdup radial profile or cross sectional distribution in two different systems (in size or in conditions) to ensure hydrodynamics similarity. If such similarity is attained, the systems should be performing desirably and similar to each other. This has been demonstrated and approved by using CT, GRD, Optical probes, Pressure transducers and RPT, using both spouted beds and fluidized beds. Figures 1 a and b, illustrate such new method.



Figures 1: (a) Radial profile of solids holdup in two different size (0.076 m and 0.152 m) spouted beds and (b) Solids velocity profile in two different size (0.076 m and 0.152 m) spouted beds at H/D level of 1.1.

The novel scale-up approach can be validated and monitored on-line using Gamma ray densitometry (GRD) technique as shown in Figure 2.

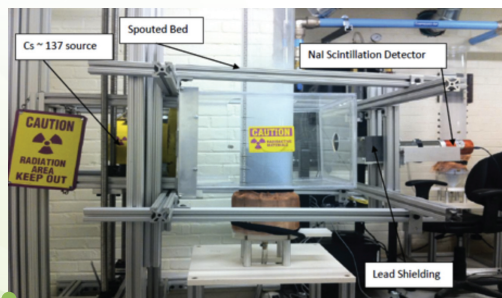


Figure 2: Gamma ray densitometry applied on spouted bed system.



Both advanced signal processing and modeling (Computational Fluid Dynamics, CFD) have been implemented and utilized to facilitate such new development for industrial implementation.

In this presentation, the new method will be discussed along with the techniques and the on-line monitoring and modeling for its implementation. An outline of how such development (both novel scale-up, computing methodology and on-line monitoring) will be implemented on phosphate processes to advance its efficiency, economics, safety, efficient energy use will be discussed in this presentation.



THE EVOLUTION OF SCREENING SYSTEMS FOR OPTIMUM GRANULAR FERTILIZER PRODUCT QUALITY

FM4

David M. Ivell, Van T. Nguyen
Jacobs, U.S.A.

The fertilizer product quality expectations in the marketplace continue to increase, particularly with respect to particle size distribution. Whereas years ago, 1.18-3.35 mm (Tyler 6 to 16 mesh) or 1-4 mm was generally accepted, 2-4 mm is the new minimum requirement. Furthermore, 90% in range is no longer considered "good". Instead the expectation is 93-98% with an SGN (Size Guide Number) of 300 or more and a UI (Uniformity Index) of 60 or more. This paper will discuss the evolution of screening system arrangements designed to meet these new expectations. Many older plants were designed with a set of double deck screens located downstream of the dryer. All exiting dryer material is screened though most of the product will be mixed back with the off-specification material after separation. In this arrangement, fines separation determines the overall size of the screen necessary. The double deck screen arrangement typically yields a product with a SGN of 270-280 and UI of maybe 57. A technique used to improve the performance of the screening system is to separate oversize and fines on separate single deck screens. With this arrangement, diversion of the required amount of product to the recycle can be done ahead of the fines screens thus reducing the load off those screens. The single deck arrangement significantly decreases the total screening surface area. A combination of the two systems described above has the potential to improve product quality significantly with an overall screening area less than that required for double deck screens alone. In this arrangement, double deck screens are used to separate oversize on the upper deck and "large" product (say +3 mm) on the lower deck. Single deck screens are used to separate fines with the product diverter being installed in the "unders" chute from the double deck screens. The combined system accrues the following advantages:

1. No "large" product is recycled and therefore results in a reduction in recycle ratio. The SGN of the recycle is decreased thus providing more surface area per ton for coating with slurry.
2. All the "large" product is exported as product thus increasing the median size of the product. In addition, the product is more closely sized with a UI over 60.



SOLAR TO AMMONIA - VIA PROTON'S NFUEL UNITS

FM5

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The biggest problem associated with solar power is intermittency. The problem is ensuring energy supply after the Sun has gone down. Balancing this cyclic and intermittent energy production along with uncertain energy demand gives headaches to all large utilities around the world. Conventional options for dealing with such imbalance of energy consist of creating flexible electricity demand and supply, but that is not always feasible. Hence options for storing energy when in excess and supplying it when the demand rises are looked into. Batteries are conventional solution for energy storage; newer options include storage in the form of hydrogen. We propose a new solution for all energy buffering problems - Ammonia! Ammonia can be a suitable medium to 'buffer' intermittent renewable energy in liquid form. We propose a completely environmentally friendly system, where there are no carbon emissions upstream or downstream. Wherein ammonia is produced decentrally from renewables (or cheap power) via Proton's NFuel units and this ammonia can be converted into power when needed via ammonia generators. Secondly, excess ammonia can be directly used as a fertilizer or chemical feedstock.

Over the longer term such decentralized and independent power production and usage system will herald the dawn of energy independency, guaranteeing security of supply by reducing reliance on imported oil and gas.



A THERMODYNAMIC MODEL FOR THE NH_4^+ , K^+ // H_2PO_4^- , $\text{H}_2\text{P}_2\text{O}_7^{2-}$, NO_3^- , Cl^- - H_2O SYSTEM

FM6

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We have developed a quantitative thermodynamic description of the $\text{NH}_4\text{H}_2\text{PO}_4$ - $(\text{NH}_4)_2\text{H}_2\text{P}_2\text{O}_7$ - KH_2PO_4 - $\text{K}_2\text{H}_2\text{P}_2\text{O}_7$ - NH_4NO_3 - KNO_3 - NH_4Cl - KCl - H_2O system, which is of great importance for fertilizers applications. The liquid phase and all solid solutions were modelled using the Modified Quasichemical Model with two sublattices in the pair approximation [1]. The model parameters are mainly obtained by the critical evaluation and optimization of available thermodynamic and phase equilibrium data for the lower-order subsystems (common-ion anhydrous binary subsystems such as $\text{NH}_4\text{H}_2\text{PO}_4$ - KH_2PO_4 and $\text{NH}_4\text{H}_2\text{PO}_4$ - NH_4NO_3 , common-cation anhydrous ternary subsystems such as $\text{NH}_4\text{H}_2\text{PO}_4$ - NH_4NO_3 - NH_4Cl , anhydrous ternary reciprocal subsystems such as $\text{NH}_4\text{H}_2\text{PO}_4$ - KH_2PO_4 - NH_4NO_3 - KNO_3 , H_2O -containing binary subsystems such as $\text{NH}_4\text{H}_2\text{PO}_4$ - H_2O , and H_2O -containing ternary subsystems such as $\text{NH}_4\text{H}_2\text{PO}_4$ - NH_4NO_3 - H_2O and NH_4NO_3 - KNO_3 - H_2O). The model is then used to estimate the properties of multicomponent salts from the assessed parameters for the lower-order subsystems, using interpolation methods along with Gibbs energy minimization software. When used in conjunction with thermodynamic databases for solids, solid solutions, and gases, these databases permit the calculation of complex multiphase equilibria in multicomponent systems. In particular, calculations of interest for the production and storage of fertilizers may be performed : solubilities, liquidus temperatures, vapour pressures of H_2O and NH_3 above melts, amount of liquid at ambient temperature under storage conditions (critical in order to avoid caking),...

In the liquid model, the various cations and anions of the system are assumed to distribute on two different sublattices. The hydrated cations $\text{NH}_4(\text{H}_2\text{O})_i^+$ and $\text{K}(\text{H}_2\text{O})_j^+$ (where $i = 1, \dots, 8$ and $j = 1, \dots, 8$) were introduced, and neutral H_2O molecules were assumed to distribute on both sublattices. The pH was assumed to be neutral and, consequently, the H^+ and OH^- ions were not taken into account. Finally, the liquid model includes the reaction of dimerization of AH_2PO_4 (where $\text{A} = \text{NH}_4^+$ or K^+) according to: $2 \text{AH}_2\text{PO}_4(\text{liquid}) \leftrightarrow \text{A}_2\text{H}_2\text{P}_2\text{O}_7(\text{liquid}) + \text{H}_2\text{O}(\text{liquid or gas})$. Higher-order reactions of polymerization (i.e. 3 or more molecules of AH_2PO_4 reacting together) may occur but they are neglected in the present model.

In particular, the experimental data used to model the phosphate-containing subsystems were mainly phase equilibria, the vapour pressure over melts and the ratio of dimerized phosphorus versus the final H_2O content of the liquid phase. All anhydrous subsystems of the NH_4^+ , $\text{K}^+ // \text{H}_2\text{PO}_4^-$, $\text{H}_2\text{P}_2\text{O}_7^{2-}$, NO_3^- , Cl^- - H_2O system have been fully optimized and evaluated at all compositions. The predictions of the model for this system are currently valid up to 1 wt% H_2O for the entire system, and up to 10 wt% H_2O for the $\text{NH}_4^+ // \text{H}_2\text{PO}_4^-$, $\text{H}_2\text{P}_2\text{O}_7^{2-}$, NO_3^- - H_2O subsystem. Reasonably accurate predictions are expected to be obtained up to about 40 wt% H_2O for the $\text{NH}_4^+ // \text{H}_2\text{PO}_4^-$, $\text{H}_2\text{P}_2\text{O}_7^{2-}$, NO_3^- - H_2O subsystem.

Calculations were performed with the FactSage [2] system. The present work is included in the FTftrtz Database of FactSage.

References:

- [1] P. Chartrand and A.D. Pelton, Metall. Mater. Trans., 2001, vol. 32A, pp. 1397-1407.
- [2] www.factsage.com



DAP FROM LOW GRADE PHOSPHATE, AN ECONOMICALLY VIABLE PROCESS

FM7

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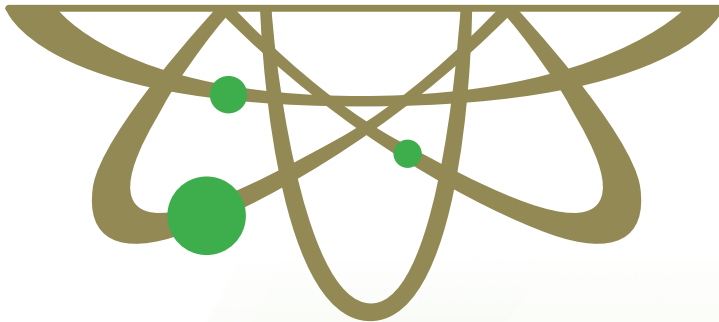
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Making high quality granular fertilizer from cheap low grade phosphate has become a challenge for fertilizer producers. Indeed, the increasing demand for phosphate led producers to investigate the use of low grade phosphate rocks containing higher level of impurities. As a result, the phosphoric acid produced from this kind of rock also contains impurity that can make it unsuitable for the production of some grade of fertilizer, as for instance the DAP or MAP. In case of a too high content of Al_2O_3 and Fe_2O_3 in the acid, the neutralization by ammonia leads to a granular fertilizer with a limited N content but also with a too low content of water soluble P_2O_5 , so that the production of DAP satisfying international specifications can be compromised. This paper presents a process option to reduce the Al_2O_3 and Fe_2O_3 content of the phosphoric acid by a selective precipitation by injection of ammonia. This preneutralization results in an acid suitable for the production of DAP and in a residue valuable under the form of a low grade fertilizer. Two sets of pilot tests on low grade Chilisai phosphate have been developed separately by KemWorks and Prayon Technologies, and have proven the technical feasibility of the preneutralization. This preneutralization step has been considered in the frame of a full DAP project, i.e. from phosphate rock, sulfur and ammonia to granular fertilizer, and has led to an economically viable project.





Energy & Water





OPTIMIZING ENERGY EFFICIENCY: AN IMPERATIVE FOR IMPROVED BUSINESS PERFORMANCE

EW1

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Many companies have recently begun to adopt energy reduction strategies, be it to lower costs through increased energy efficiency, to align with tightened government regulation or to respond to calls from the consumer to lower corporate carbon footprints. Achieving sustainable reductions in energy consumption in a cost-effective manner, though, can often prove challenging, as it requires a clear vision, a comprehensive assessment and a viable implementation strategy. When executed properly, however, such reductions can lead to substantial savings.

Over the course of its 210 year history as an owner/operator, DuPont has developed and maintained a compilation of best practices in energy management that are utilized across its global operations. These best practices represent an extensive, proprietary collection of technical and management guidelines and performance criteria for operating, controlling and maintaining energy-intensive plant systems at top efficiency. This specialized knowledge has allowed DuPont to reduce energy use by 19% across its 150+ facilities worldwide since 1990, resulting in over US\$2 billion in cumulate savings, even in light of a 41% increase in production. It has also contributed to a 60% reduction in greenhouse gas emissions since 1990 – 10 million tons per year.

This paper will discuss the methodology of adopting an effective energy culture, as well as modes of reducing energy use through improved energy management. Particular emphasis will be placed on the need for visible management commitment to drive energy management. Additionally, the methodology of building or acquiring competency in energy efficiency, while also cultivating an energy savings culture based on awareness building and behavior modification, will be discussed. Through smarter operations – managing behavior and technical elements against performance metrics – and effective discretionary maintenance to sustain efficiency, companies can realize substantial energy savings at little to no cost.

URANIUM, THE HIDDEN TREASURE IN PHOSPHATES

EW2

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During the past decade up to 167 t/yr U has been applied to farmland by P fertilisation in Germany and this amount would have been sufficient to satisfy the energy demand of $2.4 \cdot 10^6$ households if U had been extracted previously. This energy source equals the heating value of timber from $5.6 \cdot 10^6$ ha of forest land. The use of U from P fertilisers is also an uncommon contribution of agriculture to climate protection, which has been valued to 1.8 €/kg P when an equivalent value to CO₂ emission car tax bands in Germany is assumed.



THE RECOVERY OF URANIUM FROM PHOSPHORIC ACID, THE THIRD TIME AROUND

EW3

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In the 1950's three plants were built to recover uranium from phosphoric acid. These only operated for a few years when lower cost sources of uranium were developed. When the price of uranium increased in the late 1970's, at least 15 plants were built in the United States and 7 other countries. Over 40 million pounds of uranium were recovered in these plants at operating costs as low as \$11/pound. When the price of uranium dropped, the plants were shut down and many demolished. The price of uranium has again increased, reaching \$138/pound in mid 2007. Several phosphoric acid producers are expressing interest in again recovering uranium from phosphoric acid. The technology and economics for uranium recovery will be presented

NOVEL TECHNIQUE FOR FERT PHOSPHORIC ACID PURIFICATION WITH SIMULTANEOUS RECOVERY OF URANIUM

EW4

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Kamorphos, Chemical Consultants.& Engineers, INDIA

With constant rise in demand of energy, it is apparent that the world cannot rely on coal, hydroelectric, gas / oil, wind and biomass only for energy. In comparison, Nuclear power provides the lowest cost, safest and cleanest source of energy.

Despite Fukushima's negative impacts, there are numerous reasons for the growth of global nuclear power, including a world hungry for all forms of energy and increased concerns over the greenhouse gas emissions. This has also once again revived the interest of fertilizer manufacturers worldwide to develop facilities for the extraction of uranium from fert acid.

Water Soluble fertilizers are gaining popularity by the day for their high purity and water-solubility making them an ideal fertilizer for fertigation and for foliar application. Technically pure phosphoric acid is a primary raw material for producing such WSF products as well as various other downstream technical grade phosphates.

This document provides information on a novel technique developed by **KAMORPHOS**, India, for the purification of fert phosphoric acid to technical grade acid while simultaneously extracting Uranium in the same process. A unique **Two in One** novel approach to purify fert phosphoric acid in totality is reported with simultaneous recovery of uranium for its use in nuclear energy.



Phosphurin Process Summary

KAMORPHOS have taken the lead & initiative to present a very novel approach to the phosphate world with development of Phosphurin technique. It is a first of its kind of technology offering a novel Two in One solution for the purification of fertilizer phosphoric acid simultaneous to Uranium extraction. With growing shortage of manpower, increase in food consumption patterns & ease of using WSF, this could be the beginning of an Era where a trend could be set & started to manufacture fertilizers free from all impurities. In house developed reagent used in all cycles of the entire process & codenamed KROPHOS-18 is another Two in One achievement by KAMORPHOS.

Like all previous SX processes, Phosphurin has the same unit operations such as, Acid Pre - treatment, Primary & Secondary extraction, Scrub & Strip; Uranium converted to yellow cake & purified acid sent to evaporation. The total technology is executed in three cycles. While the first cycle comprises only of Uranium extraction, the second & third cycles are for total removal of remaining metals from the acid.

Conclusion

The current changes in the uranium & phosphate industry call well for a need to once again resume the practice of extracting uranium from fertilizer phosphoric acid. **Phosphurin** advantage of simultaneous purification of phosphoric acid is a double bonus. The cost of extraction & sale of Uranium simultaneous to Phos acid purification compensates much of the cost of purifying the acid. This would come as a boon for fertilizer plants to implement such technology and produce downstream purer fertilizers economically.

The SX process route is proven technology that can be used for the next generation of these plants. This current **Phosphurin** process is unique in its inherent style with no competition or comparison with any other past or current technologies available anywhere in the world. Specific advantages being a dual benefit of purifying acid with uranium extraction, purification of any P2O5 acid, acid purification possible to both technical & food grade, higher +95% uranium recoveries, high purity uranium compared to other processes, simple equipment, considerable reduced new plant capital, lower utilities & operating costs etc. This should lead to a high return on investment for the Phosphurin extraction facilities.

Commercial offer

Sufficient data on the process parameters of this unique Two in One technique for the purification of fert Phos acid with simultaneous extraction of uranium have been generated to further this program phase wise to commercial scale facilities. KAMORPHOS is interested & looking forward to develop this technique with interested Phosphate producers who are considering purifying Fert Phosphoric acid. Extraction of Uranium compensating the cost of such purification will be an added bonus.

The first step would be to outline and execute a specific development program under appropriate Confidentiality Agreement. Such a program can further be accomplished in phases and would involve primary laboratory and pilot plant test work, leading to a preliminary design engineering package for a commercial facility.

COMPREHENSION OF SYNERGISTIC MECHANISMS FOR URANIUM EXTRACTION FROM PHOSPHORIC ORES

EW5

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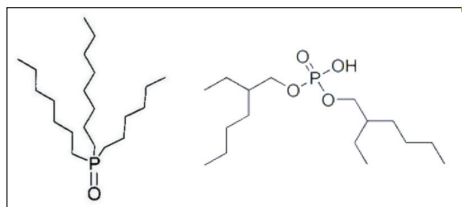
The International Atomic Energy Agency (IAEA) classified the uranium resources in two types:

- The conventional resources are the classical uranium mines.
- The unconventional resources where uranium is extracted as a mine by-product.

Phosphate rocks, used to produce fertilizers for agriculture, are considered as an unconventional resource of uranium. They are known to contain uranium in a low but significant amount. The estimated concentration of uranium in phosphate rocks ranges from 70 to 200 ppm and often attains 800 ppm. This could yield to 9 to 22 million tons of uranium reserves [1].

In order to recover uranium from phosphates ores, a process was designed in the late 1960's by the Oak Ridge National Laboratory [2]. This process is based on liquid-liquid extraction: an organic phase containing selective ligands for uranium is contacted to an aqueous phase resulting of the acidic treatment of phosphate rocks. The two ligands used in this process are HDEHP (bis(2-ethylhexyl) hydrogen phosphate) and TOPO (tri-n-octylphosphine oxide).

TOPO and HDEHP



HDEHP and TOPO extract uranium in synergism: the uranium extraction coefficient is greater for the combination of the two molecules than for the individual ones. The main advantages of this process are its good selectivity for uranium and its chemical stability.

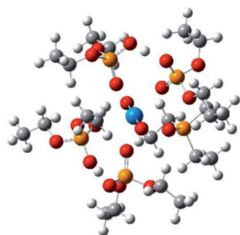
But it has got also two drawbacks:

- The uranium extraction coefficient is too low to allow a one-step extraction cycle
- There is formation of iron precipitates during the stripping of uranium which damages the purity of the extracted uranium

To optimize the process, new extractant systems have to be designed but the synergistic mechanisms are still not completely understood. The current literature concerning the extraction mechanisms of synergistic systems is still rather incomplete, so it's necessary to improve the comprehension of the phenomenon happening in the extraction middle.

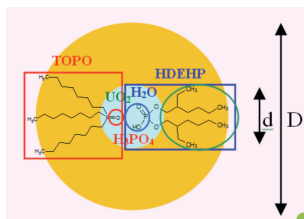
The synergistic mechanisms are investigated with two different approaches:

- The molecular approach: during the liquid-liquid extraction, the ligands form complexes with uranium in the organic phase. The aim of the molecular approach is to investigate the interaction of uranium with the ligands and the interactions between the ligands at the molecular scale. These interactions have been investigated through spectroscopic and theoretical studies. The theoretical part consists in modeling the complexes and the experimental part consists in acquiring data to probe the structure of the complexes.



Optimized structure of an
uranyl.(HDEHP-DEHP)₂.
TOPO adduct

The supramolecular approach: the species formed by HDEHP, TOPO and the cations are considered as small aggregates with particular properties: CAC (Critical Aggregation Concentration), aggregation number, diameter of the aggregate. These properties have been investigated with neutron (SANS) and X-ray scattering (SAXS) and related to the extractant properties. The aim of the supramolecular approach is to investigate the effect of aggregation on synergism.



Scheme of an aggregate

The comprehension of these mechanisms is expected to support the optimization of uranium extraction.

Keywords: uranium, phosphate rocks, synergism, HDEHP, TOPO, aggregates



UTILISATION DU PROCÉDÉ MEMBRANAIRE POUR LA PURIFICATION D'ACIDE PHOSPHORIQUE

EW6

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L'acide phosphorique est un intermédiaire important dans la fabrication des engrais et dans l'élaboration des produits purs destinés à l'industrie alimentaire et aux traitements



de surfaces. Notre principal objectif est l'utilisation du procédé membranaire pour la purification d'acide phosphorique, sachant qu'il est produit, en générale, par voie humide et contient une grande variété d'impuretés comme le Fe, Cd, V,... Ces impuretés ont des effets négatifs sur le procédé de fabrication et sur la qualité d'acide obtenu.

Divers traitements ont été utilisés pour purifier l'acide phosphorique : la précipitation, la cristallisation, l'extraction liquide-liquide et l'échange d'ions. Il n'y a que quelques études signalées pour l'osmose inverse et la nanofiltration [1,2].

Pour les solutions d'acide phosphorique très concentrées, vu les conditions de pH et de température, le nombre de membranes capables de résister pendant une durée suffisante est limité. Notre choix s'est porté sur la membrane organique PES 10 (Nadir), MPS-36 (Koch International, Roissy, France) résistant à des pH variant de 0 à 14 et Desal-DL (Osmonics).

Des abattements d'impuretés, respectivement de 30 % pour les ions trivalentes (Al, Fe,...) et de 20 % pour les ions divalents (Cd, Cu,...), dans les solutions industrielles ont été atteints en mode tangentielle, par utilisation des membranes MPS-36 et PES 10.

La membrane Desal-DL dont la stabilité chimique à ce pH est insuffisante, selon le constructeur a été testée, pour une comparaison de sélectivité. Cette membrane est plus adaptée à la séparation de l'acide phosphorique et des impuretés : forte rétention 95 % des impuretés majeures (Fe, Al, Cr,...).

Pour les 3 membranes étudiées nous constatons que la nanofiltration ne permet pas d'épurer les solutions de l'arsenic, du fluor et des sulfates. Ces ions ne sont pas ou peu retenus parce qu'ils sont probablement sous formes neutre ou monovalentes.

L'abattement des impuretés majeures et mineures a été amélioré par utilisation d'une 2ème étape en cascade discontinue.

Références :

- [1]: M.P GONZALEZ, R. NAVARRO, I. SAUCEDO, M. AVILA, J. REVILLA, CH. BOUCHARD. "Purification of phosphoric acid solutions by reverse osmosis and nanofiltration" J. Desalination. 147, 315-320, (2002).
- [2]: Simplot phosphorique acid purification process



ECONOMIE D'ENERGIE DANS UN COMPLEXE D'ACIDE PHOSPHORIQUE

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Morocco

EW7

Les procédés de fabrication d'acide phosphorique par voie humide permettent de rejeter le déchet solide soit sous forme de phospho-gypse Di hydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) ou sous forme d'Hémi hydrate ($\text{CaSO}_4 \cdot 1/2 \text{H}_2\text{O}$).

Les principaux procédés sont

- Les procédés au Di - hydrate (DH),
- Les procédés à l'Hémi /Di hydrate (HH/DH),
- Les procédés à l'Hémi - hydrate (HH).



Les procédés les plus répandus sont ceux au Di hydrate. Ils permettent de produire, au niveau du filtre, un acide à environ 28% P_2O_5 , qui nécessite sa concentration à 42%-48% P_2O_5 pour la production des engrais. D'où une consommation d'énergie sous forme de vapeur au niveau des unités de concentration.

Cependant, d'autres procédés qui consomment moins d'énergie, ont eu du succès, après la crise pétrolière des années 70. Certaines unités de DH ont été transformées en HH/DH ou HH. En effet, ces procédés héli hydrate /Di hydrate (HH/DH) ou Héli hydrate (HH) permettent de produire, au niveau du filtre, un acide phosphorique de concentration 42% à 48% P_2O_5 . Cet acide peut être utilisé directement, sans concentration, pour la production des engrais, ce qui réduirait les coûts d'investissement et d'exploitations des unités de concentration et économiserait de l'énergie.

Comme les unités d'acide phosphorique sont souvent adjacentes à une usine d'acide sulfurique qui produit fatalement de la vapeur haute pression. Celle-ci sert à concentrer l'acide phosphorique, produit par les procédés DH, pour son utilisation pour la production des engrais. Supprimer la concentration peut être avantageux si on utilise d'une façon rentable la vapeur, ainsi récupérée, à d'autres fins tel que : dessalement de l'eau de mer, vente d'électricité, vente de certificats d'émissions de CO_2 (Protocole de Kyoto), etc.

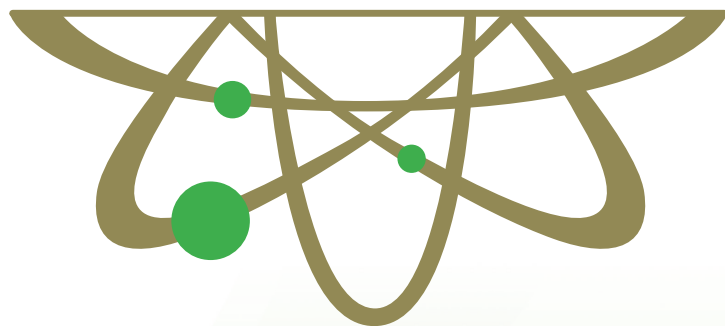
L'économie d'énergie pour une unité d'acide phosphorique qui produit 1000TP P_2O_5 /J et qui fonctionne selon les procédés HH/DH ou HH permettrait d'économiser 500 000T/an de vapeur (40 000 tonnes d'équivalent pétrole par an), par rapport à une unité qui fonctionnerait selon le procédé DH.

La transformation de cette vapeur en électricité permet de générer une puissance de 11 MW, ajoutée à 2 MW d'économie au niveau du broyage, de la concentration, du refroidissement, etc. Soit un total de 13 MW (90 000MWH/an). Ce qui correspondrait à la consommation d'une ville marocaine de 125 000 d'habitants.

Cette économie pourrait être un atout, particulièrement, pour les pays qui ne disposent pas de ressources naturelles d'énergie locale et qui importent toute leurs consommations.



Phosphate Based Materials



EFFECTS OF TEMPERATURE AND CLAY CONTENT ON MICROSTRUCTURE AND CERAMIC PROPERTIES OF PHOSPHATE SLUDGE-CLAY BLENDS

PBM1

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This study deals with the potential use of the phosphate sludge of Gantour in ceramics. For this purpose, the basic raw material, essentially consisting of quartz, fluoroapatite and carbonates, was mixed with a naturally occurring clay composed of smectite, and shaped as pellets. The clay content varied in 0-30 wt.%, and the pellets were heated in the range 900-1200 °C. The microstructure of fired samples was investigated by X-ray diffraction and scanning electron microscope, and the ceramic properties (water absorption, firing shrinkage and compressive strength) were measured. The results showed that calcium phosphate together with calc-silicates formed in fired blends. The amount of the neoformed phases depended on the clay amount as well as on the firing temperature.

Moreover, the cellular morphology of grains, manifested in free-clay samples partially disappeared at the expense of semi-vitrified particles as the clay content increased. As a result of the increase of the clay content, water absorption experienced a slight increase. However, the effect of temperature varied with the clay composition. Firing shrinkage as well as compressive strength were sensitive to temperatures exceeding 1100 °C, likely because of the melt abundance. Considering the compressive strength, a maximum manifested at around 20 wt.% clay, and the clay effect was less significant for T < 1200°C.

Keywords: Phosphate sludge; Clay; Ceramic; microstructure; properties.

COMPREHENSION OF THE PHENOMENA INVOLVED IN THE RECOVERY OF URANIUM FROM PHOSPHATE BY D2EHPA/TOPO SYSTEM AND DEVELOPMENT OF NEW CATIONIC EXTRACTANTS

PBM2

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Despite Fukushima accident, the prospects for new worldwide reactors construction continue to attract a great attention. In the most optimistic scenario, annual world uranium production should be twice important than in 2009. In this framework, phosphate rocks represent a strategic reserve of uranium that could feed up to 25% of the world nuclear power plants. Nowadays, uranium is not longer recovered from phosphoric acid even if the purification of wet phosphoric acid (WPA) appears to be of great interest for environmental and economic reasons.

This paper is focused on the solvent extraction equilibria involved in the recovery of uranium (VI) from concentrated phosphoric acid and on the understanding of the influence of the chemical structure of extractants on their affinity towards uranium (VI).

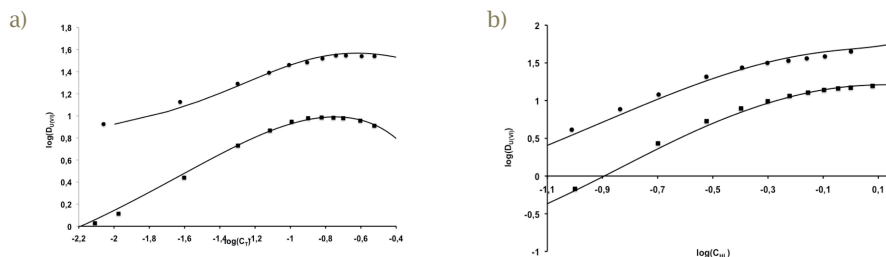
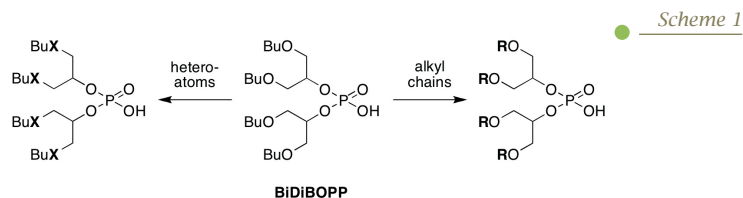


Figure 1: Logarithm of the distribution coefficient of uranium (VI) between 5.3 mol L⁻¹ phosphoric acid and D2EHPA/TOPO (■) or BiDiBOPP/di-n-HMOPO (●) diluted in Isane IP 185 as a function of (a) the logarithm of initial D2EHPA or BiDiBOPP (HL) concentration at constant TOPO or di-n-HMOPO (T) concentration (0.125 mol L⁻¹) and (b) the logarithm of initial TOPO or di-n-HMOPO concentration at constant D2EHPA or BiDiBOPP concentration (0.5 mol L⁻¹). Initial concentration of uranium=1.43 10⁻³ mol L⁻¹, temperature = (25.0±0.2) °C, phase volume ratio V_o/V_a=1. ----: Calculated with the thermodynamic model.

A thermodynamic model has been developed to simulate the distribution of uranium (VI) between 5.3 mol/L phosphoric acid and two reference systems initially developed between 1978 and 1998 for solvent extraction of uranium (VI) from WPA: (i) di-(2-ethylhexyl) phosphoric acid (D2EHPA) and tri-n-octylphosphine oxide (TOPO) and (ii) bis-(2-butoxy-1-butoxymethyl-ethyl)phosphoric acid (BiDiBOPP) and di-n-hexyl-(methoxyoctyl)phosphine oxide (di-n-HMOPO), both in Isane IP 185 as a diluent (Figure 1). Replacement of D2EHPA by BiDiBOPP is responsible for a significant increase of uranium (VI) extraction efficiency. Our thermodynamic model shows that the nature of the extracted species is similar in both cases, but with higher values of the extraction constant in the case of BiDiBOPP [1].

In order to correlate the chemical structure of the extractants with their extraction properties, a series of BiDiBOPP's analogs has been synthesized (Scheme 1) [2,3]. As a result of this study, it appears that:

- the replacement of hydrophobic chains in BiDiBOPP by longer alkyl chains is responsible for an increase of the distribution coefficient of uranium (VI) and iron (III).
- the presence of two oxygen atoms in each of the two aliphatic chains of phosphoric acid diesters, as in BiDiBOPP, enhances the affinity of the resulting molecules for both iron (III) and uranium (VI).
- the introduction of steric hindrance in hydrophobic part of BiDiBOPP improves the selectivity of uranium (VI) towards iron (III).



- [1] Beltrami, D., Chagnes, A., Mokhtari, H., Courtaud, B., Cote, G. ; Hydrometallurgy, 2012, submitted.
- [2] Beltrami, D., Chagnes, A., Haddad, M., Laureano, H., Mokhtari, H., Courtaud, B., Jugé, S., Cote, G.; Sep. Sci. Techn., 2012, LSST-2012-5962.R2.
- [3] Beltrami, D., Chagnes, A., Haddad, M., Mokhtari, H., Courtaud, B., Cote, G., 2012. Sep. Sci. Technol., submitted.

PHOSPHATE GLASSES AS A NEW ENERGY DENSITY DIELECTRIC MATERIALS

PBM3

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Actually in the world there are several technologies for energy storage. A distinct feature is showed by Fossil fuels which are actually a convenient, portable, and high-density source of energy that can only be displaced by a cost-effective alternative. However, any new energy technology requires storage capability. In order to develop large-scale power generation from renewable sources such as wind and solar, which face geographical restrictions and intermittent output, it is necessary to deal with problematic storage of energy by proposing new materials authorizing high storage capacities of energy. To keep pace with growing world power demands we need a transformative change in our approach

to storage, including the materials required. Recently many works were conducted in view to use glass-ceramics as capacitive energy storage devices which could be used to hold electrical energy generated by wind turbines and solar panels. This kind of materials has unique properties. Unlike sintered ceramics, glass-ceramics are inherently free from porosity. Glass-ceramics have, in principle, several advantages: (i) they can be mass produced by any glass-forming technique. (2i) it is possible to design their nanostructure or microstructure for a given application. (3i) they have zero or very low porosity. (4i) it is possible for them to combine a variety of desired properties.

In this present work, we present some results relative to phosphate based glasses, which could be used as the dielectric energy-storage materials to fabricate high energy density devices. They were prepared by means of rapid quenching method. DTA and X-ray diffraction analysis showed their amorphous nature. Dielectric constant of the glasses was measured at the frequency from 1Hz to 1MHz under the testing temperature from 120K to 400K. The results indicated that some samples could be suitable to be used as the dielectric media for energy storage capacitors.

PHOSPHATE GLASS OPTICAL FIBERS FOR ELECTRO-OPTICAL APPLICATIONS

PBM4

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²Chemistry Department, Laval University, Canada

The development of optical fibers that transmit both light and electricity represents one of many challenges in the field of electro-optics. The material selected must provide the capability to be drawn continuously into a fiber while maintaining the desired physical, electrical and mechanical properties. Phosphate-based glasses, owing to their solubility, stability and high crystalline transition temperatures, are good candidates for the realization of electro-optical fibers enabling the dual attribute of high optical transmission with high electrical conductivity. In particular, phosphate-iodide glasses of composition AgI-AgPO₃-WO₃ provide some of the highest ionic conductivities achievable at room temperature and exhibit good environmental stability against humidity and temperature. This paper describes the glass synthesis, casting, preform fabrication, chemical stability and fiber drawing of composite electro-optical fibers comprising AgI-AgPO₃-WO₃ phosphate glasses.

ELECTRO-CHEMICAL PHOSPHATE SENSOR

PBM5

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A novel polymer-based electro-chemical phosphate sensor for the determination of trace amounts of HPO₄²⁻ and H₂PO₄⁻ is presented. The phosphate sensor can be integrated to



conventional microelectronics or CMOS platforms to perform online phosphate sensing continuously over a wide concentration range from 10^{-6}M to 10^{-1}M , and over a range of pH from 5 to 10, with a response time of about 15 seconds. This paper describes the structural design, the sensitivity, and the accuracy of the electro-chemical phosphate sensor.



ENGINEERING OF RECHARGEABLE PHOSPHATE BASED BATTERIES

PBM6

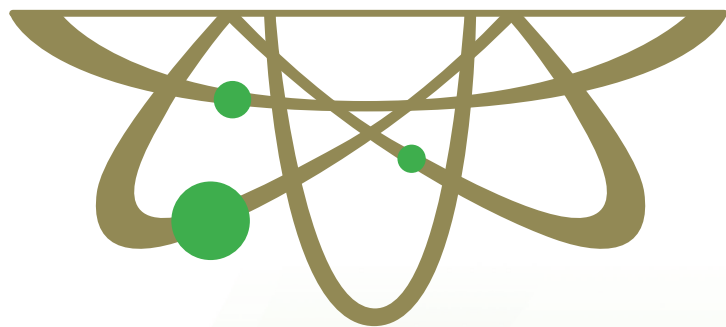
Ilias Belharouak

Argonne National Laboratory, USA

Li-ion batteries are widely used as energy storage systems in consumer electronics. There is an increasing emphasis to use these batteries for applications that have greater energy demand, such as solar, electric grid and electric vehicles. These new applications require the use of inexpensive electrode materials that must provide high-energy, high-power and enhanced thermal stability. In particular, a variety of materials, such as $\text{Li}(\text{Co}_{1/3}\text{Ni}_{1/3}\text{Mn}_{1/3})\text{O}_2$, $\text{Li}_{1.2}(\text{Ni}_{0.2}\text{Mn}_{0.6})\text{O}_2$ and LiFePO_4 , have been extensively studied to substitute the commercially available LiCoO_2 . Lithium iron phosphate (LiFePO_4) offers technological advantages over other metal oxide cathodes due of its tolerance to overcharge, and because it is much less prone to thermal runaway. Since cost and abuse tolerance are critical measures in a battery product, it is important to improve the cycling and power characteristics of LiFePO_4 to ease its wide acceptance by the battery market. This workshop intends to achieve the following: 1) provide a comprehensive course on a variety of lithium ion technologies at the component and cell levels; 2) communicate the latest information in the area of advanced phosphate materials as cathodes for rechargeable batteries, 3) provide a platform for engineers and researchers to discuss R&D and business opportunities in the field of energy storage.



WORKSHOPS





LE PROCESSUS D'INNOVATION : SON ARTICULATION ET SON PILOTAGE

Innovation in Mining Industry WS1

Antoine DUBEDOUT
Société PROPENERG, France

« L'innovation ne se réduit pas à avoir une idée, il faut aussi engager les activités qui vont lui donner toute sa valeur. En termes industriels, il faut enclencher un processus pour transformer cette idée en application réussie. Ce n'est pas une œuvre individuelle, mais un processus transversal qui implique toute l'entreprise et qui doit être mené avec rigueur et dans un souci d'efficacité à tous les stades.

Ce processus n'est pas régulier et continu. Il se décompose en plusieurs phases : création d'idées, sélection des projets et développement. Chacune d'entre elles a sa propre structure et s'appuie sur des compétences spécifiques. Comme pour tout processus industriel, chacune a aussi ses modes de pilotage particuliers avec des objectifs de performance, des moyens de mesure et des leviers d'action. Leur bonne articulation est une condition de succès du processus.

Dans un environnement compétitif, la capacité d'une entreprise à mener le processus jusqu'à son terme devient ainsi un facteur crucial de succès. C'est bien dès l'origine du processus qu'il faut se poser la question des conditions de réussite : qui, quelle organisation, sera le plus à même de le faire aboutir ? »



INTEGRATED INNOVATION PERFORMANCE (THE OVERALL SOPHEON VALUE PROPOSITION)

Innovation in Mining Industry WS1

Michel Delifer
Sopheon, USA

Challenge Number 1:

Research indicates that only 50% of new products achieve their desired business objectives.
WHY ATTEND:

Learn how we can help you implement effective innovation management processes to dramatically increase this success rate.

Challenge Number 2:

Coordination of resources to bring products to market.

WHY ATTEND:

Learn how we can help you improve throughput efficiency, enabling 15-30% more products to be brought to market for the same investment.

Challenge Number 3:

Low value of new product pipeline.

WHY ATTEND:

Learn how we can help you increase the value of your portfolio by 75-100% or more, by connecting innovation planning to business objectives, developing better initiatives in the innovation funnel, more effectively managing processes, and optimizing portfolios with our Accolade solution.



Learn How. For the first time, businesses can access a single source of the truth across Strategic Innovation Planning, Roadmapping, Idea and Concept Development, Process and Project Management, and Portfolio and In-Market Management. Sopheon's solutions have been implemented by over 200 customers with over 60,000 users in over 50 countries.

Learning outcomes: By attending this event, participants will learn:

1. The best practices in this space.
 2. The “why” behind the what
 3. The innovation performance solutions offered by Sopheon
- The value this brings to organizations.



THE PHOSPHOGYPSUM DELIMMA: CLOSURE VS. BENEFICIAL USE

Phosphogypse Management WS2

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Is the phosphogypsum by-product a waste or a resource? That dilemma dictates whether phosphogypsum stacks will have to be closed, as is the current practice in the U.S.A, or whether some of the phosphogypsum by-product will be beneficially used as is the current practice in India, China, Brazil, and other countries.

Closure of inactive phosphogypsum stacks is important from an environmental standpoint. Such closure typically involves capping the top area of the stack, and amending or covering the side slopes to promote grass growth. Collection and management or treatment of the drainable pore water from the stack is an important closure and post-closure consideration. Examples of stacks that have been closed are presented to illustrate components of a closure plan and associated closure costs.

Beneficial uses of the phosphogypsum are mostly in agriculture as a soil amendment, in cement production as a retarder, in construction of new stacks and in land reclamation, in roads as a base course, and as an industrial filler. Other uses are in making dry walls, bricks, and slow-release fertilizer (urea+phosphogypsum) granules. Potential future uses of this resource may also include sulfur recovery, and daily covers for municipal solid waste landfills. In some countries, up to 20% of the phosphogypsum produced is being beneficially used. Examples are presented to illustrate how the by-product is dewatered and handled to produce phosphogypsum suitable for various beneficial uses. Such uses increase the storage capacity of existing stacks, thus reducing the footprint of future expansion stacks at considerable savings in capital costs.

POTENTIALLY HEAVY METALS CONTAMINATION IN TOMATO AND GREEN PEPPER PLANTS GROWN IN SOILS AMENDED WITH PHOSPHOGYPSUM IN JORDAN

Phosphogypse Management WS2

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Phosphogypsum (PG) is a waste produced by the phosphate fertilizer industry that has relatively high concentrations of some heavy metals (e.g. Cd, Cr, Cu, Pb, V and Zn). The present study was conducted to investigate the heavy metal contamination in soils and vegetables fruits (tomato and green pepper), and to evaluate the possible health risks associated with the consumption of vegetables fruit grown in PG-amended soils. Contamination levels in soils and vegetables with Cd, Cr, Cu, Pb, V, and Zn) were measured, and Enrichment factor (EF), geo-accumulation (I-geo), transfer factors (TF), biological absorption coefficient (BAC), pollution load index (PLI), from soils to vegetable plants were calculated in this study. Results showed that Cd, Cr, and Pb were shown a substantial buildup with a slightly increase over control soils. The pollution load index values indicated that the PG-amended soils were considerably to moderately pollution with Cd, and moderately pollution with Cr and Ni, and low pollution with Pb, Cu, Zn and V. The geo-accumulation index values indicated that the PG-amended soils were uncontaminated to moderately contaminated with Pb, Cr, Cu, Ni, Zn, V, and moderately contaminated to heavily contaminated with Cd. The trace metal transfer for Cd, Cr, Pb, and Zn concentration was below (<1) what are considered as acceptable limits for food production in soil and vegetables (Tomato and green Pepper) at each area (FAO/WHO, 1984; EU, 2002). Soil-to-plant transfer factor (TF) values decreased from $Zn > Pb > Cd > Cr$. The BACs in plants are in the order of $Pb > Zn > Cd > Cr$, which suggests that Pb is more bioavailable to plants than Cd, Cr and Zn. However, regular consumption of vegetables plants by the local population could pose a potentially health problem from long-term Pb, Cd, Cr and Zn exposure in soil amended by phosphogypsum.

BENEFICIATION OF PHOSPHOGYPSUM WITHIN SULFUR CONCRETE: VALORIZATION POTENTIAL AND REUSE HORIZONS

Phosphogypse Management WS2

Mohamed CHOURA^a, Mohamed GOUIDER^b

^aRadioanalysis and Environment Laboratory National Engineering School, Sfax University, Tunisia

^bCompany of Studies and Development of the Northern Coasts of the City of Sfax, Tunisia.

A lot has been done around the world in the issue of the phosphogypsum (PG) waste management policy in order to reduce the negative environmental impact of the huge amounts that the phosphoric acid (used as a fertilizer) production by means of the wet acid method accounting for more than 5 tons of PG generated per ton of phosphoric acid production. In fact, world PG production is variously estimated to be around 100-280 Mt per year. The beneficiation of PG within a sulphur matrix could lead to final products



with good mechanical properties and very limited leachable heavy metals. This work aims to provide a sustainable treatment of PG by the chemical fixation and solidification technique. Sulphur emanating from a natural gas purification plant contaminated with heavy metals and mercury was used as a binder. Results of the leachability and mechanical strength assessment of different sulphur/PG mixtures after an artificial ageing by means of thermal shocks and humidity variation cycles prove that this treatment provides, over the long term, an inert solid matrix where pollutants emanating from PG and sulphur are retained with a high mechanical strength up to 40MPa. The comparison between the PG matrix with contaminated sulphur as a binder and the PG matrix with natural sulphur after the artificial ageing shows an evolution up to more than 30% in terms of mechanical strength. The post-ageing tests also prove that the mixture tested with 50% sulphur, 50% PG and sand (2% of the sulphur content) is most efficient, resulting in a total retention of copper, lead, cadmium and almost total retention of zinc and nickel. The obtained treated phosphogypsum manufactured as monolithic blocks could have different applications in the edification and civil engineering uses.



L'ÉMERGENCE DE L'APRÈS MINE EN FRANCE, REX POUR UNE MINE DURABLE

FOUCHER Jean-Luc
BRGM, France

Sustainable Mine WS3

Depuis plusieurs millénaires le développement des sociétés est étroitement lié aux ressources minérales. En Europe, cette longue tradition minière a façonné les organisations sociales. Les accélérations de la révolution industrielle et de la mondialisation ont générés une pression nouvelle sur les milieux et les hommes. Ces dernières décennies la sensibilité aux critères économiques et environnementaux ont fait évoluer la perception comme l'acceptance sociale.

En Europe et France, le cycle de fermeture des mines a débuté dans les années 80 et progressivement les grands bassins miniers (Fer, Charbon, Potasse,...) ont cessés leur activité. La réglementation minière conçue pour accompagner le développement minier ne prenait pas en compte toutes les questions techniques et juridiques de la fermeture. De graves sinistres ont émaillé les années 90 et amené le législateur à prendre en compte l'Après-Mine

Au-delà du postulat de la responsabilité première de l'exploitant, en France, l'Etat est garant des dommages causés et des dispositions pour faire face aux risques susceptibles de mettre en cause la sécurité des biens et des personnes ont été édictées. Les dispositions organisationnelles sont présentées et comparées avec 3 autres pays européens. Les principaux impacts sont évoqués, les points de vigilances et les réponses mises en œuvre évoqués au travers d'exemples opérationnels.

Les territoires qui portent les stigmates des anciennes exploitations doivent coordonner leurs moyens pour les réduire et permettre l'émergence de la mine durable, forts de ces expériences.



LA MINE DURABLE, RÔLE DE LA MODÉLISATION NUMÉRIQUE DANS L'AIDE À LA DÉCISION - EXEMPLES DE CAS INDUSTRIELS

Sustainable Mine WS3

Ahmed HOSNI

GEODERIS, France

La vie d'une mine ne se résume pas uniquement à la période de son exploitation. Deux autres étapes tout aussi importantes lui sont étroitement liées. En effet, le dimensionnement de la mine est une première étape essentielle, conceptualisée bien en amont, conditionnant pratiquement la pérennité de la mine. Sa maîtrise est fondamentale. L'autre étape, en aval, est en rapport avec la fermeture de la mine. Cette étape a été souvent mal préparée par le passé, notamment à l'égard des nouvelles exigences de nos sociétés modernes.

La présentation proposée dans le cadre du workshop « Mine durable » aborde ces facettes de la vie d'une mine à travers trois exemples différents réalisés tous pendant les années 1990. Elle sera consacrée aux outils de modélisation numérique, souvent très utiles aussi bien lors du dimensionnement de la mine, pendant son exploitation qu'après sa fermeture. Les récents développements informatiques, notamment les capacités des ordinateurs, en ont fait un outil d'aide à la décision incontournable.

Le premier exemple présente une étude hydrogéologique qui avait pour objectif d'évaluer la faisabilité technique du déjaugage d'un gisement en milieu saturé par l'implantation de puits de pompage. Le second exemple illustre l'apport de la modélisation numérique pour comprendre l'origine de la rupture d'un pilier dans une mine profonde qui exploitait le charbon. Le dernier exemple aborde le volet après-mine en France en présentant la problématique du bassin ferrifère lorrain ainsi que le rôle du modèle dans la compréhension des mécanismes de ruptures.

Les autres thèmes proposés dans le cadre du Workshop « Mine durable » vont être consacrés d'une part à la présentation des outils juridiques et techniques mis en place pour apporter des réponses concrètes aux exigences de l'après-mine en France (animation J-L. Foucher). D'autre part, des exemples seront présentés, notamment un projet européen sur la mine durable, afin d'illustrer l'importance de l'expertise dans le domaine minier (animation Ch. Didier).



«OPTIMUM FLEET RECOMMENDATION» «KOMTRAX PLUS»

Smart Mine and automation WS4

Nicolas Roussau, Komatsu, France
Chakib Benelkhadir, Stokvis, Morocco

Optimum Fleet Recommendation (OFR)

When you purchase large mining and quarry equipment, decisions often have to be made without the luxury of being able to pre-test equipment to see if it's right for your applications. Komatsu's Optimum Fleet Recommendation (OFR) is designed to do this for you. The OFR-trained application engineers will assist you in your evaluation by means of a detailed analysis, followed by recommendations and backed by comprehensive documentation. They'll help you to significantly reduce the risks, helping determine the exact machines, options and attachments that will best suit your production needs.

Komatsu's Optimum Fleet Recommendation determines the correct machine fleet to optimize your production and profitability. Predominantly used for large-scale operations, the advanced OFR software determines:

- Optimum Selection
 - Optimum Specification
 - Optimum Maintenance
 - Optimum Operation
- ... to minimize owning and operating costs.

Komtrax Plus

Komatsu's KOMTRAX Plus provides the means to monitor the health of major components on large machines, enabling the remote evaluation of the machine's condition and operations. This system has been designed to reduce repair costs and maintain optimal machine availability by helping to prevent unscheduled downtime.

The KOMTRAX Plus system enables downloaded machine data to be transmitted via the Internet and reviewed by Komatsu and Distributor service personnel. In most regions, data is also transmitted by Orbcomm satellites for added convenience and faster response time. KOMTRAX Plus reports vital information in several areas. The operating conditions of machines and their service meters can be monitored. Trends, when graphically displayed as change-over-time, enable remedial action before breakdowns occur. Fault and event codes that are displayed on the machine's monitor panel are recorded for future reference. Other data types include engine performance, real-time fault analysis, and machine operation history.



MINE AUTOMATION CHALLENGES AND TRIUMPHS

Smart Mine and automation WS4

Sean Dessureault
University of Arizona, USA

Mine automation has seen cycles of interest by major mining companies leading to spurts of development yet these huge investments have not led to the fully automated open-pit or underground mine. There are critical surface and underground automation infrastructure successes that have established the positioning and communications technologies



necessary to support an automated mine. Yet challenges to a fully autonomous or hybrid mine remain. This workshop covers the infrastructure technologies, the sensor packages, and different automation components leading toward the automated mine. Case studies of the successes and incomplete implementations of automation are reviewed from an insider's perspective. Finally, suggestions on the necessary foundations for successful automation are reviewed, specifically in the area of business process transformation from the increasingly wide use of data-generating technologies in mines and mineral processing plants. Specific technology topics include: 1) Descriptions of wireless, positioning, and sensing technologies, 2) Case studies of successes and reasons for incomplete opportunities, 3) Case studies of major automation development thrusts, 4) How IT and business process reengineering can lead toward the required changes in efficiency and effectiveness. After this workshop, attendees will be able to understand the technology investments that should occur in the short term to prepare for automation and know what companies or technologies to follow in anticipation of automation.



OPERATIONAL EXCELLENCE IN THE MANAGEMENT OF INDUSTRIAL PROCESSES

Smart Mine and automation WS4

Jean-Luc Tworek

Rockwell automation, France

In the current environment, manufacturers must be competitive and responsive. One of the means at their disposal to achieve this is the mastering of their production tools.

This mastering involves the establishment of a real control of the various processes involved. (Control does not mean conduct)

Control is:

Continuously monitor the coherence between the orders issued at the tactical level and real output. (Respect for forecast)

React to various changes which are subject tool production. (Hazards operating variability of Contents ...)

Coordinate between all sub-processes involved in the production.

Check that each entity constituting the production process works correctly (yield and quality)

Inform decision makers on the actual (vs. perceived) of the current and the production tool.

The control requires the availability of reliable information on the production process. To do this, the implementation of a tool for Collecting + Treatment + Diffusion is necessary. This tool is a Manufacturing Information System (MIS)

The control also requires control or coordination of various production processes according to business rules. In this case, the solution is tool of Manufacturing Execution System (MES)

Finally, control requires anticipating, and in this case it may be interesting to introduce tool flow simulation.

The presentation will discuss in a simple way this type of approach applied to various problems of mining production centers.



SCALE2000 - LOGICIEL DE MODÉLISATION DES PROCESSUS THERMOCINÉTIQUES DE FORMATION DE L'ENCRASSEMENT DANS LES UNITÉS DE DESSALEMENT

Desalination WS5

Mohamed AZAROUAL
BRGM, France

Le dessalement des eaux de mer et industrielles génère souvent des dépôts minéraux indésirables à différents endroits et organes (tiges d'évaporation, surface des membranes, etc.) des unités de dessalement induisant ainsi de nombreuses difficultés techniques et financières. Par principe, les techniques de dessalement sont basées sur la séparation de l'eau en deux parties : une eau douce très peu salée et une autre fortement salée aboutissant à des sursaturations thermodynamiques vis-à-vis de plusieurs phases minérales et sels. Les espèces minérales typiques susceptibles de précipiter sont nombreuses : silice amorphe (SiO_2), CaCO_3 , MgCO_3 , CaSO_4 , MgSO_4 , BaSO_4 , SrSO_4 , CaF_2 , $\text{Mg}(\text{OH})_2$, MgSiO_3 , et certains composés du phosphore tels que CaPO_4 , selon la typologie et les concentrations initiales des eaux dessalées. Afin de comprendre les interactions physico-chimiques et quantifier ces dépôts il est nécessaire de disposer d'outils numériques basés sur des approches thermocinétiques pertinentes et performantes accompagnées de bases de données thermodynamiques cohérentes. Le BRGM a développé des outils de modélisation thermocinétiques basés sur l'approche de Pitzer (i.e., SCALE2000) pour les saumures naturelles et industrielles capables de simuler les mécanismes thermocinétiques à l'origine de la formation de ces dépôts minéraux sous une large gamme de conditions de température (0 - 150°C) et de salinité pouvant atteindre 250 g/l. Ce logiciel intègre des mécanismes thermocinétiques basés sur la théorie de l'état de transition. Afin d'illustrer les conditions de formation de ces dépôts « scaling », nous avons effectué une série de simulations numériques de l'évaporation de différentes typologies d'eau de mers. Les résultats de ces simulations ont permis de mettre en évidence le risque de précipitation de plusieurs minéraux (CaCO_3 , MgCO_3 , CaSO_4 , BaSO_4 , SrSO_4 and SiO_2) à des températures comprises entre 10 et 50°C. La présentation proposée sera focalisée sur les mécanismes de formation de ces dépôts et les performances des outils numériques disponibles dans les communautés scientifique et industrielles (comme SCALE2000, PHREEQC, etc.).

THE NEW TENDENCIES IN THE TECHNOLOGY OF THE REVERSE OSMOSIS

Desalination WS5

Antonio Casañas
DOW Chemical Ibérica, Spain

The idea of this work is to review and summarize all the new tendencies in the technology of the reverse osmosis like new designs, new chemistry of membranes and improved pretreatments.

A huge amount of improvements have been made in the reverse osmosis technology since the beginnings when this was a young technology rarely used in seawater desalination. The paradigm of the inverse relation between the salt rejection and the permeability was solved with the new chemistry of the membranes developed in the early 2000s. Then the revolution of the large/huge desalination plants led to make desalination more affordable



and think about new dimensions of the RO elements having as a result the 16" elements recently developed. The need of reducing the energy consumption of the plants was satisfied with the new elements with a very high permeability though keeping a high salt rejection at the same time. The boron limitation in certain countries made the extra boron rejection seawater elements a need which is finally a reality and are being used to avoid a second pass design and hence avoid increasing the CAPEX in the building of the desalination plants.

In relation with the new designs the concepts of the internally stage design (ISD) and the split partial design will be described. Also the new ways of recovering energy will be mentioned.

The new chemistry of the membranes will go from the ultra low energy sweater elements (SWULE) elements till the new extra fouling resistant brackish water elements (XFR) passing by the extra boron rejection elements (SWXHR).

With the improved pretreatments, a comment about the results obtained with the first experiences using ultrafiltration as a pretreatment in seawater open intakes and also the results obtained with the use of these two technologies in the water reuse application.



INNOVATIONS IN THE INHIBITION AND CLEANING OF REVERSE OSMOSIS MEMBRANE SCALING AND FOULING

Desalination WS5

Stephen P. Chesters

Genesys International Ltd., UK

Although membrane scaling and fouling are already an ongoing performance issue for most plants, membrane systems are built and operated with increasingly poorer quality feed waters. It is therefore essential that new and improved products are developed so plants can continue to operate at their highest efficiency thereby saving water and energy. This presentation outlines innovations in speciality chemicals designed to inhibit membrane scaling and fouling and to clean membranes where deposition has occurred.

High phosphate waste water reuse RO plant – There is an increasing trend to treat recycled waste water and use it as a feed supply to RO plant. High levels of phosphate can cause rapid scale formation in the membranes. This paper discusses phosphate chemistry and field trials of a new antiscalant used to overcome acid dosing.

Calcium sulphate precipitation – Mining requires large quantities of desalinated water, often produced from ground waters containing high levels of calcium, magnesium, silica and sulphate and thus requiring sophisticated speciality antiscalants and dispersants. This section examines the use of new antiscalant compounds developed specifically to inhibit the formation of calcium sulphate. The chemistry and deposition mechanisms are presented along with a sulphate specific antiscalant. Results from an operating plant are presented showing the improvement in plant performance.

Removing clay from membranes – Clay is a common place foulant and very difficult to remove from membranes. This section describes the mechanisms and products developed to effectively remove clay. A number of case studies are described.



PHOSPHORIC ACID PRODUCTION PROCESSES DEVELOPED BY PRAYON

Phosphoric process manufacture WS6

Marc COLLIN, Benoît VAN MASSENHOVE

Prayon Technologies S.A., Belgium

Prayon Technologies s.a ("PRT") is the owner of the technologies which have been developed within the Prayon Group. Active for more than 70 years, Prayon Technologies is considered as an undisputed leader in the phosphoric acid production technology field. PRT has designed, developed and accompanied the construction of more than 130 plants of acids in more than 35 different countries. More than 30 different phosphate rocks are utilized in these plants which offer a huge range of capacities.

Services offered by Prayon Technologies are essentially of two types: licensing activities through design of new or revamped plants and consulting activities (audit, training, rock testing).

During this workshop the main specific features of the Prayon processes will be presented, namely: the multi-compartments attack tank, the digestion concept and the low level flash cooling. The purposes of these features will be discussed.

ISOTHERMAL PHOSPHORIC ACID PROCESS

Phosphoric process manufacture WS6

Richard D. Harrison

PegasusTSI, USA

This presentation will cover the Isothermal Phosphoric Acid Process including patent history, the evolution of capacity, publications concerning the process, and the newest installation. Typical industrial installations range between 700 to 1000 metric tons/day. Typical electrical power consumption is half that of competing dihydrate reactor technologies. Similarly, reactor volume is typically about half that of other phosphoric acid reactors. The number of agitators is only two, instead of the usual eight for conventional dihydrate processes. Capital investment costs are significantly lower than other dihydrate phosphoric acid processes. Likewise, operating and maintenance costs have proven to be lower than conventional dihydrate reactors. Additionally, the dedicated vacuum cooler system maintains reactor temperature even in the heat of the summer months. Finally, optimum capacity for the first proposed Moroccan Isothermal Reactor will be discussed, so that a side by side demonstration can be arranged.

Cette présentation portera sur le processus phosphorique Acide isotherme y compris l'histoire des brevets, l'évolution de la capacité, des publications concernant le processus, et la nouvelle installation. Installations industrielles typiques varient entre 700 et 1000 tonnes / jour. La consommation électrique typique est la moitié de celle des autres technologies de réacteurs dihydraté. De même, le volume du réacteur est typiquement d'environ la moitié de celle des autres réacteurs d'acide phosphorique. Le nombre d'agitateurs n'est que deux, au lieu de huit habituellement pour les procédés conventionnels dihydraté. Les coûts d'investissement sont nettement plus faibles que les procédés dihydrate d'autres d'acide phosphorique. De même, les coûts d'exploitation et d'entretien se sont avérés être plus faible que les réacteurs conventionnels dihydraté. En outre, le système de vide dédié refroidisseur maintient la température du réacteur, même dans la chaleur des mois d'été. Enfin, la capacité optimale pour le réacteur isotherme marocaine première proposition sera discutée, de sorte que d'un côté par côté de démonstration peuvent être organisées.



JACOBS PHOSPHORIC ACID REACTION TECHNOLOGY

Phosphoric process manufacture WS6

James Byrd

Jacobs Engineering SA, USA

At the heart of each Phosphoric Acid Plant is the reaction circuit. Jacobs offers technology as state of the art in modern Phosphoric Acid Production. Internal recirculation and the ability to trim reactor slurry prior to the filter feed provide precise control over excess sulfates and crystal growth. Considering the Jacobs design mixing tee for return acid, high agitation and mixing in the front end, super saturation zones and losses are minimized. Using very finely ground rock allows the Jacobs reactor to operate in the high yield mode with recoveries around 97.5% through the filter. Annular design allows for extended runs between turnarounds and for potential operation if one agitator fails equating to high operating factors. Flash cooling and an ample maturation circuit provides the disengagement zone which allows final crystal growth prior to filtration. All of these control mechanisms make the Jacobs reactor a highly efficient tool in phosphoric acid production.



FLUORIDE AND SILICA PRODUCTS FROM POND WATER AND FSA

Fluoride valorisation WS7

Vaughn Astley

Dr Phosphate, USA

The presence of significant levels of fluoride and silica in phosphate rocks leads to high concentrations of fluorides and fluorosilicates being found in the phosacid process product and the waste products and streams around the phosphoric acid facility and their associated evaporators.

The recovery of fluoride and silica products from pond water, fluorosilicic acid, etc., will be discussed.

ECONOMIC ASPECTS OF UTILIZING FLUOSILICIC ACID AS RAW MATERIAL FOR THE MANUFACTURE OF HYDROFLUORIC ACID AND ALUMINIUM FLUORIDE

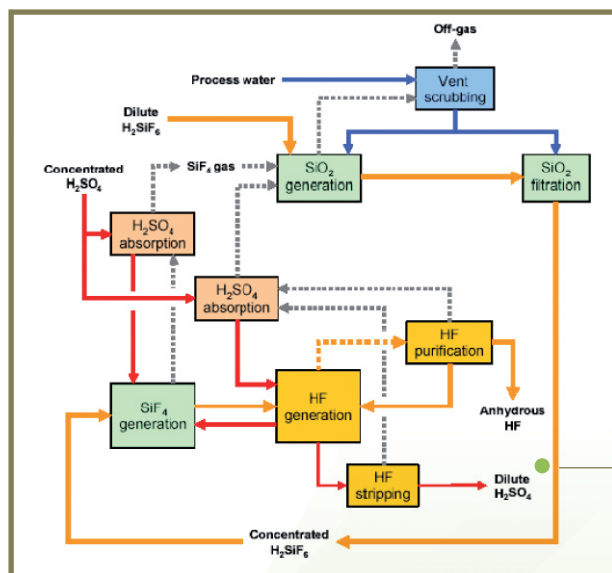
Fluoride valorisation WS7

Alain Drevet

AD Process Strategies Sarl, Switzerland

Fluosilicic acid (FSA) is a potential source of fluorine instead of using fluorspar (fluorite ore) for the production of anhydrous hydrofluoric acid (AHF) and its downstream products e.g. production of high density aluminium fluoride (see below typical flow chart for such technology (Davy, 2005, "Hydrofluoric acid from fluosilicic acid").

Using fluosilicic acid as an alternative source of fluorine makes sense basically if this alternative is far much attractive than simply using fluorspar. This paper is an attempt to determine the conditions for implementing such FSA technology taking into account the various costs: costs of raw materials, costs of logistics, capital cost, etc which are specific to each technology (FSA or fluorspar technologies). These factors are of course well known to affect the economics of the process. The purpose of this paper is to quantify more precisely influences and consequences of these costs.



*Davy, 2005, "Hydrofluoric acid
from fluosilicic acid"*



FSA NEUTRALIZATION WITH CALCIUM COMPOUNDS

Fluoride valorisation WS7

Salah F. Albustami, PEa, Stephen W. Hilakosa
Jacobs Engineering SA, USA - Maroc

As environmental regulations continue to restrict chemical processing emissions, phosphate plant operators will eventually be required to neutralize fluoride waste materials. Most phosphate plants currently use direct contact barometric condensers with recirculating cooling pond water that is saturated with fluoride salts. Most of this fluoride is allowed to precipitate as the recirculating water cools in large cooling pond systems. When forced to treat fluoride contaminated water, phosphate producers typically use lime or limestone neutralization prior to discharging effluent. A better environmental alternative is to use scrubbers to remove fluorides as fluosilicic acid prior to condensing the vapors in barometric condensers. If a market cannot be found for the fluosilicic acid, it can then be neutralized with phosphate rock to produce a weak phosphoric acid. This technique is not currently used because it is not profitable. This paper discusses Fluosilicic Acid neutralization with several calcium compounds such as phosphate rock, lime and limestone.



PHOSPHORIC ACID FILTRATION

Phosphoric acid filtration technology WS8

Gabriele Ghiringhelli
FLSmidth Milano Srl, Italy

According to the well known phosphoric acid production flow sheet, and regardless the various types of processes herein implemented, a filtration step is involved to achieve the separation between gypsum and phosphoric acid.

This is one of the worst environment to apply a filter due to the high temperature and high acid concentration. The extreme and peculiar conditions make the design of the Phos Acid filters critical for good performances and equipment life.

After two years of operation of our filtration system at the biggest Phos Acid plant in the world, located in Saudi, and after the recent acquisition of one of the largest horizontal belt filters ever installed in Phos Acid, FLSmidth has acquired and consolidated a consistent experience in design and operation of horizontal belt filters.

The speaker will take into consideration the major aspects involved in design and operation of a belt filter in phos acid such as :

- Material and design of rubber belt
- Material and design of filter cloth
- Tailored applications oriented engineering solutions
- Typical filter performances

and will present the overall FLSmidth capability in filtration of Phos Acid.



AOUSTIN™ TABLE FILTER, THE LOGICAL SOLUTION FOR FILTRATION OF PHOSPHORIC ACID

Florent Bouquet
RPA PROCESS, France

Phosphoric acid filtration technology WS8

After having designed the first ever continuous vacuum belt filter for phosphoric acid filtration in 1948, RPA PROCESS, owner of the brand AOUSTIN™, has been the exclusive worldwide licensee for the fabrication of UCEGO™ table filters during 50 years leading to the installation of around one hundred table filters specially designed for the P2O5 filtration.

The robust design of this table filter technology is worldwide known with filters being still in operation after 35 years of P2O5 filtration.

Aim of this paper is to present what makes this technology the logical filtration solution for phosphoric acid production processes, from maintenance point of view to process performances aspects, including unequalled productivity rates in terms of P2O5 filtered per m2 together with high P2O5 recovery.

Thanks to recent technological developments, RPA PROCESS is now ready to provide to the market up to 320 m² AOUSTIN™ Table filters, in line with the new market trends for greenfield projects.



FLOATFORCE, PROVEN FLOTATION BENEFITS

Luis Rudolphy
Outotec, Finland

Flotation WS9

The heart of the flotation cell is the rotor-stator mixing mechanism, which mixes the slurry, disperses air and generates kinetic turbulent energy. Turbulence is needed in order to accelerate the particles and give them sufficient energy, so that they will attach to the bubbles. Outotec's latest mixing mechanism has again increased the performance on all Outotec flotation tank cells where a conventional OK mechanism has been upgraded to FloatForce. FloatForce improves flotation hydrodynamics, mixing at the same aeration rate and maintaining mixing at a higher air dispersion rate.

Some of FloatForce mixing mechanism features are; increased bubble area flux S_b ; improved air-hold up volume; increased suspension of coarse particles as well as enhanced flotation cell hydrodynamics. All these features result in large benefits for FloatForce users, such as operation flexibility, possibility to increased recovery, longer wear part lifetime as well as the possibility to reduce power consumption from flotation operations.



PROCESS AND FLOTATION CELL DESIGN CONSIDERATIONS FOR PHOSPHATE APPLICATIONS

Flotation WS9

Asa Weber^a and Gerald Luttrell^b

^aFLSminerals, USA

^bDepartment of Mining & Minerals Engineering, Virginia Tech, USA

Theoretical flotation models suggest that there is a strong relationship between bubble-particle collision rates and particle size distribution. For fine particles, flotation kinetics is improved by higher energy dissipation rates that increase collision frequencies between bubbles and particles. Conversely, flotation kinetics of coarser particles is often diminished at higher energy dissipation rates due to higher detachment rates associated with turbulence in the rotor-stator region. Other restrictions to coarse particle recovery are bubble-particle aggregate buoyancy and froth recovery. As a result, flotation circuits that process coarse and fine fractions separately have been shown to improve overall metallurgical performance. Improvements in both fine and coarse particle recovery can also be realized by proper flotation equipment selection and equipment design modifications. Of course, routine maintenance and proper operational procedures are paramount in effective plant operations. This presentation will discuss design parameters that should be considered as part of Greenfield feasibility or a plant optimization study. The design parameters include (i) the effect particle size has on the flotation circuit, (ii) flotation equipment selection, (iii) flotation equipment design modification, and (iv) equipment operational and maintenance requirements.

ETUDE DE L'ÉVOLUTION DES IMPURETÉS LORS DES OPÉRATIONS DE DÉSURSATURATION DE L'ACIDE PHOSPHORIQUE INDUSTRIEL

Fouling in phosphoric acid WS10

**L. Khamar^{a,b}, M. EL Guendouzi^{a *}, M. Amalhay^b, N. Omalek^a, S. Qassemi^a,
M. Azaroual^c**

^aPhysical Chemical Laboratory, Faculty of Sciences Ben M'sik, Hassan II University, Morocco

^bOCP Group, Maroc

^cBRGM -Water, Environment and Ecotechnology Direction, France

La désaturation de l'acide phosphorique industriel est une opération unitaire intégrée, soit explicitement, soit implicitement dans les procédés de transformation chimique des phosphates minéraux par voie humide (WPPA). Cette opération consiste à améliorer la qualité de l'acide par élimination ou la réduction de la concentration de quelques impuretés qui pénalisent sa qualité ou impactent directement les performances des unités de production en aval. Ces impacts sont généralement dus aux encrassements et se manifestent au niveau des performances en terme d'augmentation de la consommation spécifique des utilités et de la réduction de la productivité accompagnée de détérioration des équipements de production (conduites, pompes, filtres, échangeurs de chaleurs,...). Vu l'importance et l'impact de la qualité d'acide phosphorique dilué et son traitement, sur les performances du reste de la chaîne de production, nous avons étudié l'opération

de désaturation et de clarification de cet acide dans diverses conditions de séjour et de température. Cette approche nous a permis de déterminer, d'une part l'évolution de la concentration et de la nature des différentes phases d'impuretés présentes dans l'acide initial et en second lieu de remonter et déterminer les conditions optimales de traitement d'acide; afin de les adopter pour l'amélioration des performances des unités de production. La maîtrise de ces opérations permet au niveau industriel de réduire les impacts négatifs des impuretés en termes de corrosion d'abrasion et de qualité d'acide produit et d'améliorer la productivité de l'étape de concentration et d'épuration de l'acide marchand.

Le présent article reprend et explique ces différentes approches et les résultats enregistrés.

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Keywords: fabrication acide phosphorique; désaturation, impuretés; température.



AMÉLIORATION DE LA PERFORMANCE DE LA CONCENTRATION D'ACIDE PHOSPHORIQUE PAR LA RÉDUCTION DU PHÉNOMÈNE D'ENCRASSEMENT

Fouling in phosphoric acid WS10

Hamid Mazouz & Abdelaâli Kossir

OCP, Maroc

Dans l'industrie du phosphate différents procédés sont utilisés pour la concentration d'acide phosphorique par voie humide. La formation de dépôts sur la surface des échangeurs de chaleur est l'un des problèmes les plus rencontrés lors de la concentration d'acide phosphorique. Pour faire face à ce phénomène la plupart des entreprises procèdent par des modifications au niveau de la conception de l'échangeur. Toutefois, cette solution ne peut empêcher la formation de dépôt, en raison des concentrations élevées de sulfate de calcium produit par le processus de fabrication d'acide phosphorique.

Le sulfate de calcium est considéré comme le principal ingrédient du dépôt formé à la surface des échangeurs de chaleur. De ce fait, par le blocage de la formation des cristaux de sulfate de calcium, il est possible d'inhiber et empêcher sensiblement la formation de dépôts dans le processus d'évaporation de l'acide phosphorique.

Notre travail a pour but d'étudier la prévention de la formation de dépôt en ajoutant des agents antiscalants dans l'acide phosphorique lors de son évaporation. Deux agents antiscalants innovants et biodégradables ont été testés dans une unité pilote en Batch de concentration d'acide phosphorique. Cette unité est de 20 litres de capacité, équipé de deux échangeurs de chaleur tubulaires en graphite. L'évaporation est conduite sous vide à 60 mmHg, le chauffage est assuré par la recirculation de l'huile chaude à travers les tubes en graphite.

Les essais ont été réalisés dans les mêmes conditions en utilisant de l'acide phosphorique frais avec et sans ajout d'agents antiscalants. Les dépôts formés sur la surface des tubes en graphite ont été récupérés, puis quantifiés et analysés par DRX pour l'identification des cristaux formés.

Les résultats montrent une diminution de la formation de tartre de 40% à 50% après l'addition d'antiscalants à une concentration entre 2 ppm et 5 ppm. Par ailleurs, l'utilisation d'antiscalants a affecté le processus de concentration en augmentant la cinétique d'évaporation et la concentration d'acide phosphorique, pour les mêmes conditions d'évaporation.

Mots Clefs : Concentration d'acide phosphorique, dépôt, échangeurs de chaleur, encrassement, antiscalant.



SCALE CONTROLLING CHEMICAL ADDITIVES FOR PHOSPHORIC ACID PRODUCTION PLANTS

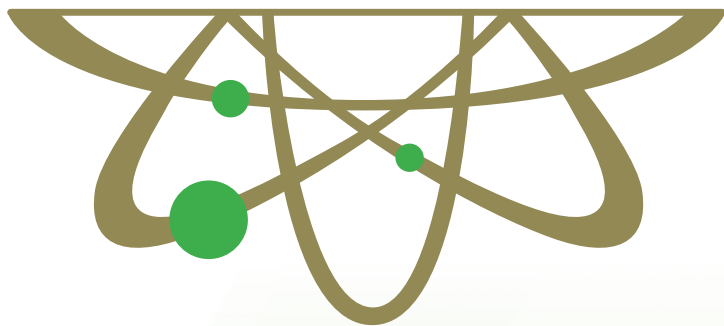
Fouling in phosphoric acid WS10

John Carr*, Lei Zhang, Matthew Davis, SA. Ravishankar, and Greg Flieg
Cytec Industries, USA

During the past two years, Cytec Industries has successfully developed and demonstrated an anti-scalant technology that substantially reduces the fouling issue that remains a perennial problem in wet-process phosphoric acid production plants. The technology has offered significant benefits at various points in the process including a 90% reduction of scale mass in process piping, reducing the number of tubes plugged in a heat exchanger by 85% with concomitant decrease in cleanout time of 85%, and increasing the operational cycle of a heat exchanger by almost 100%. To cap all these benefits, there are no downstream effects and product grade acid was produced throughout all of the trials. The technology is easily implemented at existing plants with no requirement for significant capital investment.



COURSES



Topic	ICM Versus JORC Guidelines, 43-101 Regulation for Mineral Resources and Reserves Estimation
Location & Date	Room Ouarzazate – Sofitel Hotel Royal Baie - Agadir, May 6, 2013
Time	9:00 am -12.00 am; 2.00 pm - 05.00 pm
Facilitators	Daniel Gagnon, Ing. (General Manager – Mining Group, Met-Chem Canada Inc.) and Schadrac Ibrango, Ph.D., P.Geo. (Senior Geologist, Met-Chem Canada Inc.)
Language	French
Number of attendees	12 to 20 Persons

Objective of the short-course

This one day short course aims at providing a quick review on the CIM (Canada) and JORC (Australia) guidelines related to mineral resources and mineral reserves estimation. The first part will be related to mineral resources estimation while mineral resources estimation will be discussed in the second part. A third part will present a comparative analysis of CIM and JORC guidelines and will also discuss of the Canadian regulation 43-101 on respecting standards of disclosure for mineral projects

Who should attend?

The course is recommended for mining professionals who, without being mineral resources and reserves specialists, would like to improve their knowledge on the practices and standards in that area of the mining industry.

Short courses content

The course is structured into 3 parts:

I- ETAPES GENERALES POUR L'ESTIMATION DE RESSOURCES MINERALES

- Exploration et forage
- Données historiques versus récentes
- Construction et validation d'une Base de Données
- QA/QC
- Modélisation géologique et construction de solides
- Analyse Statistique
- Analyse Géostatistique
- Modèle de Blocs
- Interpolation (différentes Méthodes)
- Classification des blocs de ressources interpolées
- Publication des résultats

II- ETAPES GENERALES POUR L'ESTIMATION DE RESERVES MINERALES

- Paramètres d'opération
- Paramètres économiques
- Définition des limites économiques (fosses et souterrain)
- Design de mine
- Plan miniers
- Estimation de la flotte d'équipements
- Estimation de l'Opex et Capex
- Re-validation des limites économiques
- Estimation des réserves



III- GRANDES LIGNES SUR LES NORMES ET DEFINITIONS DE L'ICM RELATIVE AUX RESSOURCES ET RESERVES MINERALES (EDITION 2005)

- Personne Qualifiée
- Étude préliminaire de faisabilité
- Renseignements sur l'exploration
- Ressources Minérales
 - Définition
 - Ressources Minérales Présumées (ou Inférées)
 - Ressources Minérales Indiquées
 - Ressources Minérales Mesurées
- Réserves Minérales
 - Définition
 - Réserves Minérales Probables
 - Réserves Minérales Prouvées
 - Classification et relation entre Ressources et Réserves Minérales

IV- GRANDES LIGNES SUR LE CODE JORC POUR L'ESTIMATION DES RESSOURCES ET RESERVES MINERALES (EDITION 2012)

- Définition du code JORC
- Personne Compétente
- Facteurs Modifiants et relations entre Ressources Minérales et Réserves Minérales
- Ressources Minérales
 - Définition
 - Ressources Minérales Inférées
 - Ressources Minérales Indiquées
 - Ressources Minérales Mesurées
- Réserves Minérales
 - Définition
 - Réserves Minérales Probables
 - Réserves Minérales Prouvées

V- ANALYSE COMPARATIVE ENTRE NORMES ICM ET CODE JORC POUR LES RESSOURCES ET RÉSERVES MINÉRALES

VI- CONCLUSION

Registration information

Access to courses is conducted by a preliminary registration on SYMPHOS Website or through the Technical Secretariat. The places are limited.

Registration fee is: **250 Euros per course including all taxes**. This price covers the courses and the course materials as well as lunch and coffee break.

Thématique	Techniques de Flottation des Minerais Phosphatés
Lieu & Date	Salle Ouarzazate, 6 Mai 2013, hôtel Sofitel Baie - Agadir
Horaire	9.00 am – 12.00 am & 2.00 pm - 5.00 pm
Animateurs	Pr. Mohammed EL ASRI, Faculté des Sciences et Techniques Fès
Langue principale	Français
Nombre de participants	12 à 20 Personnes

Objectif du cours

- **Comprendre** les phénomènes de chaque étape du processus de **flottation**.
- **Connaitre** le principe de **traitement de surface**, est des tensioactifs.
- **Comprendre** les phénomènes de la dépression, de la collection et de moussage.
- **Distinguer** les différents réactifs chimiques utilisés dans le procédé de flottation.
- **Comprendre** et optimiser la consommation des réactifs de flottation.

Qui participe

Ce cours s'adresse particulièrement aux personnes qui s'intéressent à l'enrichissement des minerais par flottation directe ou inverse.

Contenu du cours

Le cours traitera les aspects suivants :

- Bases de la minéralurgie, principe de la flottation
- Réactifs chimiques de flottation (nomenclature, caractérisation, propriétés,...)
- Les cellules et colonnes de flottation
- Réglage et optimisation des paramètres de marche d'une unité d'enrichissement de minerai de phosphate par flottation
- Étude de cas : enrichissement par flottation inverse d'un minerai phosphaté à gangue silico-carbonatée.

Informations pour inscription

L'accès au cours se fait par inscription préalable sur le site web SYMPHOS ou à travers le Secrétariat Technique. Les places sont limitées.

L'inscription est payante : **250 Euros TTC par cours**. Ce prix couvre le cours, les supports de cours ainsi que le repas du déjeuner et la pause café.

Thematic	The Direct use of Reactive Phosphate Rocks in Crop Production
Location & Date	Room DRAA, Hotel Sofitel Baie -Agadir, 6th may 2013
Time	9.00 am – 12.00 am & 2.00 pm - 5.00 pm
Animators	Nassir A. and L. Cisse (OCP) Sri Rochayati and Husnain (ISRI)
Language	English
Number of attendees	12 to 20 Persons

Objective of the short-course

The main objectives are to:

- Provide an overview of the present world situation and prospects for the direct use of phosphate rocks in crop production
- Present the physical and chemical characterizations of phosphates rocks for direct application
- Review the main factors affecting the agronomic effectiveness of phosphate rocks applied to different crops
- Give some economics considerations relating to the direct use of phosphate rocks

Who should attend?

This workshop is designed for innovative farmers, agronomists, soil scientists, researchers and extensionists from national and international agricultural research institutes and universities, as well as policymakers from governments and ministries in charge of agricultural productivity and planning. Executives and managers of fertilizer and agricultural input organizations will find this program extremely interesting. Government officials involved in developing strategies for increased agricultural production through the use of emerging technologies that promote resource conservation and increased efficiencies should also benefit from the program. Participants should be fluent in English.

Short courses Content

INTRODUCTION

OVERVIEW OF THE DIRECT USE OF PHOSPHATE ROCKS IN CROP PRODUCTION

CHARACTERIZATIONS OF PHOSPHATE ROCKS FOR DIRECT APPLICATION

- Chemical and physical characterizations
- Kinetics of dissolution in soils
- Phosphate rocks reactivity scales
- Comparison with standard water soluble fertilizers

FACTEURS AFFECTING THE AGRONOMIC EFFECTIVENESS OF PHOSPHATE ROCKS (PRs)

- Reactivity of PRs
- Climate conditions
- Crop species
- Soil and crop management systems
- Technologies for improving the initial agronomic effectiveness of PRs

SOIL TESTING FOR PHOSPHATE ROCK APPLICATIONS

- Conventional soil tests
- Non-conventional soil tests



EFFECTS OF ELEMENTS OTHER THAN PHOSPHORUS ASSOCIATED WITH THE DIRECT USE OF PHOSPHATE ROCKS

- Secondary nutrients
- Micronutrients
- Liming effect

ECONOMIC CONSIDERATIONS FOR THE PROMOTION AND WIDE APPLICATION OF THE DIRECT USE OF PHOSPHATES ROCKS

PRESENT WORLD SITUATION AND PROSPECTS FOR THE DIRECT USE OF PHOSPHATE ROCKS

CASE STUDIES: Asia and Latin America

CONCLUSIONS

Registration information

Access to courses is conducted by a preliminary registration on SYMPHOS Website or through the Technical Secretariat. The places are limited.

Registration fee is: **250 Euros per course including all taxes**. This price covers the courses and the courses' materials as well as meals of lunch and coffee break.



SHORT COURSE N°4

Thématique	HSE in design
Lieu & Date	Salle Lounge ART, Hotel Sofitel Baie -Agadir, 6 mai 2013
Horaire	9.00 am – 12.00 am & 2.00 pm - 5.00 pm
Animateurs	Rachid M'hamdi Chef département HSE in Design et Rachad Zakaria ingénieur sénior au département HSE in design à Jacobs Engineering SA
Langue principale	Français
Nombre de participants	12 à 20 Personnes

Objectif du cours

L'objectif de ce cours est de fournir un aperçu sur le rôle de l'ingénieur HSE in design dans une société d'ingénierie et les activités à réaliser dans le cadre des projets industriels. Dans la première partie nous présentons un aperçu sur la réglementation Marocaine et internationale en matière d'environnement. La deuxième partie présentera la loi marocaine sur les études d'impacts : contexte, méthodologie de mise en œuvre. La troisième partie présentera l'activité HSE in design.

Qui participe

Ce cours intensif s'adresse aux ingénieurs, chefs de projets industriels, responsable HSE, responsable environnement.

Contenu du cours

Le cours sera structuré en 4 grandes parties qui sont les suivantes :



- Partie I : la réglementation Marocaine et internationale en matière de l'environnement pour la réalisation des projets industriels.
- Partie II : le HSE in desgin
- Partie III : les études d'impacts sur l'environnement
- Partie IV : Les études de danger et de risques :

Information pour inscription

L'accès au cours se fait par inscription préalable sur le site web SYMPHOS ou à travers le Secrétariat Technique. Les places sont limitées.

L'inscription est payante : 250 Euros TTC par cours. Ce prix couvre le cours, les supports de cours ainsi que le repas du déjeuner et la pause café.



SHORT COURSE N°5

Thématique	Technologies de Dessalement des Eaux de mer et des Eaux Saumâtres : Aspects Techniques, Energétiques et Exploitation
Lieu & Date	Salle Tarroudant - Agadir (Maroc), 7 Mai 2013
Horaire	9.00 am - 12.00 am & 2.00 pm - 5.00 pm
Animateurs	Azzeddine ELMIDAOU, Professeur (Président de la Société Marocaine des Membranes et de Dessalement, Université Ibn Tofail, Kénitra, Maroc.)
Langue principale	Français
Nombre de participants	12 à 20 Personnes

Objectif du cours

L'objectif de ce cours d'une journée est d'exposer les différentes technologies de dessalement en s'arrêtant plus sur les technologies membranaires et particulièrement l'Osmose Inverse. Les aspects techniques d'une station de dessalement par Osmose Inverse seront traités ainsi que les aspects énergétiques et les difficultés d'exploitation.....

Qui participe?

Ce cours intensif s'adresse aux professionnels du secteur de l'eau et particulièrement ceux qui désirent améliorer leurs connaissances dans le domaine de dessalement, particulièrement les aspects pratiques des stations.

Contenu du cours

Le cours est organisé en 3 grandes parties qui sont les suivantes :

- Partie I : Les différentes technologies de dessalement
- Partie II : L'Osmose Inverse : aspects techniques et énergétiques
- Partie III : L'exploitation d'une station de dessalement.

Information pour inscription

L'accès au cours se fait par inscription préalable sur le site web SYMPHOS ou à travers le Secrétariat Technique. Les places sont limitées.

L'inscription est payante : 250 Euros TTC par cours. Ce prix couvre le cours, les supports de cours ainsi que le repas du déjeuner et la pause café.

Topic	Mining and Sustainable Management
Location & Date	Room ZAGOURA, Hotel Sofitel Baie -Agadir, May 7th, 2013
Time	9.00 am – 12.00 am & 2.00 pm - 5.00 pm
Facilitators	Rachid Hakkou, Professor at Cadi Ayyad University Mostafa Benzaazoua, Professor UQAT, Canada Chawky Beldjelida, Professor à CEGEP Abitibi, Québec, Canada
Language	French
Number of attendees	12 to 20 Persons

Objectives of the short-course

- To acquire the necessary concepts for mines exploitation involving sustainable development
- To assess mining impacts on the environment
- To know the design and monitoring parameters of tailings and wastes rock dump
- To acquire the necessary concepts for mine reclamation

Who should attend?

- Miners
- Geologists
- Mineral processing engineers

Short courses content

- Mining exploitation and sustainable development: a variety of situations
- The three pillars of sustainable development in a contemporary mine
- Integration of a specific environmental management mechanism during a mine project :
Case of Voisey's Bay (Labrador)
- Overview of the mining environment
- Stockpiling of solid tailings
- Nature of mine wastes: origin, physico-chemical and geotechnical characteristics
- Selection of tailings and waste rock site storage, design and construction of tailings dams and waste-rock dump (physical stability...)
- Techniques and methods for mining environmental assessment. Measures to be taken to eliminate and reduce the negative impacts of mining on the environment
- Presentation of different techniques for the rehabilitation of open pit mines
- Concept and example of integrated mine wastes management
- Case study: Restoration of the abandoned Kettara mine using phosphates by-products

Registration information

Access to courses is conducted by a preliminary registration on SYMPHOS Website or through the Technical Secretariat. The places are limited.

Registration fee is: **250 Euros per course including all taxes.** This price covers the courses and the course materials as well as lunch and coffee break.



Thématique	Modélisation et Simulation des Procédés de Transformation des Phosphates
Lieu & Date	Salle Ouarzazate, Hotel Sofitel Baie -Agadir, 7 mai 2013
Horaire	9.00 am – 12.00 am & 2.00 pm - 5.00 pm
Animateurs	Pr. Tijani Bounahmidi
Langue principale	Français
Nombre de participants	12 à 20 Personnes

Objectif du cours

- Mettre en évidence la nécessité de combiner différentes approches de modélisation pour simuler le comportement de procédés régis par des phénomènes complexes tels que ceux de l'industrie des phosphates.
- Montrer le besoin de collaboration entre les ingénieurs de production et ceux de la R&D pour mener à bien la combinaison des différentes approches de modélisation à l'aide de simulateurs commerciaux.

Qui participe?

- Ingénieurs de procédés; Ingénieurs de production; Ingénieurs de R&D; Ingénieurs automaticiens

Contenu du cours

- Méthodologie de l'ingénierie des procédés assistée par ordinateur
- Les principaux phénomènes mis en jeu dans les procédés : les équilibres thermodynamiques; la cinétique de transformations chimiques ; la cinétique des phénomènes de transfert et les écoulements
- Les trois grandes catégories de modèles de procédés : modèles physico-chimiques ; modèles de population et modèles statistiques
- La validation des mesures
- Les simulateurs commerciaux de procédés en régimes statique et dynamique et les conditions de leur bonne utilisation
- Etude de cas :
 - modélisation d'un procédé de concentration d'acide phosphorique
 - modélisation d'un procédé de fabrication d'engrais DAP.

Informations pour inscription

L'accès au cours se fait par inscription préalable sur le site web SYMPHOS ou à travers le Secrétariat Technique. Les places sont limitées.

L'inscription est payante : **250 Euros TTC par cours**. Ce prix couvre le cours, les supports de cours ainsi que le repas du déjeuner et la pause café.

Topic	4 R Nutrient Stewardship for Improved Nutrient Use Efficiency
Location & Date	Room DRAA, Hotel Sofitel Baie -Agadir, May 7th, 2013
Time	9.00 am – 12.00 am & 2.00 pm - 5.00 pm
Facilitators	A. Johnston, M. ElGharous, S. Zingore and H. Boulal(IPNI)
Language	English
Number of attendees	12 to 20 Persons

Objective of the short-course

IPNI 4R Nutrient Stewardship

Background information on Sub-Saharan Africa

Moroccan Agriculture

- Moroccan fertility and fertilizer research agenda

- National strategy adopted or to be adopted to improve fertilizer use by farmers

Examples of 4R practices to Improve Nutrient Use Efficiency

Soil fertility status and nutrient requirements in Sub-Saharan Africa

Who should attend?

This workshop is designed for innovative farmers, agronomists, soil scientists, researchers and extensionists from national and international agricultural research institutes and universities, as well as policymakers from governments and ministries in charge of agricultural productivity and planning. Executives and managers of fertilizer and agricultural input organizations will find this program extremely interesting. Government officials involved in developing strategies for increased agricultural production through the use of emerging technologies that promote resource conservation and increased efficiencies should also benefit from the program. Participants should be fluent in English.

Short courses content

IPNI 4R Nutrient Stewardship

- The concept of 4R Nutrient Stewardship
- Factors to consider in selecting the right source, rate, time and placement of nutrient application
- Nutrient management planning and accountability

Background information on Sub-Saharan Africa

- Characteristics of major farming systems in SSA (climate and crops)
- Status of fertilizer use in SSA at the regional and country level
- Fertilizer use by crop and crop production levels
- Why has fertilizer use remained low?
- Key challenges for improving fertilizer use
- Key challenges for improving fertilizer management
 - Outdated recommendations
 - Weak and extension services
 - Lack of good extension knowledge products
- IPNI contribution to the improvement of fertilizer management in SSA
 - Fertilizer management trials (Maize; legumes and oil palm)
 - Knowledge product development and knowledge sharing
 - Nutrient management decision support tools



Moroccan Agriculture

- The particularity of Moroccan agriculture
- The importance of fertilizer in crop production
- Moroccan fertility and fertilizer research agenda
- National strategy adopted or to be adopted to improve fertilizer use by farmers

Examples of 4R practices to Improve Nutrient Use Efficiency

- A series of case study examples will be reviewed where use of the 4R concepts are implemented to improve nutrient use efficiency

Soil fertility status and nutrient requirements in Sub-Saharan Africa

- Integrated soil fertility management
- Major soils and nutrient deficiencies (macro and micronutrients)
- Farm-level variability and need for site-specific fertilizer recommendations
- N, P, K, S yield gaps and management options
- 'Smart fertilizer' products for Africa

Registration information

Access to courses is conducted by a preliminary registration on SYMPHOS Website or through the Technical Secretariat. The places are limited.

Registration fee is: **250 Euros per course including all taxes.** This price covers the courses and the course materials as well as lunch and coffee break.



SHORT COURSE N°9

Topic	Process Transformation in Production, Safety, and Sustainability Through Information Technology
Location & Date	Room DRAA, Hotel Sofitel Baie -Agadir, May 7th, 2013
Time	9.00 am – 12.00 am & 2.00 pm - 5.00 pm
Facilitator	Dr. Sean Dessureault, Associate Professor - University of Arizona - USA
Language	English
Number of attendees	12 to 20 Persons

Objective of the short-course

This short course covers three key areas in emerging innovations driven by information technology. First, we cover mobile equipment monitoring technology, the types, selection, implementation, and most importantly, the effective use. The second key area is the use of processing plant information, and historians in particular, to derive improvement strategies and integration with other parts of the business. Finally, the use of social media and sustainability indicators are covered by reviewing the applications of data warehousing of sustainability and social media data leading toward a Stakeholder Intelligence Suite of tools and provides practical examples of this technology in the Americas. Throughout this short course, the common theme of integrated data and business process change are the next great leap in productivity and efficiency.



Who should attend?

CIOs, Mine Managers and Engineers, Plant Managers and Engineers, Corporate Social Responsibility personnel, Continuous Improvement coordinators. Please bring a connected devices such as a smartphone, tablet, or laptop.

Short courses content

Part 1: Selection, Implementation, and Effective Use of Mobile Equipment Monitoring Technology as a Lead toward Automation

Careful selection, implementation and then application of business intelligence (database know-how) is the only means of maximizing value from investments in mobile equipment monitoring technology such as Terrain (i.e. CAES, Aquila), Pegasus, or Jigsaw MineOps. This short course provides guidance on the selection, purchasing and implementation of modern data-generating technology used in mobile fleet operator assist and/or fleet management. Specific technology and implementation topics include:

- Mobile equipment monitoring technology, and suggested categories to be assessed when selecting a vendor's product
- Implementation pitfalls and best practice
- Purchasing and support contract provisions
- Hardware: on-board computers, touch screens, wireless data communications (telemetry), positioning (GPS), and how to avoid or mitigate problems.
- Software: office, on-board, operating systems, back-end databases
- Corporate, regional, local, and vendor minimum support & training requirements.
- Case studies in selection, evaluation of bids, purchase, and implementation:
 - Case study 1: fleet management systems
 - Case study 2: High-precision GPS drill monitoring system

After this section, attendees will be able to:

- Consider and then weigh all issues for comparing a particular vendor's equipment monitoring technologies, and understand the categories for evaluating them.
- Ensure baseline requirements are present in a purchasing contract

Part 2: Plant Historians and the Integration of Process Data with Mine Data.

A clear overview of the types of data found at mines, both relational data sources, as well as plant historian and SCADA systems. Innovations in information technology and business intelligence will be reviewed as a lead-in toward mine-to-mill-to-market integration at a highly granular level. We will also review how business and operational intelligence is used as a means of providing return on investment for information technology, improving performance, and changing to a more accountability and analytics-focused culture. Specific technology and implementation topics include:

- Difference between a relational database management system (RDBMS) and a Data Historian
- Case study 3: Historian selection (OPC HDA)
- Data Warehousing and Business Intelligence Systems theory and practice

After this section, attendees will be able to:

- Understand the difference between data historians, relational databases, and OLAP cubes.
- Create a mine-to-market strategy focused on efficiencies in productivity and profit

Part 3: The use of Social Media and Sustainable Development Data at reducing Social Risk in Mine Development and Operation.

Social Media is fast becoming a key technology for both marketing products as well as and political activism. This is both an opportunity as well as a risk for mineral development. Most urban citizens are disconnected from the mineral production process and hence rarely value mines or their benefits in terms of jobs or needed raw materials. As a consequence,



significant activism, often originating from non-local sources, block or attempt to limit mineral development. Furthermore, clear misinformation can be spread quickly through social media, and can metastasize into an uncontrollable negative message that will be challenging to disprove. By using the power of modern data mining and social media, mineral development firms can better understand and address stakeholder concerns. This short course component introduces the applications of data warehousing of sustainability and social media data leading toward a Stakeholder Intelligence Suite of tools and provides practical examples of this technology in the Americas. Specific technology topics include:

- A review of the underlying technology and approaches to monitoring and data mining of social media and sustainability data.
- Practical application (case studies) of a Sustainability Intelligence Suite
- Practical application (case study) of a Stakeholder Listening and Analysis toolkit

After this course, attendees will be able to:

- Understand the technologies marketing companies use to track social media data.
- Recognize and begin planning for the impact of social media on the future of mineral development in its ultimate implications on Sustainable Development.

Registration information

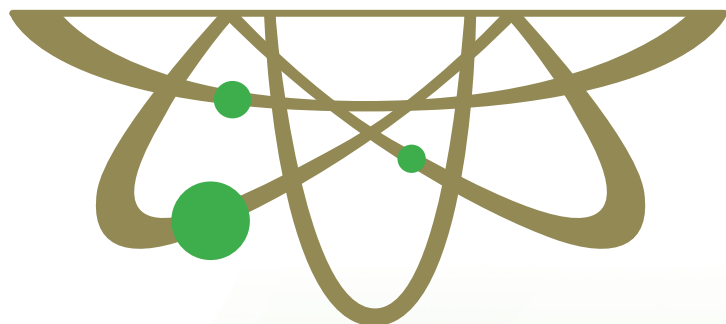
Access to courses is conducted by a preliminary registration on SYMPHOS Website or through the Technical Secretariat. The places are limited.

Registration fee is: **250 Euros per course including all taxes.** This price covers the courses and the course materials as well as lunch and coffee break.





CONFERENCES





INNOVATE: YES YOU CAN

Conf 1

Jamal Chaouki

École Polytechnique de Montréal, Canada

This article introduces the basic principles of creativity: how to create conditions to promote creativity and the emergence of ideas leading to discoveries and innovation: 1) how to think outside the box and become flexible, 2) major steps to innovation: what are the scientific stages of invention, 3) what are the obstacles to innovation, and 4) how to innovate? Two methods, creative breathing & TRIZ, will be discussed.



IMPLEMENTATION OF INNOVATION MANAGEMENT - LESSONS LEARNED

Conf 2

Huub Rutten

Sopheon, Netherlands

Sopheon has implemented Innovation Management processes, practices and software in over 200 large organizations in various industrial sectors. Most of these are company-wide, global implementations. These are always multifunctional and touch on the nerves system of the organization. Many implementations are successful, but some were not.

The lecture will first of all define what Innovation Management means and position it within the framework of the overall company management, because many functions and processes come together in Innovation Management, for instance product design and research, supply & logistics, manufacturing finance and of course also IT. Secondly the lecture will present some typical Case Stories of good and bad implementations and the efforts and hurdles companies have to overcome. As a conclusion the lecture will do a small exercise that can help the audience to identify the state of Innovation Management of their own organization.



HOW TO GET PUBLISHED IN A RESEARCH JOURNAL AND AUTHOR'S RESPONSIBILITIES AND RIGHTS

Conf 3

Dean Eastbury
Elsevier, UK

OBJECTIVE OF THE CONFERENCE

This course aims to provide: (1) a guide to the best practice for preparing manuscripts prior to submitting to an academic scientific research journal, and (2) a guide to publishing ethics and author's rights.

CONFERENCE CONTENT

Two power point presentations. The slides will be made available to the audience afterwards.

1. HOW TO GET PUBLISHED IN A RESEARCH JOURNAL

Why Publish with Elsevier

How to Publish with Elsevier

- what steps do I need to take before I write my paper?
- how can I ensure I am using proper manuscript language

2. AUTHOR'S RESPONSIBILITIES AND RIGHTS

What are my responsibilities as an author?

Now I've written this paper, who technically owns it?

What can I do with my paper once it has been published?



THE AUDACITY TO INNOVATION

Conf 4

LOTFI EL-GHANDOURI
Creative Society Group, Madrid, Spain

Innovation is quite a buzzword nowadays. It is easy to spell, but it is hard to live on a day to day basis. Audacity is the seed of the process and being collectively audacious is quite a challenge. This conference will introduce the innovation ecosystem key components to sustain it. It will focus on psychological paradigms that we need to foster within our teams and our organizations. How can we have the audacity to reach our next level? How can we generate an audacious ecosystem that can sustain the innovation process?



LA CONFIANCE : UN FONDEMENT DE L'INNOVATION TRUST: A FOUNDATION OF INNOVATION

Conf 5

Youssef Gaboune

Ethical Leaders™ & How Humans Work™

Peut-on vraiment innover quand le niveau de confiance dans les équipes et les organisations est au plus bas ?

Qu'est ce qui détruit la confiance entre collaborateurs?

Comment créer des climats de confiance dans les équipes et dans les organisations ?

La leadership par la confiance est une constituante fondamentale du processus d'innovation à l'échelle d'équipes et d'organisations.

La conférence sera une occasion de se pencher sur les facteurs les plus importants qui construisent et détruisent la confiance dans les équipes et organisations, tels qu'identifiés dans les plus récentes études internationales en la matière.

Il est temps de donner à la confiance sa valeur dans les organisations, de la mesurer et de la nourrir de manière durable si on veut développer un véritable leadership de l'innovation.

Could we really innovate when the level of trust among teams and organizations is at rock bottom?

What destroys trust among employees?

How could we establish climates of trust among teams and organizations?

Leadership through trust is a fundamental component of the innovation process at both the team and the organization levels.

The conference will provide an opportunity to tackle the most important factors that build and destroy trust in teams and organizations, based on the most recent international studies in the field.

It is time to give trust its value in the organizations, measure it and feed it in a sustainable way if we want to develop a true leadership of innovation.



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