Arab Fertilizer

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Arab Int'l. Organization هيئة عربية دولية
Arab Fertilizer Association
Since 1975

Editorial

MR.Saad Abu El Maaty
AFA Chairman
Chairman & CEO
Abu Qir Fertilizers & Chemical Ind. Co.

Heading from the increasing strategic role played by fertilizer industry in providing world food and facing ongoing population growth, the 13th of October was determined to celebrate Global Fertilizer Day. This day targets raising people awareness across the world of the vital role of such a significant industry in improving people lives and entrenching the integrated management of plant nutrients (4R Nutrient Stewardship).

Notably, fertilizer has a pivotal role in food security achievement, when used in a balanced and effective way.

This goal is achievable by using the 4R approach in fertilizers (Right Product/ Right Place/ Right Time/ Right Rate).

Since old ages, the human being has been keen on improving and increasing agricultural crops production, by adding numerous mineral or organic materials.

From half a century, farmers across the world have used 17 million tons of chemical fertilizers in their lands. Nowadays, they are using 8 folds of such amount.

By 2030, the world population rate is expected to reach eight billions; two of every three people of city residents will be among the number of people suffering from hunger. Therefore, a consensus was reached among scientists and researchers on methods of agricultural development in response to the pressing demographic and economic directions in the world at large. Also, the increase in individual income levels will lead to creating high and unbalanced demand on food, which inevitably will require achieving within three decades rise in food production with an amount exceeding 60% more than the current rate.

Chemical fertilizers diversify and differ in production and consumption volume as per its type. However, the production and consumption of nitrogenous fertilizers highly exceed the production and consumption of the remaining types of fertilizers; amounting to 60% of the total chemical fertilizers production. This significance usage of such fertilizer type is attributed to being used in producing the main crops across the world, namely wheat, corn, cotton and sugar cane.

These chemical fertilizers are considered among the key production requirement in Egypt, which can affect, as per type, time of usage and adequate price, food productivity as well as agricultural production costs and return.

Fertilizer industry, in general, has a strategic significance, as the horizontal and vertical expansions in agricultural production field to cover the food and industrial needs of the increasing population provide an increasing and ongoing demand. Reports of Food and Agriculture Organization (FAO) have demonstrated that the ideal application of fertilizer has contributed in raising cereal crops production by 55%.

Bearing in mind the limited arable lands locally and internationally, the role of fertilizers will maximize in future emphasized by world population increase in general.

I would like to express my appreciation for the confidence and support provided to my election as AFA Board Chairman for the coming session. All thanks go to previous AFA chairmen, Board members and Secretariat team, for being highly efficient and professional. Wishing all success in promoting Arab fertilizer industry to reach remarkable international levels. I am fully confident of your effective support to achieve AFA desired goals.

Issue Report

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Arab Fertilizer

- AFA is a non-profitable, Arab International Organization established in 1975. AFA is operating under the umbrella of Council of Arab Economic Unity.
- AFA comprises Arab institutions and companies working in the fields of fertilizers manufacturing, trading in addition to other related fields.
- AFA aims, generally, at coordinating and developing technical relations between member companies, together with all issues related to fertilizer industry. AFA represents a framework through which Arab companies work and get to know the latest technological developments in fertilizer industry. It further provides Arab companies' representatives with the opportunity to strengthen relationships with international institutions, organizations and companies working in the field of fertilizer industry, trade and usage.

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Press Release

Studies & Research

Tunisian Companies Host

29th AFA International Fertilizer Technology Conference

"Arab Fertilizers Technical Excellence"

Tunisia: 11-13/10/2016

AFA organized in cooperation with AFA Tunisian member companies the 29th AFA International Fertilizer Technology Conference & Exhibition, in Tunisia, from 11-13 October 2016, in Regency Tunis Hotel. The Conference was honored by the attendance of Her Excellency Hela Sheikhrouhou, Minister of Energy, Mines & Renewable Energies. It was further held under the auspices of the following Tunisian companies:
- Compagnie des Phosphates de Gafsa
- Groupe Chimique Tunisien
- TIFERT Company

The three-day five-session Conference discussed 19 working papers that were selected taking in consideration the coverage of nitrogenous, phosphate and potash fertilizers industries. The papers tackled the following themes:

- **Operation, innovation, technology, research and development**
- **Equipment and maintenance**
- **Saving energy**
- **Health, safety and environment**

More than three hundred participants joined the Conference from different countries. It is a source of interest for Arab and international companies specialized in fertilizer industry. Notably, key international companies working in the fields of technology, equipment and chemical production were keen on attending such an international event. To illustrate, it is an opportunity to meet with fertilizer industry specialists and recognize latest developments highlighted in the regional working papers, presenting companies' expertise in environment protection, preventive maintenance and production methods development.

The Conference was accompanied by an industrial exhibition, in which 12 Arab and international companies participated from: Tunisia, KSA, Italy, UK, Belgium, Denmark, France, India, Netherlands, China and Russia. These companies presented the state-of-the-art in-

Her Excellency Hela Cheikhrouhou

ternational technologies in all fertilizer industry sectors as well as technical services and engineering equipment provided in such a field.

On the margins of the Conference, the one hundred and six AFA Board meeting was held. Also, other meetings were convened for specialized committees, namely the Economic Committee and Technical Committee as well as the meetings of the working groups concerned with communication, public affairs, training and rehabilitation.

The Conference was inaugurated **Her Excellency Hela Cheikhrouhou,** Tunisian Minister of Energy, Mines & Renewable Energies, with a speech, in which Her Excellency welcomed the Conference participants in Tunisia and commended the distinguished attendance, reflecting the significance of fertilizer industry with regard to countries' economies, agricultural production and increase in yields.

Mr. Romdhane Souid

The Tunisian Minister called upon fertilizer manufacturers to concert efforts in order to address the challenges facing such vital industry, carry out related developments and take in consideration the latest technologies in fertilizer industry to enhance world food security.

Mr. Romdhane Souid, Chairman & General Manager of Gafsa Phosphates Company, Tunisian Chemical Group and Tunisian Indian Fertilizers Company, followed Her Excellency and delivered the below speech:

In my name and on behalf of Gafsa Phosphates Company, Tunisian Chemical Group, Tunisian Indian Fertilizers Company and Arab and foreign companies participating in this Conference I would like to welcome and thank Her Excellency Hela Cheikhrouhou, Minister of Energy Mines and Mr. Hashem

Dr. Abdul Rahman Jawahery

Al Hamidy, Secretary of State for Mines, for inaugurating the proceedings of the 29th AFA International Fertilizer Technology Conference. With no doubt, Her Excellency Hela Cheikhrouhou, Minister of Energy Mines and Mr. Hashem Al Hamidy, Secretary of State for Mines, participation in the Conference opening ceremony affirms the priority given by the State of Tunisia to such a pivotal sector and the development process.

Mr. Hedhili Kefi

I further would like to welcome all the attendants, participants and speakers, in this Conference and to thank AFA for choosing Tunisia as a venue for the Conference.

At the outset, I would like to pinpoint the importance of this event and the resulting practical recommendations of benefit to phosphate and fertilizer sectors in our Arab countries economies. Paying due attention to phosphate fertilizers industry increases daily by most of the world countries concerned with agricultural security. This makes the demand on chemical fertilizers also receives special attention in world markets. Thus, we gather today to discuss phosphate and fertilizers present and future prospects in AFA member countries internally and externally, believing in the leading role of such a sector in the industrial field and its contribution in the national economies of all Arab countries, affecting the balance of trade and economic indicators. It is noteworthy that this sector contributes in GDP (raw materials) by 3% and in hard currency return by 10%. It further provides directly 26.500 job opportunities and salaries amounting to 500 million TND. We are currently passing by some obstacles on the production level, strenuously working to restore our status and occupy high ranks in both production and marketing.

I would like to seize this opportunity to thank all the organizers of the Conference especially AFA for preparing and convening such an event, tackling different scientific and technological themes and highlighting energy saving as well as health, safety and environment issues. Looking forward for the event to fulfill its aspired goals of developing our productive sectors and become a driver to enhance investment and development fields in fertilizer industry sector locally and internationally.

Dr. Abdul Rahman Jawahery, AFA Board chairman and President of Gulf Petrochemical Industries, delivered a speech in the Conference opening ceremony, in which he welcomed Her Excellency Hala Sheikh Roho, Tunisian Minister of Energy and Mines.

He further extended his appreciation to the Tunisian companies for sponsoring the Conference and for their outstanding hospitality. AFA Secretariat was also commended for the well organization of the Conference and the distinguished attendants were warmly welcomed.

Dr. Jawahery has referred, in his speech, to the remarkable status occupied by Arab fertilizer industry internationally. To illustrate, Arab production exports of fertilizers to international markets amounted to 64% phosphate rocks, 58% phosphoric acid, 42% tri-super phosphate, 19% Ammonia and 34% urea. All and above, other products are exported with varying and essential amounts despite all the challenges encountering such a vital industry.

Mr. Hedhili Kefi, Representative of Tunisian fertilizer industry in AFA Board, also started his speech by welcoming Her Excellency Minister of Energy and Mines and thanking the efficient engineers, researchers and experts as well as the sponsoring companies: Gafsa Phosphates Company, Tunisian Chemical Group and Tunisian Indian Fertilizers Company.

He mentioned that the Conference tackles engineering researches and studies related to designing different types of fertilizer manufacturing laboratories, taking in consideration the active human factor and reducing the environmental footprint of this activity. He added that preparing for such an event started from nearly one year, as a committee was formed to organize the proceedings of such an event, follow up the scientific affairs, interventions and revising materials prior to presentation.

Mr. Kefi affirmed the Conference points of strength, which were revealed in the well choice of the tackled pillars, namely energy saving being of significance in the framework of technical engineering processes. This is particularly reflected in the preliminary design phases and subsequent decisions based on the energy saving condition, as the industry sector receives great attention in this regard for consuming nearly one third of world energy final consumption. It is worth noting that programs were allocated to improve the efficiency of energy usage in order to reach sustainable development. Believing in such a priority, which requires managing the efficiency of resources and natural wealth besides using environmentally clean systems, economic and socially acceptable within the framework of development, energy and environment policy integration, the significance of saving energy consumption in the industrial sector were considered. To illustrate, scientific experiments have proved the increase in opportunities and potentials to increase the efficiency of using energy in such sector. Moreover, the effective usage of energy systems revealed high economic feasibility and strategic excellence to establish and improve the infrastructure without the need to increase energy consumption. The studies carried out, in countries following strict policies concerning effective usage of energy, have shown that despite of being highly costing procedures at the outset, they proved to be economically feasible as for the applying industries.

Some studies pinpointed that in industrial fields, when generating energy from fuel, the wasted thermal energy could be made use of in heating or industrial activity. The currently traditional usage of energy in most factories consumes only thirty per cent effectively. Using energy and heat merging techniques in the production process amounts to ninety per cent of effective usage of energy.

With regard to the obstacles that may encounter energy efficiency efforts in the industrial sector, they are generally shown below as follows:

- Lack of specified goals to improve energy level and efficiency in factories, leading to high consumption;

H.E. Mr. Mohammed Abdallah Zain

- Low fuel and electricity prices resulting in paying no attention to energy efficiency when buying industrial equipment;
- Use of old techniques in factories;
- Rare internal policies for factories energy efficiency.

The world has been witnessing, for decades, adverse environmental impacts resulting from different human activities, thus human living conditions deteriorated and the environment issue became of great importance. Many local and international conferences and forums were convened to address the environment issue and scholars, scientists and even people from the public paid due concern to the environment.

Environment is the place where we live. It is surrounding us, namely land, water and air. Any human activities violating the ecosystem result in disasters. Nowadays, world industrial development in various fields led to wastes adversely affecting our surrounding environment.

In the shed of such increase in environmental volatilities, organizations and institutions were established to raise manufacturers' awareness of protecting the environment and taking required measures, especially in the design and construction phases, to preserve the environment.

Therefore, the sound methods for environment preservation, obstacles faced by factories in this regard, necessary procedures to deal with factories wastes and other numerous relative issues will be addressed by experts and researchers through their interventions during the Conference; tackling environment as the Conference second pillar.

With this in mind, the technological development currently taking place and the accompanied industries development have caused many risks that should be taken into account, reviewed and addressed by human being in an attempt to avoid reasons behind such risks.

Factories and other vocational institutions are unnatural environments for workers, as they include toxic materials, machineries, gases, liquids and solids some of which are highly risky. Vocational safety is the responsibility of everyone in the production or work site. So, vocational safety is another issue redressed by the Conference. Generally, vocational safety are systems that should be respected by workers in order to avoid various work risks. In order to achieve vocational safety goals, some components should be considered, important of which:

- Sound technical design conforming to the establishments principles of protection;
- Implementation process based on sound scientific principles of construction.

Another issue of importance was maintenance, a process passed by different phases of development. From the industrial revolution and till recent time, the common maintenance methodology was a reaction-based one, namely after a machine breaks down it is being fixed. Thus, if the machines are properly working, no intervention is made.

The capital costs of industrial projects components most of the time amount to millions of dollars. Hence, it is logical to maintain such high cost components by setting effective program for planned maintenance taking in consideration all factory elements without exception. However, the impediment mainly faced is that the institutions management overlooks the maintenance role, whether preventive, remedial, planned, rescuing or urgent in order to reduce expenses to achieve more profits.

H.E. Mr. Mohammed Abdallah Zain, who started by welcoming Her Excellency Hela Cheikhrouhou, Minister of Energy, Mines & Renewable En-

ergies, and extending warm greetings to AFA Tunisian member companies for sponsoring the Conference and supporting AFA proceedings. He then commended the distinguished attendants reflecting the significance of Arab fertilizer industry.

At the outset I would like to welcome all the attendants in the cherished land of Tunisia, home of an ancient civilization as well as generous, authentic and courteous people.

With pleasure, I extend my thanks to the supporting teams from Gafsa Phosphates Company, Tunisian Chemical Group and Tunisian Indian Fertilizers Company in addition to Mr. Hedhili Kefi, for the ongoing promotion of AFA activities and proceedings as well as for hosting and organizing such a Conference.

Our meeting today reflects a collective dedication to continue the development of such a strategic industry. An industry that provides for the best utilization of resources, being indispensable for a sustainable agricultural sector. Therefore, this is an endeavor that highlight fertilizer industry stakeholders' keenness upon facing the related challenges, with all its positive and negative implications on food security status and energy provision condition, so as to achieve aspired to sustainable development.

We are fully aware of the myriad challenges faced by our member companies, at the top of which the decrease in fertilizers prices internationally, the matter that requires applying significant technical and economic procedures in order to surmount such an adversity. To note, this can also be achieved by increasing profitability through the reduction of production costs, based on the following aspects:

First: Increase in Production Capacity

Companies are encouraged to communicate with one another in order to exchange expertise and information with regard to factories qualification, technological development and production capacity expansion. This can also be fulfilled by raising staff awareness via effective participation in workshops, convened in cooperation with experts from member companies and international think tanks.

Second: Energy Saving

AFA realizes that fertilizer production is an energy-intensive field, as fertilizer production consumes 1.2% of total international energy percentage. Therefore, energy saving is considered one of the significant factors of improving fertilizer factories economies. By doing so, production cost and accordingly product price can decrease, which lead to an increase in profitability, thus enhance factories sustainability.

Third: Sound Operation

Soundness of operation should be taken in consideration to ensure ongoing processes and stable operation indicators. This can be achieved by urging our member companies to improve the work environment, raise staff awareness of using personal protection equipment and apply an effective system for Process Safety Management (PSM); minimizing wasted working hours. It is worth commending in this regard the developed capacities of Arab fertilizer industry leaders, who were capable of surpassing the encountered challenges and thus putting Arab fertilizer industry in an eminent status, hence leading international market in nitrogenous, phosphate and potash fertilizers.

Fourth: Rationalizing Raw Materials

The rationalization of raw materials, production inputs and improving the qualitative consumption of such materials are also considered of the key factors.

Now, allow me to present an overview of AFA most remarkable activities and achievements that were accomplished this year:

First: Training programs and specialized workshops:

"Process and Maintenance Optimization" Workshop, 11-14 April 2016, Aqaba, Hashemite Kingdom of Jordan.

The highly experienced companies ThysseenKrupp Industrial

Solutions (UHDE) and PRAYON have professionally implemented such workshop program. This Workshop was characterized by the high attendance rate, which exceeded one hundred twenty participants from AFA member companies.

"Process Safety Management" Workshop, 24-26 May 2016, Kuwait

The three-day Workshop program was carried out pinpointing the basics and principles of process safety management. The Workshop program was prepared in cooperation with Petrochemicals Industry Company (PIC), SABIC and DUPONT.

"Energy Saving in Fertilizer Industry" Workshop, 29-31 August 2016, Marrakesh, Kingdom of Morocco

The Workshop program comprised of distinctive sessions delivered by seven international companies:

- The French DUPONT
- The Belgian PRAYON
- The American JACOB
- The German Thyssenkrupp
- The Dutch Stamicarbon
- The Russian R&D Institute of Urea
- The British Alexander Proudfoot

Second: Working groups:

□ Technical Committee Working Groups

1. Health, Safety and Environment (HSE) Group

The group activities, this year, included

- Issuing the manual of "HSE Best Practices in AFA Member Companies";
- Issuing the manual of "Comprehensive Matrix for Regular Maintenance Management Based on HSE Aspects";

- Issuing Annual HSE Performance Report of Member Companies;
- Organizing a one-day workshop in Egypt to introduce Egyptian companies' management to corporate responsibility topics.

2.Energy Saving Working Group

The group implemented the following programs during 2016:

- Self-auditing program for energy saving management;
- Issuing Energy Culture Booklet in English and Arabic;
- Preparing databases of energy saving projects in member companies;
- Issuing group achievements booklet.

3. Maintenance and Operations Working Group

4. Qualification and Training Working Group

- This group started working during the second half of this year.

□ **Communication and Public Affairs Working Group:**

- Issuing Manual of Company Identity Guidelines;
- Preparing a media and journalism database in Arab countries;
- Organizing a training program on social communication skills;
- Issuing group achievements booklet.

□ **Agricultural Working Group**

The group most significant achievements during this year are as follows:

- Issuing a manual on the Four Rights (4Rs) (Right Source, Right Rate, Right Time, Right Place);
- Convening workshop on fertilizer awareness and soil analysis as well as participating in Morocco agricultural caravans;
- Preparing database for agricultural research center in the Arab region.

With this in mind, AFA has in cooperation with member companies succeeded in transferring Morocco leading and successful caravan experience to other countries in the Arab region. Notably, AFA has successfully applied the first agricultural caravan in Egypt during April of this year.

In addition, based on efforts exerted by SABIC and approval provided by Saudi Ministry of Environment, Water and Agriculture, AFA is contributing in four agricultural caravans of dates and palms, namely Riyadh Caravan then Ihsaa, Qa-

sim and Madina Caravans.

Furthermore, there is another caravan that will be launched in Oman. It is noteworthy that Oman India Fertilizer Company (OMIFCO) has been striving to receive an approval from His Excellency Oman Minister of Agriculture and Fisheries in order to launch the caravan. Accordingly, the caravan place, time and type of crop were identified and the caravan implementation team was formed.

We are also in the process of preparing other caravans, perhaps in Tunisia for example that will be followed by other Arab countries.

In conclusion, I would like to express deep gratitude to Her Excellency Minister of Energy, Mines & Renewable Energies Hela Cheikhrouhou for her honorable attendance to and hosting of such a Conference. I would also like to extend all appreciation to Gafsa Phosphates Company and Tunisian Chemical Group, and particularly to Mr. Ramadan Saweed, Mr. Hedhili Kefi, Mr. Hady Fakhakh and the assisting team for their distinctive support, organization and hospitality, all of which will effectively contribute to the success of such a significant international technical event.

All thanks also to AFA Board Chairman Dr. Abdul-Rahman Jawahery, distinguished AFA Board members and to all the attendants for their enhancement to the common technical Arab work.

Wishing all success to our gathering, industry and Arab region at large and to fulfill our specified noble goals.

Program

Session I

- *Innovative Process Equipment and Technologies for Phosphate Beneficiation*

Scott Turner, Manager Ore Testing and Beneficiation Jacobs Engineering- ***USA***

- *How to Advance your Urea Production: practical case studies*

Eelco Mostert, Sales & Service Manager, Stamicarbon - ***The Netherlands***

- *DH Phosphoric Acid Plant Conversion to HH – Focus on High CO2 Phosphate*

Malik Aqel, Phosphate Process Technology Expert thyssenkrupp Industrial Solutions - ***Germany***

- *Topsoe Furnace Manager System Benefits for Ammonia Producers*

Hakon Juel Hansen, Manager, Business Integration,
Haldor Topsoe A/S - ***Denmark***

Session II

- *MicroMist Venturi Scrubbing; the Best Available Technique for Emission prevention in Urea Production*

Wilfried Dirkx, Licensing Manager, Stamicarbon - ***The Netherlands***

- *Extension of Urea Reactor Remaining Life Time*

Panshin Artem, Senio Engineer of Group of Corrosion Inspection & Welding
NIIK (R&D Institute of Urea) - ***Russia***

- *Troubleshooting Urea Load Limitation –How Misleading the Process Indications Could Be*

A. Munem Alnajjar, Urea Plant Superintendent, GPIC - ***Bahrain***

- *GCT – SIAPE Process in TSP Production*

Hedi Saidi, GCT - ***Tunis***

Session III

- *Stewardship for Improving Potash Quality Strategic Implementation:*

"Conversion from Dynamic to Static Fluidized Bed Cooler"

Ala'a AlOmari , Process Specialist, APC - ***Jordan***

- *Greening bulk handling and Trasportation: Bedeschi Experience in the Fertilizer Sector*

Pietro de Michieli, Chief Operating Officer Bedeschi Spa - ***Italy***

- *Treatment of Malodorous Gases in Phosphoric Acid Plant*

Houcine El Mirri, GCT - ***Tunis***

- *Syngas Compressor Performance Improvement by Makeup Gas Suction Chiller Installation*

Nayif A. Al-Fard , Manager Ammonia Plant Al-Bayroni- ***Saudi Arabia***

Session IV

- *New Generation Low Temperature Shift Catalyst from Clariant*

Prasanth Kumar, Technical Director (Middle East & Africa),Business Unit - Catalysts Clariant - ***Bahrain***

- *UFC Manufacture for Urea Production*

Malika Oukhedou, Key Account Manager
Johnson Matthey- ***Sweden***

- *Breaking Frontiers in Ammonia Plant Operation*

Johan Jönsson, Product Manager
Haldor Topsoe A/S- ***Denmark***

- *Utilization of Excess CO2 from Sabic Affiliates*

Metib Al Solami, Operation manager- SAFCO - ***Saudi Arabia***

Paper in Brief

Innovative Process Equipment and Technologies for Phosphate Beneficiation

Scott Turner
Manager Ore Testing & Benefication
Jacobs Engineering, USA

With the fluctuation in phosphate fertilizer prices, rock producers continue to seek new and innovative technologies to improve efficiency and reduce the unit costs of phosphate beneficiation. In recent years, Jacobs has proposed the use of a variety of advanced technologies to clients in the phosphate industry to address these concerns. This paper provides an overview of four technologies that exhibit great potential to improve the phosphate beneficiation process in the areas of comminution, sizing, flotation, and water recovery. Ultimately, laboratory and pilot plant test work is required to validate the suitability of each technology for specific ore bodies.

How to advance your urea production: practical case studies

Stefan Schaafsma
(Head of Sales & Services),
Eelco Mostert
(Sales & Service Manager)
Stamicarbon, The Netherlands

The Stamicarbon services portfolio has been developed over time and gradually more services and products have been added, based on specific urea plant challenges and needs discovered during years of plant operation. This enables urea producers worldwide to advance their urea production and optimize their plant performance. In this paper, Stamicarbon will share practical real-life cases and the solutions; which resulted in optimized production capacity and increased product quality, lowered emissions and energy levels, enhanced mechanical integrity of the HP equipment and increased safety and knowledge level of the plant staff.

DH Phosphoric Acid Plant Conversion to HH – Focus on High CO2 Phosphate

Malik Aqel
Phosphate Process Technology Expert
thyssenkrupp Industrial Solutions, Germany

High CO2 Phosphate Rock represent a capacity constrain in Phosphoric Acid Plants due to excessive CO2 gas release and foaming, which requires high Reaction volume.

tkIS present its solution to the industry that will turn this problem into an opportunity for existing DH plants to significantly expand their capacities by conversion into HH

Topsoe Furnace Manager system benefits for ammonia producers

Hakon Juel Hansen
Haldor Topsoe A/S, Denmark

Primary steam-methane-reformer (SMR) firebox catalyst tubes represent very costly heat transfer surface area in the ammonia plant. These catalyst tubes continuously degrade due to time-and-temperature effects the moment they are commissioned. While time-in-service is straightforward to measure, temperature is not. Typical, historical tube temperature measurements have been acquired by personnel opening firebox peep doors, physically looking into the furnace, and spot checking temperatures using a variety of methods, including imagery, direct contact, IR, and calibrated eyeball, among others.

The Topsoe Furnace Manager (TFM) leapfrogs these antiquated methods of monitoring a furnace firebox by providing remotely accessible, on-line, data and image acquisition of

the furnace tubes and burners 24/7 without direct personnel interaction with the firebox. The system comes with an easy-to-use historian with data trending and storage of tube images. The stored data and images provide benchmarks for training use, and equipment history for turn-around reference.

The presentation will illustrate how the TFM ensures optimal performance of the furnace and improves both personnel and process safety while also improving furnace efficiency and increasing on-stream performance by providing real-time data operators can use to balance the firing. The TFM is a permanent, fixed installation of an array of image collectors continuously capturing temperatures and images of the tubes and burners. Operations can set alarms for a bank of tubes, burners or specific hot spots. On-line data transmission will allow the operator to balance the firing profile and respond to an alarm without opening a single peephole. This provides a major improvement in both the unit performance and personnel safety. Remote access to the data and images means that experts can also participate in troubleshooting and furnace optimization, engaging the entire furnace support organization.

When personnel are free from direct interaction with furnace fireboxes by looking in peep doors, they provide a higher value by optimizing furnace operations. The TFM employs a laptop computer in the field to enable plant personnel to make burner adjustments without looking in the firebox. This makes large furnace operations safe and manageable.

The TFM is commercially proven on both side-fired and top-fired SMR furnaces in ammonia plants, and is currently in successful operation on three continents. The TFM is the next step in operational excellence, and furnace safety.

MicroMist Venturi Scrubbing; the best available technique for emission prevention in urea production

Wilfried Dirkx

(Licensing Manager),

Stamicarbon, The Netherlands

Worldwide, sub-micron particulate emission regulations are becoming increasingly strict. Stamicarbon and EnviroCare have co-developed a high efficiency off-gas scrubbing technology and integrated this with Stamicarbon's second-generation fluidized bed urea granulation technology. By quenching and accelerating the granulation off-gas through MicroMist Venturi (MMV) tubes, particulate emissions as low as 10 mg/Nm3 can be achieved. An additional polishing wet electrostatic precipitator (WESP) can further reduce particulate emissions to as low as 5 mg/Nm3. This paper discloses the fascinating story of the conceptual development, pilot testing, detailed design and fabrication of the Stamicarbon-EnviroCare MMV scrubbers for two new grass-roots urea granulation plants in the USA.

Extension of Urea reactor remaining life time

Panshin Artem

Head of Group of Corrosion Inspection & Welding

NIIK (R&D Institute of Urea), Russia

Urea reactor by Tecnimont based on the full liquid recycle process is in service since 1981. The reactor's inside diameter is 1658 mm, the height is 36 m.

In 2011 the Urea plant faced the problem with a fluid leak through the lining of Urea reactor. Upon inspection of the reactor it was found out that the existing design was not in compliance with the available project documentation.

After some partial minor repairs of Urea reactor in 2012 the most hazardous areas of the lining

were excluded from the structural design.

In 2016 NIIK (R&D Institute of Urea) performed the works of Urea reactor relining for a total height of 15 m. The duration of all repair works did not exceed 17 working days (instead of initially planned 25 days) due to the unique repair technology by NIIK.

Troubleshooting Urea Load Limitation – How Misleading the Process Indications Could Be

A. Munem Alnajjar

Urea Plant Superintendent,

B. GPIC , Bahrain

This paper will illustrate how process parameters could lead to misleading ,GPIC Urea plant faced a major load limitation during 2011 - 2012 led to the curtailing of the Urea production by (200) TPD.

Process indications showed more carbamate recycling was taking place which put the doubts on:

1 - HP stripper getting overloaded and flooded resulting in carbamate carry-over with stripper off gases to carbamate separator.

2 - HP carbamate ejector operating at high pressure (~ 248 Barg), eventhough carbamate separator level remaining high

The issue was further complicated by the level increase in the carbamate separator and non-availability of the Urea stripper level indications.

The result of the root cause analysis and the troubleshooting that was based on the process indications pinned the urea production limitation to the HP carbamate ejector malfunctioning which was replaced in 2010 turnaround. However, during November 2012 turnaround when the inspections were carried out, an entirely different convict was found !!

This paper summarizes all the analysis done toward pining the root cause failure before identifying the real cause behind such load limitation. The paper also describes the actions taken to rectify such cause

GCT – SIAPE Process in TSP Production

Heidi Saidi

GCT, Tunis

In the TSP manufacturing process, many improvements have been implemented since 1953 for the GCT – SIAOE.

The second version of this process registered in 2004 is based specifically on the use of concentrated industrial phosphoric acid in the existing plant with GCT-SIAPE Dryer/Granulator.

This allows the increase of the production about 60% and a drying energy saving of almost 35%

Stewardship for Improving Potash Quality Strategic Implementation:

"Conversion from Dynamic to Static Fluidized Bed Cooler"

Alaa Alomari

Process Specialist,

APC - Jordan

Potash demand, like most commodities, is cyclical. However aggregate demand graphs indicate an upward trend. For instance, global demand in 2000 was 40 million tonnes. By 2005 demand increased to 50 million tonnes before plateauing at 60 million tonnes in recent years. Analysts project demand to further increase to 70 million tonnes by 2020. In retrospect, the recent macroeconomic conditions of the market have presented APC with several challenges. To mitigate these risks a strategic decision was implemented to further reduce APC running cost while improving potash product quality through our Fluidized Bed Cooler conversion initiative. This ensured that regardless of potash market prices and demand, we were able to maintain healthy margins offset the cyclical nature of the market.

The unique characteristics of potash can present challenges during processing. Potash is hygroscopic; it easily absorbs and

retains moisture from the environment. Consequently, potash is prone to clumping and sticking during processing. To overcome this obstacle potash cooling is prerequisite. Four types of coolers were available in the market; column, rotary, dynamic and static fluidized bed . These four coolers presented us with nine options for installation. The criteria for selection was Safety, operational reliability, steady control, easily interfaces with newly installed DCS, low maintenance & operating costs and life span. The most crucial criteria for selection were a proven track record for implementation at fertilizer plants.

The proceeding step involved conducting pilot tests on two different coolers that met our criteria selection process. After the results were analyzed we decided that a static fluidized bed was cooler best suited our needs. The design stage of the static fluidized bed cooler included selection of loop type (open or close), cooling media, material selection, de_dusting system selection, Minimized amount of mechanical conveying equipment, utilization of existing conveying equipment, utilization of the existing building stock as far as possible to reduce the reconstruction scope for structural engineering, reducing production downtimes during reconstruction.

The project is successfully installed and will be commissioned during May 2016, the paper will also highlight on commissioning and start-up stages.

Our expectations are: -

Operate the new cooler based on best practices to cool HLP dryer product from 220°C to 100°C.

Increased Overall Equipment Effectiveness (OEE) and thus less production losses.

Reduce dust content with end product and emissions of dust are also eliminated.

Preventing product abrasion and degradation through slow and controlled movement of the potash.

Higher overall heat transfer coefficient.

Greening bulk handling and transportation

Marco Bertorelle

Chief Operating Officer,

BEDESCHI, Italy

While in the past, the environmental safeguard was not an issue, nowadays ports worldwide consider the prevention of pollution a first objective, especially with import/export of dry bulk cargo as fertilizers. In this case, the risk of spillage and dust production is very critical. Problems can occur during the loading or discharge operation, but also if the material need to be stored in the port zone. To achieve a reduction of emissions the first step could be the use eco-friendly bulk handling equipment. Bedeschi, thanks to its research and development in green technology, is able to design and produce machines, which incorporate sophisticated dust control measures, able to reach the highest environmental standards.

During the conference, we will present some successful case studies in the fertilizer industry showing solution to reach the main objective: guarantee both efficiency and green environmental conditions in the ports.

Treatment of Malodorous Gases in Phosphoric Acid Plant

Houcine El Mitri

GCT, Tunis

Abstract

The attack of phosphates by sulphuric acid to produce phosphoric acid is accompanied by the release of hydrogen sulphide (H2S) and other sulphide organic materials (R-SH). These releases confer to gases resulting from the reaction a characteristic odor which constitutes an annoyance and an environmental problem.

The removal of H2S odors by adsorption on the activated carbon is a technique adopted in other scopes of application.

A test of phosphoric reactor off-gas treatment by the activated carbon was conducted in DAP plant of GCT in Gabes. The success obtained on the laboratory level and on a pilot unit led us to carry out an industrial test.

Paper in Brief

Syngas Compressor Performance Improvement by Make-up Gas Suction Chiller Installation

Nayif A. Al-Fard
Al-Bayroni, S. Arabia

- Al-Bayroni Company Profile
- Background
- Energy Optimization Project – Major Modifications
- Syngas Compressor without Suction Chiller Modification
- Syngas Compressor with Suction Chiller Modification
- Benefits Summary

New Generation Low Temperature Shift Catalyst from Clariant

P. Kumar
Technical Director
Clariant, Bahrain

Synthesis gas (or Syngas) is one of the most important building block in Chemical Industry. Ammonia and Methanol, are the essential chemicals derived in this process. Typically, Syngas production involves several different catalytic steps based on feedstock type, quality, poison type, process technology involved, etc.

Reforming is considered as the core process of any Syngas plant while Shift conversion is spread into two or more processes (such as High Temperature Shift catalyst or HTS and Low Temperature Shift catalyst or LTS) based on the operating temperature window and syngas purification efficiency. The copper / zinc based Low Temperature Shift catalyst is one of the most expensive catalyst used in a typical Ammonia and Hydrogen flow sheet, at the same time it has the highest impact on the economics in the plant. Furthermore in an Ammonia plant, a more active LTS catalyst decreases the inert concentration in the Ammonia Synthesis loop which reduces purge gas losses and increase energy efficiency of the ammonia production. The paper describes the advantages of Clariant's new generation Low Temperature Shift Conversion catalysts ShiftMax®217 in combination with the completely chromium free chloride guardShiftGuard®200. The protection power of ShiftGuard® 200 enables

the high performance catalyst ShiftMax®217 to show its highest initial activity with low MeOH byproduct formation and minimized deactivation over the lifetime. Furthermore, it makes sure that the LTS catalyst system can keep its excellent mechanical stability and avoids premature catalyst replacement due to catalyst poisoning. The paper demonstrates how this catalyst system, backed up by excellent Technical Services can contribute to the overall profitability of Ammonia and Hydrogen plants.

Clariant is a leading global developer and producer of catalysts for industrial processes since the acquisition of Süd-Chemie in 2011. With a total of 18 production sites, 14 sales offices, and 11 R&D and technical centers it is headquartered in Munich, Germany. Approximately 1750 employees serve customers around the world. Aimed at delivering sustainable value to customers, Clariant's catalysts and adsorbents are designed to increase production throughput, lower energy consumption, and reduce hazardous emissions from industrial processes. The broad portfolio also includes products that enable the use of alternative feedstock for chemical and fuel production. www.clariant.com/catalysts

The FORMOX™ integrated UFC process

Malika Oukhedou
Key Account Manager,
Johnson Matthey Plc, Sweden

Urea formaldehyde concentrate (UFC) is a common stabilization agent used in the production of urea. As the UFC requirement for most ammonia-urea operators is often too small to be made economically on-site, it is usually purchased, often at considerable expense as a raw material.

Johnson Matthey has used its extensive know-how in ammonia, methanol and UFC production to develop the FORMOX™ integrated UFC process. This allows an ammonia-urea operator to manufacture small quantities of UFC in a manner which gen-

erates significant on-going cost savings.

The paper

- describes the integrated UFC process
- discusses the risk assessment process used during the development of the process
- considers the reliability and operability of the process
- Uses case studies to demonstrate the cost savings that can be realised through the use of the process.

Innovative developments in high temperature shift catalysis

Johan Jönsson

Haldor Topsoe A/S, Denmark

Until now, all commercially viable high temperature shift catalysts have been based on iron and chromium and have not undergone any major changes in over 50 years. The main challenge with the conventional formulation is the minimum required plant steam-to-carbon ratio due to over-reduction of the iron content at levels below the minimum. Topsoe is removing this limitation with the introduction of its latest catalyst product, SK-501 FlexTM, which has an entirely different formulation based on zinc oxide and zinc aluminum spinel. Free of iron, SK-501 FlexTM allows more operational flexibility, making it possible to increase production capacity by 3–5% in a modern ammonia plant.

Overall fuel consumption can also be significantly decreased for more efficient production. When combined with state-of-the-art technologies in revamp and new designs, the catalyst is a major asset that opens up new potentials for optimizing plant performance and improving profitability. In addition, the complete absence of chromium in SK-501 FlexTM gives producers a further advantage of reducing health, safety, and environmental risks. As the first of its kind, the catalyst is a vanguard in the future of water gas shift catalysis, meeting growing pressure from legislative bodies and safety standards while continuing to push the boundaries of operational excellence.

Utilization of Excess CO2 from Sabic Affiliates

Metib Al Solamy

Operation Manager

SAFCO, S. Arabia

- SAFCO operates four Ammonia-Urea complexes using NG as raw material.
- Liquid Ammonia and CO2 are used as raw material to produce Urea
- All the ammonia plants of SAFCO had extra CO2, which was being vented.
- To improve Sustainability and to reduce GHG emission, SAFCO decided to build a standalone urea plant SAFCO-V (SF-V), utilizing the excess CO2.
- Other raw material, ammonia, is also supplied from the stored ammonia in SAFCO storage tanks
- SAFCO-V project was conceived as a part of SABIC-2025 sustainability strategy to reduce the greenhouse gas emissions (GHG).
- CO2 venting was identified from other affiliates e.g. UNITED.
- SAFCO explored to utilize this CO2 to contribute positively in SABIC sustainability KPIs.
- CO2 grid project was launched to construct grid from UNITED up to SAFCO.
- SABIC CO2 grid was integrated with the existing SAFCO CO2 grid.
- This capacity of grid was designed to take input from UNITED in the first phase and from other affiliates in future

Exhibition

The compagnie des Phosphates de Gafsa (CPG)

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Company profile :

- The compagnie des Phosphates de Gafsa (CPG) is an anonymous public entreprise with an industrial and marketing character,operating in the exploitation of phosphate deposits in Tunisia.
- compagnie des Phosphates de Gafsa was established in 1896.
- With over a century of experience in mining upgrading and marketing Tunisian phosphates,CPG is one of the leading phosphate producers worldwide with a current annual production capacity exceeding 8 million metric tons.
- In Gafsa mining Bassin, there are 6 production sectors for phosphate extraction and treatment located in Mdhilla, Metlaoui Kef Schfaier,Metlaoui Kef Eddour, Moulares, Redeyef and Maknasi

Washing plants	Open cast mines	shipping
Metlaoui (5 plants) Mdhilla (3 plants) Moulares (1 plan) Redeyef (1 plant) Kef eddour (1 plant) Maknasi (1 plant)	Kef schfaier Tables of Metlaoui Kef eddour central Kef eddour west Jallabia Mzinda Oum lakhcheb Moulares Redeyef Maknasi	Sfax port

FUTURE DEVELOPMENT: CPG is producing currently 8 million tones of phosphate and is looking to develop its production to reach 13 million tons in the next decade.

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Company profile:

Tunisia is a leading country, worldwide, as far as natural phosphate and mineral fertilizers are concerned. The activity of ore beneficiation and production of various mineral fertilizers is more than 70 years old.

GCT owns 4 industrial sites located in SFAX and MDHILLA (for TSP), GABES (for Phosphoric Acid, DAP, DCP and AN) and SKHIRA (for Phosphoric Acid).

GCT has developed within its field of activity, its proper processes and made a considerable contribution within its boundaries in Tunisia and worldwide.

The phosphate field holds an important position within the Tunisian economy both in labour level and in trade balance worldwide. Natural phosphate and its by-products (Phosacid, DAP, TSP, DCP...) are exported to 50 countries in 5 continents.

PARTNNERSHIP & ALLIANCES

GCT is approaching traditional customers with potential capacity of marketing phosphoric fertilizers to launch new projects.

GCT established long term partnerships with CHINA, INDIA and looking foreward for new alliances with other partners.

GCT successfully implemented SACF JV in CHINA with CNCCC (1998), and TIFERT (2013) in TUNISIA with CIL and GGSFC from INDIA.

GCT is investing in a new TSP project in TUNISIA with a capacity of 500 000 MT/Year expected to be in operation in 2017.

FUTURE DEVELOPMENT

GCT is processing currently 6.5 million tons of phosphate rock and is looking to reach 11 million tons for production of diversified products in the next decade.

TIFERT

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Company profile

Tunisia has been one of the leading phosphate producers in the world while India is among the major consumers of phosphate-based fertilizers. Two Tunisian state-owned companies, viz., Companies des Phosphates de Gafsa (CPG), and Groupe Chimique Tunisien (GCT) are engaged in processing phosphate rock and producing and exporting phosphate derivatives. India has been the largest buyer of Tunisian phosphate and phosphoric acid for over a decade.

A joint venture to produce Phosphoric acid has been established between the two Tunisian companies CPG and GCT and two Indian companies, viz., Gujarat State Fertilizers and Chemicals Limited (GSFC) and Coromandel International Limited. The plant was established in Skhira in September 2006 and a Phosacid joint venture was incorporated in the name of Indian-Tunisia Fertilizers (TIFERT). Both Indian companies GSFC and Coromandel hold 15% share each in this 465 million USD project with balance 70% being held by GCT and CPG. TIFERT will process around 1.4 million tons of Tunisian phosphate rock per year producing 360,000 tons of phosphoric acid annually (360KT P2O5/Y) which would be exported in equal shares to the two Indian partners.

TIFERT is equipped with the latest technology and

meets the international environment standards. The plant was scheduled to be commissioned in 2011. However, the revolution in Tunisia in January 2011, followed by civil disturbances in various parts of the country, particularly in the Governorate of Gafsa, where the phosphate mines are located, has caused some delay. The situation has since improved and the project is expected to start production by April 2013.

EFC nv

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Company profile:

EFC NV is a Belgian based filtration technology supplier with over 25 years of experience.

EFC NV offers a complete line of fiber bed mist eliminators and systems to abate liquid mist emissions. Our Atephos fiber bed mist eliminators, also referred to as fiber bed filters or candle filters, are optimal for removing sub-micron liquid aerosols from gas and air streams.

EFC's technologies are used extensively by facilities seeking to reduce emissions in a wide range of industries and applications. EFC filters candles are innovative due to the variable bed densities technology offering our customers a wide range of possibilities to optimise their filtration process by increasing the efficiency, reducing the operational costs or to save on capital investment costs.

Besides liquid and air filtration, EFC NV has its own specialized oil filtration division. This covers Hydraulics and Lubrication applications. Filtration and separation technologies dedicated to markets like Energy, P&P, Steel, Petrochemicals, Automotive, and all the ones requiring advanced cleanliness and reliable productivity. Filter elements that are stress resistant, Purifiers removing free and dissolved water and gasses, full range of filter vessels, Varnish removal units that breaks varnish formation cycle before it starts !

EFC NV does not just sell filters, it provides technology and innovation to give pure air and pure liquid. Like no other, EFC NV recognizes the complexity of filtration issues, which means we can offer ready-made solutions tailored to the specific needs of the customer.

East China Engineering Science and Technology Co., Ltd. (ECEC)

Contact person:
Xia Lungang, Regional Marketing Director
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Company profile:

East China Engineering Science and Technology Co., Ltd. (ECEC) is a public listed company and an EPC turkey contractor, and also one of the leading engineering companies in China. From the year founded in 1963, ECEC has successfully completed more than 2,000 projects across China and in other countries.

The main expertise of ECEC is as follows.

- Phosphate compound fertilizers (MAP, DAP, NPK, TSP, SSP, etc.), Nitrogenous fertilizers (ammonia, urea) & Potassium fertilizers.
- Basic chemical raw materials (phosphoric acid, sulfuric acid, caustic soda, air separation, hydrogen generation).
- Organic chemicals (methanol, MTBE, MEK, melamine, PP, LDPE, etc.).
- Environmental protection, Municipal wastewater treatment, Industrial wastewater treatment.

- Thermal Power Plant (Coal, Gas), Tank Farms for oil, gas and chemicals.

Haldor Topsøe A/S:

www.topsoe.com

Company profile:

Haldor Topsoe A/S is a world leader in catalysis and surface science. We are committed to helping our customers achieve optimal performance. We enable our customers to get the most out of their processes and products, using the least possible energy and resources, in the most responsible way. This focus on our customers' performance, backed by our reputation for reliability, makes sure we add the most value to our customers and the world.

NAQ Global Companies

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Company profile:

Established In Year 2006 in Porto Alegre in Brazil, and expended to India & UAE in Year 2009. Further in 2010. New manufacturing unit established in Uberaba in Brazil.

Main Activities

Manufacturing and Supplying latest generation Specialty products & Providing World Class Expert Technical Services for Fertilizer Quality Improvement

Notable Achievements

Company Manufactures:

1. Anti-caking Agents for Urea, NPK, DAP, MAP, AN, AS & other Phosphatic & Mixed Fertilizers
2 Granulating Aids

For NPK, DAP, MAP, CAN, AN

ANP, AS and other phosphatic

Complex fertilizer.

3. Dust Suppressor for fertilizer dust control, Sulphur & Rock Phosphate Handling.
4. Micro Nutrient Binders
5. Filtration Aid
6. Defoamers for Phosphoric Acid Plants and for Phosphatic Fertilizer plants.
7. Froth Flotation Agents for purification of rock phosphate and other minerals.

Turnover: Group Turnover - USD 100 million

Bedeschi

www.Bedeschi.com

Company profile:

Bedeschi is one of the oldest companies in Europe for heavy clay, bulk handling and crushing equipment manufacturing. Bedeschi has more than 100 years of experience in designing and

implementation of machinery for various industry like brick and roof tiles, marine installation, mining and generally it specializes in all kinds of cargo handling equipment and fertilizer handling equipment (we invite you to visit our website www.Bedeschi.com).

Pall Corporation

Company profile:

Pall Corporation designs and supplies a wide range of Filtration and Separation technologies to eliminate solid and liquid contaminants from fluids including:

particulate filters for gas and liquid service, liquid/gas coalescers, liquid/liquid coalescers, and membranes for water treatment. These products, along with our local field testing and field service capabilities, our engineering capabilities and our technical expertise, enable us to fulfill diverse fluid purification requirements in any size. Pall technologies have proven superior field performance, enabling operators to enhance plants reliability and availability, and to meet their environmental commitments.

Throughout the Middle East region, in both upstream and downstream sectors, Pall technologies have enhanced the protection of units and equipment that are critical to production, such as gas treating units, condensate stabilization units, compressors and turbines, water injection wells, as well as transportation pipelines and their final users

Stamicarbon

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Company profile

Stamicarbon, headquartered in The Netherlands, is a global leader in the design and project development of chemical plants, licensing of technologies and a supplier of high-end equipment and services for the petrochemical industry. This leading position is based on almost 70 years of experience in licensing and is maintained by our continuous innovations in technologies, products and materials. We have licensed more than 250 urea plants and realized more than 90 revamping and optimization projects. Together with our excellent network of reputable partners we can provide all the technologies, equipment, products and related services you'll need to get your solution up and running. With these activities Stamicarbon fulfills its pioneering vision to enable the world to feed itself and to improve the quality of life.

Saudi Specialty Chemical Industries Co. Ltd (SSCI)

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SSCI is a global leading manufacturer of custom-made additives for mining & fertilizer industries. Our product range includes antifoams both water & oil based, anticaking, antidust and coloring agents for granular fertilizer, granulating aids, flocculants and floatation agents.

Having an experience of more than 18 years as a leading manufacturer for water treatment chemicals, home care, construction/coating, textile, ceramics, phosphate/fertilizers, mining, leather, paper, oil & gas along with fully equipped R&D, strong manufacturing and logistics capabilities, and sales and service networks in Saudi Arabia, India, UAE, Morocco, Jordan, Egypt, Indonesia, & China, SSCI is enough capable to meet clients quality expectation & delivery requirements.

With a mission to be viewed by customers as partner not supplier, SSCI managed to become one of the market leaders in the field, serving customers all over the globe, with focus on Middle East and North African "MENA" markets.

SSCI believe in endeavoring sustainable development & innovation & its major advantage lies in exactly determining what chemical technology works best for a particular application to solve the customer's trouble.

Langley Alloys

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Company profile:

Established in 1938, Langley Alloys have a worldwide reputation for inventing and supporting advanced stainless steels, nickel and bronze alloys. The company first developed Super Duplex FERRALIUM® 255 in the 1970's and has refined the grade to be a leading high performance alloy for demanding applications. The requirement for sustained functional performance in severely corrosive and abrasive conditions, of modern phosphoric acid productions plants have been successfully met by FERRALIUM ® 255 and other High strength corrosion resistant alloys within the Langley stock range.

Veolia

Veolia Water Technologies is the global leader in large-scale, highly integrated process solutions utilizing HPD evaporation and crystallization technology. Our focus is the development of unique process designs and technology for our industrial clients in a broad range of markets.

For over 85 years, HPD evaporation and crystallization technology has helped clients meet their fiscal, production and environmental objectives by providing systems that recover valuable products and by-products, reuse/recycle valuable water resources and reduce effluent volume through unique evaporation and crystallization process design and technology.

AFA Workshop:

Plant Nutrition & Economic Farming for non Specialists

13-15/11/2016 – Riyadh (SABIC Academy)

AFA in cooperation with SABIC organized a workshop on "Plant Nutrition & Economic Farming for non Specialistss" hosted by SABIC, Kingdom of Saudi Arabia, Riyadh, during 13-15/11/2016.

AFA seeks, through its members, to enhance its role as an international key player in fertilizer production and agricultural nutrients fields; boosting international food security status through the achievement of higher yields and the enrichment of soil nutrients. In this framework, AFA works on affirming that its members are continuously pursuing sustainable agricultural development.

The Workshop was inaugurated by **Eng. Anas Kentab** EVP Agri- Nutrient SABIC and **Eng. Mohamed Abdullah Zain** AFA Secretary General, delivering speeches welcoming the attendants and affirming the significance of such AFA-SABIC organized Workshop.

The Workshop was attended by **Mr. Jamal Eddine Bensari** AFA Board Vice Chairman, **Eng. Adel Al Danf** Helwan Fertilizers Company Chairman, Oman Farmers Association Chairman and Oman Ministry of Agriculture Advisor together with around 30 participants representing AFA member companies, agricultural experts and departments' staff from Morocco, Egypt, Sudan, Bahrain, Oman and Jordan.

This agricultural Workshop is the first of its kind to be hosted by SABIC. It aimed at effectuating AFA role, enhancing communication between AFA members of producers and final consumers and coping with international markets information, requirements and changes to achieve food security in the Arab region.

The Workshop topics included a number of key issues, important of which:

- Fertilizer Global Challenges.
- Comparison Between Organic and Inorganic Sources of Nutrients.
- Nutrient Cycling in Agro-ecosystems & Environment

- Fertilizer Marketing – Opportunities and Challenges
- 4R Nutrient Stewardship
- Fertilizer & Water Management in Irrigated Agriculture – Fertigation
- Fertilizer Production Value Chain
- How to Develop Mineral Fertilizer Recommendations
- Economics of Fertilizers Use in Agriculture
- SABIC (date Palm NPK) Research Methods
- Moroccan (OCP) & Egyptian (Evergrow) Experiences
- Site visit: ESTIDAMAH Research Center.

The Workshop has accomplished a number of the aspired results and was praised by AFA officials and participants, as they called for mainstreaming the workshop in AFA participating countries. It is noteworthy that on the margins of the Workshop, the fifth meeting of AFA Agricultural Committee was convened.

Moreover, such a Workshop was accompanied by a successful initiative, i.e. the Saudi agricultural caravans, carried out by SABIC in partnership with KSA Ministry of Environment, Water and Agriculture and in cooperation with AFA. This endevor targeted to provide the Workshop with the practical and applied nature of the agricultural experiences, as the third day of the Workshop was allocated for a field visit to the agricultural caravans (Riyadh Caravan).

It is worth noting that continuing the agricultural caravan action plan is underway, as it is planned to launch 4 caravans across KSA in the areas known for planting palm trees (Riyadh, Ehsaa, AL Qassim, and Medina).

Program

Welcoming and Introduction)
SABIC + AFA
Fertilizer Global Challenges
K. Al Rohily, *SABIC*
AFA General Overview
Mohamed Abdallah Zain
Secretary General, AFA
OCP Caravan, Morocco
Hassan Rafik, *OCP*
Evergrow Caravan, Egypt
Dr. A. AbdelKhalik, *Evergrow*
4R Nutrient Stewardship
Dr. Kaushik Majumdar &
Dr. Munir Al Rusan, IPNI
Nutrient Cycling in Agro-ecosystems and the Environment
Dr. Al-Rabhi, *SABIC*
Discussion
Leading by AFA
Fertilizer & Water Management in Irrigated Agriculture – Fertigation
Dr. Munir Al Rusan , IPNI
Comparisons Between Organic and Conventional Farming
K. Al Rohily, *SABIC*
Fertilizer production value chain
A. Dajam, *SABIC*
How to Develop Mineral Fertilizer Recommendations
Dr. A. AbdelKhalik, Evergrow
Economics of Fertilizers Use in Agriculture
A. Dajam, *SABIC*
SABIC (Date Palm NPK) research methods)
A. Musabehi, *SABIC*
Discussion
AFA/OCP
Concluding Remarks and Distribution of Certificates
AFA/SABIC
Visit SABIC Caravan &
Visit ESTIDAMAH

SABIC's Agricultural Awareness

Caravan begins journey to support date farmers in collaboration with Ministry of Environment, Water and Agriculture

An Agricultural Awareness Caravan, a new SABIC initiative to support the date farming community in Saudi Arabia in collaboration with the Ministry of Environment, Water and Agriculture and the Arab Fertilizer Association, was launched in Riyadh on November 13. The Caravan will provide advisory services to date palm farmers with the aim of raising their efficiency in farming methods and help seek solutions to their problems in the field.

The inaugural ceremony was attended by Anas Kentab, SABIC Executive Vice President, Agri-Nutrients, Dr. Saud bin Mohammed Al Huqail, Director of Agricultural Awareness, Ministry of Environment, Water and Agriculture, Jamal Edeen bin Sari, Vice-Chairman of the Arab Fertilizer Association, Mr. Mohamed Abdallah Zain, AFA Secretary General.

After the inaugural ceremony, the Caravan, comprising five specially equipped vehicles, began its journey from the front of the SABIC headquarters on a tour of Al-Riyadh, Al-Ahsa, Qassim, and Madinah regions, to end on December 8. The five vehicles are equipped with supplies and specialized equipment, including an internet-enabled computer, audio-visual systems, and a mobile lab to analyze soil and water samples for possible on-the-spot solutions.

As part of the Caravan's program, agricultural specialists from SABIC and the ministry will visit a number of farms in the region and advise farmers on correct palm cultivation methods. The specialists will hold open meetings with the farmers and respond to any queries that they may have on palm cultivation. They will help farmers apply various mechanisms in growing and caring for palm trees, address their problems scientifically, create awareness among them on plant diseases and pests, es-

pecially the red palm weevil, and promote prevention and control methods.

A mobile exhibition showcasing devices to detect the red palm weevil and other related exhibits will be part of the Caravan. It will reach out to agricultural laborers, students and guest house owners to educate them on how to eradicate the harmful pest.

The Caravan initiative, which is an important tool to achieving SABIC's 2025 strategy through communication and engagement with farmers, is a step towards further enhancing the ongoing strategic cooperation between the ministry and SABIC for the benefit of the domestic agricultural sector.

Workshop On

Developing Future Leaders

Aswan: 6 - 8 December, 2016

AFA in collaboration with Egyptian Chemical Industries Company (KIMA) organised a workshop on Developing Future Leaders in Aswan: 6 - 8 December, 2016.

Facing challenges is a main characteristic of the current era. Comprehensively, we are currently living, in a time, where challenges show up in all aspects of life and not only industrial and economic ones, thus, the Arab region is in a dire need for leaders with new thoughts and policies that enable them to encounter such crucial challenges. Challenges occur everywhere as a result of the rapid changes in world incidents, namely daily updated technology and new work systems and procedures requiring knowledgeable and perceptive leadership. With this in mind, AFA convened a workshop concerned with such an issue, which attracted a remarkable number of attendants. The Workshop attendance exceeded 60 participants from different fertilizers companies in Egypt and the Arab region.

The workshop was organized, based on the recommendation of AFA Training and Qualification Committee that periodically meet to establish and study the best human, technological and scientific methods of development, pursuing the provision of holistic means of development for AFA members from one side and the Arab region at large from another side.

General Magdy Hegazy: Necessity to make the best use of such a significant training workshop.

Aswan Governor, **General Magdy Hegazy** inaugurated, such a training workshop. The Workshop was attended by AFA Board Chairman and Africa Representative in IFA, H.E. Mr. Saad Abu Al Maaty, AFA Secretary General H.E. Mr. Abdullah Al Zain, KIMA Board Chairman, H.E. Mr. Eid Al Hout and Aswan University Officer in Charge Professor Mohamed Abdel Qader.

To highlight, **H.E. General Magdy Hegazy** commended the pioneering role played by AFA to promote chemical and fertilizers indus-

tries as well as to provide ongoing support to all AFA member companies. These endeavors seek to inform such companies with the latest developments in this field to cope with modern technology and high technical methods in order to be used in performance development, production increase and economic, social and agricultural development. General Hegazy further confirmed the governorate keenness upon providing the required assistance to the awareness-raising agricultural caravan, regarding palm planting, to be launched by AFA in Aswan, which aims at reaching farmers in the field and raising their awareness concerning adequate usage of fertilizers and timing of application. This targets the achievement of the best production rates of different agricultural crops, especially date crops, which Aswan governorate is famous for.

General Magdy Hegzy pinpointed the necessity to make the best use of such a significant training workshop, which tackles the suitable means and methods for the development of future leaders, being one of the currently most important issues that requires special attention and consideration. He also affirmed that among the key characteristics of successful leadership are the challenge taking spirit, perseverance and surrendering not to despair; highlighting that "what cannot be completely attained should not be completely left". In addition, General Hegazy called upon the Workshop participants to exert more efforts to obtain additional skills and experiences in various fields, thus to become role model of future leaders needed to bear the responsibility of accomplishing the aspired development and enlightenment processes during the coming period. Notably, he asserted Aswan governorate full preparation to receive and host more AFA conferences, training courses and technical workshops. This pursuit

will have a positive return on enhancing the governorate executive efforts exerted to activate and support tourism, particularly festivals, conferences and sports tourism in addition to families and groups' tourism.

At the beginning of his speech, H.E. Mr. Saad Abu Al Maaty expressed his pleasure regarding the remarkable success of the Workshop professionally and scientifically. In his speech, Mr. Ma'ty discussed the Workshop three key objectives: 1. (Holding Discussions) which took place among participants and attendants, being the right way to acquire expertise, knowledge and exchange opinions. 2. (Transferring Experience) among members. 3. (Communicating) effectively with the attendants. His Excellency has clarified that the secret of leaders' success starts with being fully familiar with all the details and different industry phases and not to be confined to a specific specialization from one side, and being aware of the by-laws and work system and not to be restricted to the technical aspects only from another side.

His Excellency also discussed the main challenges facing fertilizer industry, namely production inputs, pricing, marketing expertise and management. In concluding his speech, Mr. Ma'ty presented the Workshop five core recommendations: (1) leadership is a kind of art and a skill that can be obtained and developed, whether from other people or specialized training courses. (2) Development and change are main characteristics of a successful leader, so success seekers should avoid routine, work on reaching positive and better results and to go on with the development process. (3) An action plan should be established with an agreed upon timeframe. (4) The capability to form a serious hardworking team believing in the significance of their work. (5) The capability to measure performance, being the outset of institutions success, by using KPIs for measuring performance and ensuring success continuity.

From his side, **H.E. Mr. Mohamed Abdullah Al Zain** emphasized that the training Workshop aims at transferring and exchanging expertise and identifying successful experiences of participants from fertilizers institutions and companies coming from different Arab countries. He added that the Workshop also yearns for making use of the working papers and the recommendations presented in order to boost sustainable development processes and achieve a pioneering status in fertilizer industry field. To note, the training Work-

shop is based, as per its agenda, on primary pillars, namely highlighting the art of leadership making, pinpointing future leaders means of preparation and qualification to become professional trainers, tackling methods of developing member companies training departments and divisions, identifying the best training methods using latest international techniques in addition to presenting the best practices and successful training experiences of member fertilizer companies.

His Excellency has further clarified that among AFA important tasks is organizing numerous conferences and scientific forums, encompassing a huge number of international specialized organizations, institutions and companies. AFA also convenes numerous seminars and training workshops for all people working in fertilizer and chemical industries, and launches awareness-raising caravans in a variety of domains in different Arab countries. Besides, it encourages

scientific research that targets fertilizer field services and entrenches means of effective coordination and cooperation as well as exchanging expertise in all fields between member companies and other specialized international institutions and companies. AFA also optimizes modern mass media means and communication systems to raise fertilizer industry image and reputation among such means and strategic international policy makers, via the enhancement of procedures and continuous solutions provided by AFA to handle international social issues related to fertilizer production and food security.

In his speech, **H.E. Mr. Eid Al Hout** focused on the importance of holding such kinds of specialized workshops, which in turn assist in building a generation capable of bearing the coming phase requirements. He added saying that good work starts with reform, scientific awareness and increasing knowledge. He further welcomed and expressed willingness to host other workshops or proceedings, for instance the agricultural caravans. Moreover, he confirmed the necessity to effectuate social responsibility and identify current phase requirements.

Accordingly, the Workshop fulfilled the aspired educational and guiding dimensions. AFA was also keen organize a number of trips to touristic places in Aswan. A visit was made to Philae Temple in the evening and a visit to the Nubian Village was paid associated with a Nile Cruise.

Program

Session I

Introduction to Leadership "Lecture and group discussion"

- Introduction to leadership and Management
- Attributes effect on leader
- Leader types
- Leadership models and styles

Session 2

Leadership Behaviors "Lecture and Activity"

- How to build leadership
- Leadership behaviors
- Leading teams and groups

Session 3

Coaching and Mentoring "Activity"

Session 4

Group Dynamics "Lecture and group discussion"

- Group dynamics
- Types of group dynamics
- Group Development

Session 5

Coaching and Group Presentations "Activity"

Introduction

Group activity (Competition)

- Review Day 1

Session 1

Interpersonal Skills "Lecture, group discussion and activity"

- What is interpersonal skills
- Types of interpersonal skills
- Self-esteem tools

Session 2

Coaching and Mentoring "Activity"

Session 3

Change Management "Lecture"

- Change leader
- Change structure
- Models of change

Session 4

Body Language "Lecture and Activity"

- Motivation
- Creating space for your staff

Session 5

Coaching and Group Presentations "Activity"

Introduction

Group activity (Competition)

- Review Day 2

Session 1

Personal Assessment "Lecture and Activity"

- What is personal assessment
- MBTI
- Values

Session 2

Conflict Management "Lecture and Activity"

- Conflicts in managements
- Resolution or Resolve
- Risk Managements

Session 3

Decision Making and Problem Solving "Lecture and Group Discussion"

- Background to decision making
- Types of problems
- Problem solving process

Session 4

Managing Self and Others "Lecture and Activity"

- Performance management
- 360 Feedback
- Clear KPIs and Objectives

Session 5

- Round table discussion
- Closing and Certificate Distribution

Arab Potash realizes JD 50 M net profit after taxes, provisions and royalties until the end of September this year

Amman - 31/10/2016 -- Arab Potash Company (APC) posted a net profit of approximately JD 50 million after taxes, provisions and royalties until the end of the third quarter of this year.

APC Chairman of the Board of Directors Jamal Al Sarayrah affirmed that despite the difficult circumstances and challenges facing the global fertilizer industry and the global economic slowdown, which led to a drop in product prices by more than 26% compared to last year, APC was able to realize profits until the end of September this year.

Al Sarayrah added that APC continued to implement its cost control policies by increasing the efficiency of its operational and production activities in order to reduce production costs, sustain a profit margin sufficient to ensure the continuity of production operations and sustainability of APC plants, and to cover operating expenses in a manner commensurate with revenues.

Al Sarayrah noted that APC's profits until the end of the third quarter came mainly from non-operational activities and from the profits of subsidiaries and affiliated companies, in line with the policy approved by the Board of Directors to diversify the Company's sources of income through strategic investments in downstream industries in order to increase the Company's benefits from the potash supply chain and the profit margins achieved from it.

Al Sarayrah noted that APC spent around JD 7 million until the end of the third quarter of this year under the corporate social responsibility (CSR) program on building schools, hospitals and community halls to improve the level of services provided in local communities and other governorates in the Kingdom.

Al Sarayrah revealed that APC is currently studying investment in downstream industries from Dead Sea minerals, in keeping with the expansionary investment policy currently being considered by the Board of Directors. APC is considering launching three projects with a significant investment.

CEO of the Arab Potash Brent Heimann said that APC is still working to overcome the challenges of high electricity tariffs compared to other potash producing countries, which poses a challenge to the competitiveness of APC products in the global markets, in addition to the accumulation of challenges related to the profitability of new investments in downstream industries.

Heimann pointed out that APC is diversifying its energy sources for its facilities to maintain profitability and to be able to expand in the future.

IPNI on Learning from Commercial Oil Palm Crop Performance

December 15, 2016. Penang, Malaysia – Like all farmers, oil palm planters learn from their own experiences. Yet, they are rarely sure if an exceptionally good or bad outcome is due to chance or a given combination of management practices and environmental conditions. On the other hand, extension agents and plantation advisors often combine information from controlled experiments in conditions that are assumed to be similar to a specific plantation, as well as their own experience, to support planters with managing their palms.

Unfortunately, this sort of knowledge transfer has its flaws. According to Dr. James Cock, senior agricultural advisor to the International Plant Nutrition Institute (IPNI), such a process in heterogonous oil palm growing environments may lead to firstly, the selection of technology by researchers which does not do well under real conditions and is therefore rejected by oil palm operators, or secondly, the rejection of technology by scientists because it did not perform well in trials, but might have done well under commercial conditions. Acknowledging this problem, IPNI's Southeast Asia Program tested, under its Plantation Intelligence® Program, a potential solution.

"We surmised", says IPNI's Dr. Cock, "that, if each harvest event is adequately characterized and a large number of such characterized events are analyzed together, it should be possible to associate crop response to management within a particular set of growth conditions."

IPNI termed such sets of growth conditions "Homologous Events" (HEs). They used soil and climate information from a 6,000 ha commercial estate in one of IPNI partner plantations to test the idea.

The yield of fresh fruit bunches was analyzed from 2009 to 2013 on the conceptual basis that if HEs can be defined in terms of growing conditions and used to account for part of the yield variation, then the remaining variation within these events can be attributable to controllable management practices. The team found that HEs for the two years before and the year of the harvest improved models used to explain yield variation. Yield differences were in accordance with the expected effects of the distinct HEs confirming their validity as an analytical tool. They demonstrated that HEs with normal conditions gave the highest yields, HEs with either deficit or surplus water gave intermediate yields, while a combination of both deficit and excess water had the lowest yields.

IPNI's Senior Oil Palm Advisor, Christopher R. Donough, asserts that this is "a unique approach for commercial oil palm operations to understand the combined impacts of drought and flooding on crop performance".

The research, supported by IPNI's supporting partner Canpotex International Pte. Limited, was recently published in Agricultural Systems (149:99–111, 2016).

"Global Fertilizer Day" Celebrates Fertilizers' Contribution to Global Food Security and Nutrition

Ahead of World Food Day, Here are 7 Ways the Fertilizer Sector is Making a Positive Impact Around the World

Paris, France, 13 October 2016 – Our planet is working harder than ever to grow the crops that will nourish a projected nine billion people by 2050. Continuous innovation to sustainably boost productivity in the face of a changing climate and scarce natural resources is bringing us ever closer to our goal to end hunger by 2030.

"Fertilizers play a key role in this process, ensuring our soils have the vital nutrients they need to grow healthy crops," says Charlotte Hebebrand, Director-General of the International Fertilizer Association (IFA). "In recognition of this responsibility, the fertilizer industry supports a range of initiatives which aim to make fertilizer use as efficient, productive and sustainable as possible."

Ahead of World Food Day on 16th October, IFA is proud to announce the newly created Global Fertilizer Day on 13th October. This day celebrates fertilizers as one of the most important inventions of our time, contributing to an estimated 50 per cent of today's food production. Visit the website at: fertilizerday.com.

As part of this celebration, here are seven ways the fertilizer industry is contributing to global food security and promoting sustainable fertilizer use:

1. Connecting African Smallholders to Input Markets

The African continent suffers the most from a wide agricultural yield gap with cereal crop yields only one-tenth as high as those in the United States. Sub-Saharan Africa fertilizer use is still far below 20kg per hectare. It is no coincidence that 65 per cent of African soils are depleted of nutrients. African leaders issued a call in 2006 to increase fertilizer use by a factor of five in their «Abuja Declaration on Fertilizer for the African Green Revolution» – but this target has unfortunately not yet even come close to being achieved.

IFA supports the African Fertilizer and Agribusiness Partnership (AFAP), which is working to connect smallholder farmers to fertilizer value chains. Their work is supporting farmers to test their soils, access the right fertilizers and set up effective fertilizer distribution networks, through warehousing and trained agro-dealers.

2. Helping Expert Volunteers to Build Fertilizer Value Chains in Africa

IFA and AFAP have also combined efforts to increase knowledge of soil and fertilizer management through the African Fertilizer Volunteers Program (AFVP). AFVP is a call to global fertilizer industry experts willing to volunteer their time and knowledge towards building the African fertilizer value chain. The program works to mobilize global expertise and provide targeted support across the fertilizer development value chain in Africa.

Volunteers come from around the world and have a broad range of expertise, from project development and financing to manufacturing, distribution and quality assurance. Volunteers are either sponsored by their own organization or they apply to the program as individuals. Volunteers are already making a significant contribution to developing Africa's agriculture potential and improving the livelihoods of African small-

holder farmers.

3. **4R Nutrient Stewardship**

   Fertilizers play a crucial role in food security, but must be applied in a balanced and efficient way. To help farmers towards this goal, the global fertilizer industry has developed the "4R Nutrient Stewardship" principles based on four simple concepts: using the right source (or product), at the right rate, at the right time and in the right place. The 4Rs principles are the same globally, but their local application varies depending on local soil, climate and crop conditions. They help farmers to increase their economic outcomes, as they contribute to maximize nutrient uptake, while minimizing greenhouse gas emissions. Watch a video on 4R Nutrient Stewardship here.

4. **Turning a smartphone into a crop nutrient tester**

   New technologies are now making it easier for farmers to apply fertilizers more effectively. These include tools such as GPS systems, yield monitoring, variable rate fertilizer application, remote sensing and crop sensors for increasing nutrient use efficiency, soil health, crop productivity and quality.

   Smartphone apps and web-based tools can help farmers with nutrient management advice tailored to their farming conditions and needs. For instance, one smartphone app can measure the nitrogen levels and uptake of their crops, as well as making recommendations for nitrogen fertilizer application, based on photographs. It calculates the nitrogen uptake based on leaf cover, leaf green colour and estimated fraction of brown leaves.

   Despite being an advanced agricultural tool, these apps are user-friendly and can be adapted for most farmers. By calculating more precise nutrient needs, they help farmers to reduce fertilizer waste, and thus safeguard the environment and save unnecessary input costs.

5. **Training Agro-Input Dealers in East Africa**

   Smallholder farmers, many of whom are struggling to produce enough food for themselves and their families, require tools and information to improve their yields. These can come in the form of local agro-dealers, who sell the necessary products, including fertilizers, and can advise on their proper use.

   In East Africa, the International Fertilizer Development Centre (IFDC) has partnered with the International Fund for Agricultural Development (IFAD), to provide training to 1,400 agro-dealers in Kenya, Uganda and Tanzania. The participants received advice not only on the products they sell, but on how to run a business. Equipped with good information, they are able not only to grow their own businesses, but the yields of their customers too. Watch the video here.

6. **Strengthening science and technology transfer in China**

   In China, there still tremendous scope for more efficient and effective fertilization to ensure maximum crop yields and minimum losses to the environment. To adapt and optimize use, the International Plant Nutrition Institute (IPNI) and the Chinese Academy of Agricultural Sciences (CAAS) have conducted extensive research, pioneered a soil testing procedure and developed a computerized soil testing and fertilizer recommendation system known as the Systematic Approach for Soil Testing and Fertilizer Recommendation Program.

   The team has conducted over 4,000 trials for all major soil types with more than 100 crops, discovering the optimal fertilizer to be used in each case. Over the years, more than 360,000 people have benefited from this new knowledge, which has been disseminated via field demonstrations and local television.

7. **"Protect & Sustain" Product Stewardship**

   As part of its major responsibility to ensure fertilizers are produced, transported and used as safely and sustainably as possible, IFA has devised the "Protect & Sustain" initiative for its members worldwide. The initiative helps fertilizer companies to implement effective product stewardship programs. An award – known as the IFA Green Leaf Award – is given every two years to a member that has shown excellence in implementing the Protect & Sustain initiative.

Inspired by
The School of Athens, Raffaello Sanzio 1509-1511
Vatican Museums. Photo Scala Archives

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Stewardship for Improving Potash Quality Strategic Implementation:

"Conversion from Dynamic to Static Fluidized Bed Cooler"

Eng. Ala'a Omari
Process Engineer Specialist
The Arab Potash Company

Introduction

Company Overview

Arab Potash Company (APC) is the eighth largest potash producer worldwide by volume of production and the sole producer of potash in the Arab World. It also has one of the best track records among Jordanian corporations in the areas of work safety, good governance, sustainable community development, and environmental conservation.

Established in 1956 in the Hashemite Kingdom of Jordan as a pan-Arab venture, APC operates under a concession from the Government of Jordan that grants it exclusive rights to extract, manufacture and market minerals from the Dead Sea until 2058. In addition to its potash operations, APC also invests in several downstream and complementary industries related to Dead Sea salts and minerals, including potassium nitrate, bromine and other derivatives.

As a major national institution and economic contributor, APC employs more than 2,200 workers across its locations in Amman, Aqaba and Ghor Al Safi.Potash production began in 1983 and has since progressed with various schemes aimed at optimizing and expanding this production. The initial plant was built to a capacity of 1.2 million tones of product.

This was expanded in the late eighties to handle 1.4 million tones and key modifications were undertaken with the Solar System to enhance the production of the ore accordingly. A second plant based on different technology and of a capacity of 0.4 million tones was built in 1994 and this brought the total production capacity to 1.8 million tones. Then another cold crystallization plant of 0.45 million tones was built in 2010 and this brought the total production capacity to 2.45 million tones. Further expansion is currently under evaluation to bring the total potash capacity to 3.2 MMTP.

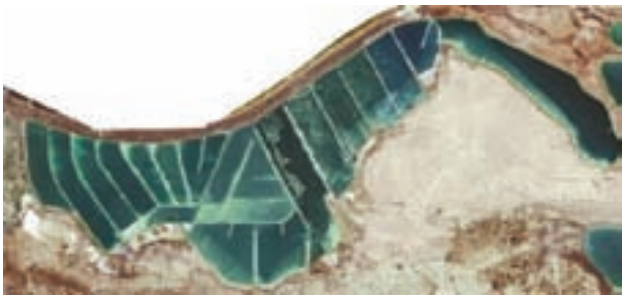
APC management recognizes that Safety, Quality & Environment are crucial for assuring business sustainability, profitability and growth, APC successfully achieved certificates of compliance of the following international and local standards: Occupational Safety and Health Management System Standard –OHSAS -18001, Environmental Management System Standard (EMS) -ISO -14001:2004, Quality Management System Standard (QMS) - ISO -9001:2000, Quality Management System Standard (QMS)- ISO- 9001:2000, General requirements for the competence of testing and calibration laboratories" standard-ISO-17025:2005 and Jordan Quality Mark.

The capital of the Arab Potash Company is 83.3 million Jordanian Dinars. It has a concession from the Jordanian Government to exploit, manufacture, and market the mineral resources of the Dead Sea, until 2058.

The Arab Potash Company employs over 2000 personnel and has offices in Amman, Safi and Aqaba. It owns extensive housing and recreational facilities near its plants, and in addition, it provides the surrounding region with assistance in social, medical, economic and vocational development.

Potash Production Process Description

At the heart of the Ghor El-Safi site are a 112 km2 solar evaporation ponds system and ore processing plants. The brine from the Dead Sea is pumped at a yearly average rate of 350 million t/a into the solar evaporation system by main intake pumping station, where the initial concentration process is undertaken at the salt ponds where NaCl deposits. The remaining brine is pumped into the Carnallite ponds, to precipitate the raw Carnallite.



The precipitated raw Carnallite is the raw material for producing potash is precipitated as mixture of Carnallite (KCl.MgCl2.6H2O) and NaCl. This bed is harvested as a slurry from beneath the brine and delivered to booster pumps on the dikes and then to the refinery through floating pipes.

The Raw Carnallite is harvested and pumped to three refineries. The original plant employs hot leach technology to process the Carnallite to extract potash, but the newer facilities employ cold crystallization.

In the hot leaching unit, the Carnallite slurry is received, dewatered and decomposed in two stages in an agitator tanks. The resulting solids from the decomposition are a mixture of potassium chloride and sodium chloride: this mixture (known as Sylvinite) is dewatered and washed. The resulting cake is conveyed to the Sylvinite processing stage.

In the next Sylvinite processing stage, the Sylvinite cake is leached by heated lean brine to crystallize at draft tube crystallizers. Then the potash slurry from the last-stage crystallizer is directed to dewatering process (cyclones, centrifuges and dryer). In the drying stage, the cake from the centrifuges is conveyed to an oil-fired rotary dryer to remove the last traces of moisture entrained with the crystals. From the dryer, the product is sent to a fluidized bed cooler and then to the screening system, while the dust is collected, using a cluster of high-efficiency cyclones and bag filter system.

Anti-caking agent is added in carefully controlled amounts to minimize the natural tendency of potash to agglomerate during storage and shipment. Free-flowing properties are thus ensured to facilitate handling of these products by the customer.

The second processing plant introduced the cold crystallization process. This plant (CCP-1 & CCP2) operates separately from the hot leach refinery and is operated at ambient conditions, with a lower energy requirement. In the process, the carnallite salt is firstly beneficiated by wet screen to obtain coarse carnallite. The process is utilized the flotation technology where fine carnallite is beneficiated in which sodium chloride is floated and pumped to the tailings area. In the crystallization stage, coarse carnallite and fine carnallite are decomposed in crystallizer system in the presence of water. Potassium chloride crystals are formed in the crystallizers. Crystallization unit is being feed to cold leaching stage to remove adhering high MgCl2 brine from the crystallizer product, the product is followed by the dewatering stage. The dryer product is then cooled in a rotary cooler and conveyed to the potash storehouse after adding anti_caking reagent.

In CCP2, a new compaction plant has also been installed to produce more than 250,000 ton per year of high-quality potash. The new compaction plant comprises a post-treatment unit that enhances the quality of granular potash.

Section Two

Background

Potash demand, like most commodities, is cyclical. However aggregate demand graphs indicate an upward trend. For instance, global demand in 2000 was 40 million tons. By 2005 demand increased to 50 million tons before plateauing at 60 million tons in recent years. Analysts project demand to further increase to 70 million tons by 2020. In retrospect, the recent macroeconomic conditions of the market have presented APC with several challenges. To mitigate these risks a strategic decision was implemented to further reduce APC running cost while improving potash product quality through our Fluidized Bed Cooler conversion initiative. This ensured that regardless of potash market prices and demand, we were able to maintain healthy margins offset the cyclical nature of the market.

The unique characteristics of potash can present challenges during processing. Potash is hygroscopic; it easily absorbs and retains moisture from the environment. Consequently, potash is prone to clumping and sticking during processing.

Potash is usually stored in warehouses that have no temperature and humidity control. During storage and transportation, potash may experience large temperature and humidity changes. Moisture accumulation on potash surfaces will penetrate toward the inside of a potash bed over time. For this reason, significant quantities of potash are wasted due to caking.

In general, caked potash is caused by: -

- Improper anti_caking mixing & addition.
- Product Temperature.
- Storage & Transportation Conditions.

Section Three

a. Methodology

Therefore, a systematic and organized process action plant has been developed to reduce the impact

of the main causes of potash caking, this include, improve the reliability of equipment, review all downtime incidents, monitor the process parameters and replace major equipment with more reliable efficient such as anti_caking mixing system of standard grade, dedusting system and HLP cooling system..

Standard potash product temperature from the cooler was relatively high (Avg. 99oC) compared with the optimum temperature of anti_caking reagent addition point (82 oC) to ensure efficient mixing and to avoid amine flashing.

HLP Dynamic Fluidized Bed Cooler Performance

Run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Average
Inlet	210	180	182	180	181	186	181	197	185	183	179	180	195	189	186
Outlet	99	99	99	97	95	102	105	103	102	98	99	97	98	97	99

To overcome hot potash product, a complete overhaul had been carried out for the dynamic fluidized bed cooler, nevertheless the performance and the on stream factor quiet low, therefore a decision has been taken to replace the existing dynamic fluidized bed cooler by a modernized high efficient type, consequently a comprehensive study has been carried to select the suitable cooler type.

Four types of coolers were available in the market; column, rotary, dynamic and static fluidized bed. These four coolers presented APC with nine options for installation illustrated below: -

1. Two Rotary Coolers after screens.
2. Two Rotary Coolers before screens.
3. Fluidized bed cooler after screens (The bed contains tube bundles supplied with brine).
4. Fluidized bed cooler after screens (cooling of the product just with ambient air).
5. Fluidized bed cooler after Dryer (cooling of the product with ambient air and liquid media).
6. Column Cooler after screens.
7. Column Cooler before screens.
8. Dryer & Cooler Unit Before screens.

The criteria for selection was Safety, operational reliability, steady control, easily interfaces with newly installed DCS, low maintenance & operating costs and life span. The most crucial criteria for selection were a proven track record for implementation at fertilizer plants.

	Advantages	Disadvantages
Rotary	• Robust and proven equipment	• High capital. • Bad maintenance Conditions. • Heavy – demand complicated steel construction. • High power consumption. • Significantly required space.
Column	• Robust equipment. • No moving parts. • Small foot print.	• None proven equipment in potash. • Tube bundles are in direct contact with potash. • Bad maintenance conditions.
Static Fluidized Bed	• Robust and proven equipment • No moving parts.	• High power consumption. • Significantly required space.
Dynamic Fluidized Bed	• Robust and proven equipment0	• High capital. • Bad maintenance Conditions. • Heavy – demand complicated steel construction. • High power consumption. • Moving parts.

Meanwhile, the column has the highest advantages and the lowest disadvantages, the merely concern was its proven technology in potash industry.

b. Pilot Tests: -

Based on the above, APC invited the manufacturer companies of column coolers who are leaders in this field to offer comprehensive pilot scale column cooler. Two offers have received to install a column cooler pilot scale.

The objective of carrying out the pilot trial testing using column cooler to cool HLP dryer product discharge to acceptable temperature in order to provide on-site evaluation of the column cooler for cooling potash under typical process conditions. The test will be configured to simulate as closely as possible the conditions and operation of the full size equipment. This pilot test has an intended run period of approximately one work week minimum and will target the following objectives: -

- Demonstrate that the cooling capability and operating parameters confirm APC modeling.
- Evaluate pilot unit operation under typical process conditions
- Confirm that the product will flow at the selected heat exchanger plate spacing and that mass flow is achieved and maintained with the selected discharge device
- Verify that no build-up or scaling forms on heat exchanger surfaces.

Based on the above results, the column cooler gives the impression that it is a suitable method for

Pilot Testing

Test Conditions

Product Flow:	350-700 kg/h	Cooling Medium:	Brine, process water
Plate Spacing:	28mm (centers)	Dry Air Purge:	Testing with purge air

Cooling was achieved at every stage of testing. A variety of scenarios were simulated to give an overview of experimental operation ranges. The following table gives a summary of findings.

Test Results

Run	CM	Run time	Temperature [°C] in	Temperature [°C] out	Temperature [°C] Δ cooling	[%] flow rate	Cooling medium in [°C]	out, upper [°C]	out, lower [°C]	ΔCM upper [°C]	ΔCM lower [°C]	Flow rate upper bank [m³/h]	Flow rate lower bank [m³/h]
1	B 1)	3h	231	50	181	465	28.8	38	31	9.4	1.7	1.7	1.3
2	B 2)	1.30h	203	40	162	508	39	47	39	8.1	1.4	1.5	1.4
3	B 2)	1.30h	222	47	175	420	39	45	42	6	3	1.3	1.2
3 a	B 2)	0.30h	208	44	164	530	36	51	40	15	2	0.9	0.7
4	B 3)	1.45h	223	54	169	510	37	48	42	11	5	0.6	0.6
5	H_2O	3h	230	33	198	409	23	30	26	7	3	1.1	0.6

cooling potash, it offering efficient cooling capabilities and convenient operating conditions, the main findings are: -

- The flow of the material was smooth and uniform.
- No stable or semi-stable arches formed anywhere in the unit.
- Mass flow was clearly established.
- Heat exchanger plates were clean and residue free.
- Use of dry purge air prevented scaling on plates

The main challenges during the pilot tests were how to maintain dew point of air in void space below plate temperature to avoid condensation on exchanger plate surfaces. The major output was caking of potash on the plates which leads to: -

- Loss of performance.
- Frequent stoppage for the sake of frequent cleaning.

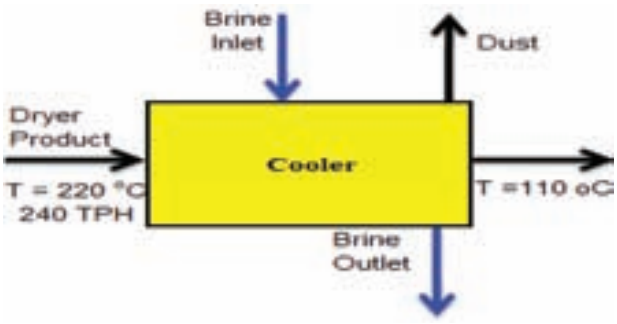
To avoid caking phenomena and afterward analyzing the results, it has been decided that a static fluidized bed was cooler best suited APC needs. The scope of supply included replacement the existing vibrating fluidized bed cooler at the Hot Leach Plant (HLP) with one static fluidized bed cooler in a step to relocate the position of the cooler to cool down all dryer products instead of cooling only standard product. At the same time, the plant shall be expanded by an additional third product screen. However, this issue is not further considered in this paper.

Section Four

Static Fluidized Bed Cooler:

a. Design Criteria

The detailed engineering scope of work has included installation a static fluidized bed cooler in the HLP in order to replace the existing dynamic fluidized bed cooler. The project will essentially include certain modifications in the existing layout of the screening building which embraces the dynamic fluidized bed cooler. The new static fluidized bed cooler shall be designed to handle the entire discharge of the existing rotary dryer at around 220 °C and to cool it down to around 90 °C. The new cooler shall have a capacity of around 240 tons per hour and it shall be equipped with means to produce a cooled product with controlled temperature in the range of 80 – 110 °C to cope with variations in ambient temperature from 5 – 45 °C and dryer product temperature of 170 – 230 °C.



However, the design should take into consideration that no excessive cooling takes place. This requirement is needed to allow for melting the anti-caking reagent added at a downstream stage which typically has a melting point of around 70 oC. For this purpose, the material (potash) should not be cooled lower than 90oC even in the cold season and even when the production rate falls significantly below 240 tph.

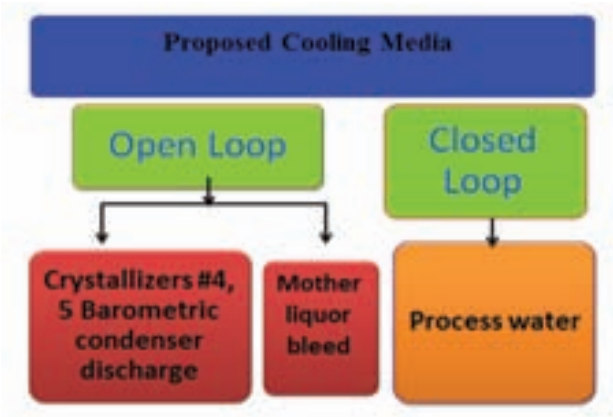
Moreover, the output of the design criteria should consider the following objects during the planning:

- Minimized amount of mechanical conveying equipment.
- Utilization of existing conveying equipment (screw conveyer)
- Utilization of the existing building stock as far as possible to reduce the reconstruction scope for structural engineering.
- Reducing production downtimes during reconstruction.
- Automated operation by using remote-controlled actuators.

Furthermore, the basic engineering design stage of the static fluidized bed cooler included selection of loop type (open or close), cooling media, material selection, de_dusting system

selection, Minimized amount of mechanical conveying equipment, utilization of existing conveying equipment, utilization of the existing building stock as far as possible to reduce the reconstruction scope for structural engineering, reducing production downtimes during reconstruction.

The most critical point during basic engineering design was the selection of the cooling loop type (open or close) and the cooling media as illustrated below, an intensive study has been carried out to determine the most suitable option, the advantage and disadvantage of each option have been determined: -



1. Close loop: -

- The cooling media will be Water with an approximate quantity of 340 m3/hr. min. @ 38 °C, the calculated return water temperature will be 49°C min.

and the estimated make up water will be 5% Max.

• The main concern will be increase the Heat Load on the plant cooling towers which are almost work working at their maximum heat load in the Summer time.

• Adding an extra 340 m3/hr with heat load which is about twice the current load will be impossible.

• Thus, a proposal of enlargement of the existing cooling tower and the pumping station has been studied by installing a new cooling tower in the HLP with a capacity of 400 m3/hr to cool down the return water, the study findings indicate that proposed option is unprofitable due to: -

1. High capital cost.
2. High running cost in terms of operation and maintenance.
3. Approx. double equipment efforts.
4. High space requirement
5. Complicated dense measurement devices and control system.

2. Open loop: -

• This option is simpler than closed loop, but the critical point was the selection of the cooling media, two cooling brine options have been studied.

1. Mother liquor brine: -

The mother liquor cooled brine is pumped to barometric condensers of the first four crystallizers in series counter currently with crystallizers' content flow, i.e., overflow and underflow.

The main advantages and disadvantages of using this brine source are: -

2. crystallizers # 4&5 where downstream heat re-

Advantage	Disadvantages
• Close Cooling brine source.	• Rich KCl Brine.
• Less Corrosive brine than carnallite brine.	• Higher brine temperature will negatively effect decomposition process.
	• No heat recovery and will negatively affect crystallization yield.
	• More pump head is required.

moval takes place then then, to carnallite pan C4. This source is high corrosive (high MgCl2).

The main advantages and disadvantages of using this brine source are: -

Advantage	Disadvantages
• Purge Brine (will not affect plants process)	• Highest brine feed temperature in summer season.
• Closet Cooling brine source.	• High corrosive brine.
• Easy to discharge outlet brine (by gravity to tails tank).	• No heat recovery.
• Simple measurement devices & Control System.	
• Lower space requirement.	

The findings of the loop selection study are summarized in the below table:

	Advantages	Disadvantages
Open Circuit	• Simple. • Fewer measurement devices. • Less control. • One cooling media will be used. • Less Maintenance. • More space.	• High corrosive cooling media. • High requirements for cooler material.
Closed Circuit	• Low corrosive cooling media. • Low requirements for cooler material.	• New Cooling tower required. • More equipment (secondary cooler is a must). • More control technology. • Two cooling media will be used: water & Air. • Controlling product temperature is not easy. • High operating cost due to: - • Losses of makeup (~5%). • Treated water.

Final conclusion: -

• Using open loop technology relative to close loop is better.

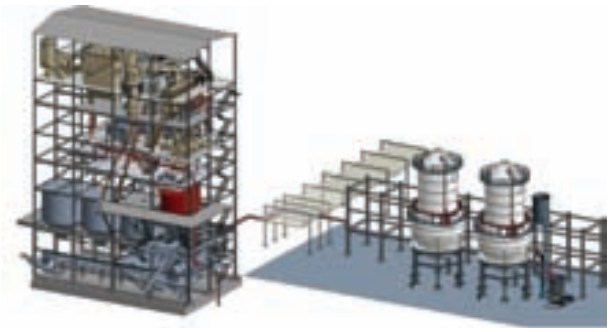
• Use Carnallite thickener O/F brine after cooling on the barometric condenser #5.

• Select suitable material of construction as titanium grade 11.

b. Project Components

The basic engineering design has determined the project component with equipment specifications, purchase requisitions have been issued for different international suppliers and based on the technical and

#	Equipment	Supplier
1.	HLP fluidized bed cooler equipped with dedusting system	Andritz Fliesbett Systeme GmbH
2.	Bucket elevator, Drag conveyor, Slide gate valves - hand wheel and the Slide gate valve – pneumatic	EMDE Industrie - Technik GmbH
3.	Cooling pumps	WEIR SOLUTIONS FZE
4.	Steel structure	Temme-industriebau
5.	Manual valves	IWZ Wolfgang Zierz
6.	Chutes	Hoffmeier Industrieanlagen GmbH
7.	Instrumentation & Electrical devices	MATEC Elektro- und Automatisierungsanlagenbau GmbH
8.	Frequency inverter for pumps	Vacon
9.	Fiber glass pipe lines.	STEULER-KCH GmbH
10.	Insulation material	Local supplier/ Negemco



commercial evaluation purchase orders have been issued to suppliers as illustrated in the below table:

C. Detailed Engineering Design

Section Five

Dismantling and Installation Of New Fluidized Cooler With All Accessories

The Arab Potash Company has decided to carry out the installation of the New Fluidized bed Cooler with all related accessories and new steel structure at Hot Leach Plant during the schedule shutdown of Feb. 2016.

It had been agreed to carry out the works in two phases to reduce the time required for shutdown: -

Phase	Duration	Plant status
One	29/11/2015 to 27/2/2016	During plant operation
Two	28/2/2016 to 7/4/2016	Major shutdown

The Arab Potash Company assigned local contractor to carry out the installation works of the new fluidized bed cooler, the works included safe dismantle existing machinery and steel structure and install a New Fluidized bed Cooler with all accessories and new steel structure at Hot Leach Plant as described below: -

1. Safe dismantling of Existing machinery and transfer them to APC scrap yard

- 7 cyclone and related accessories including fans.
- 5 screw conveyors.
- Three supply Fans.
- 7 Exhaust Fans.
- Cooler with dimension 9.15mt X 2.70mt at Elevation 20.35 and weight approx. 24 ton and related accessories.
- Various Chutes at various levels.
- Safe dismantling of Existing steel structure and transfer them to APC scrap yard.
- Grating and checkered plates.
- Roof steel structure and cladding.
- Handrails.

2. Installation of steel structure: -

- Welding Reinforcement Plates on Existing Columns
- New steel structure.
- New Checkered Plates.
- New Handrails.
- New stairs.
- Touchup paint for new steel structure.
- Reinstallation of Steel Roof.
- Reinstallation of Roof Cladding.

3. Installation of new equipment's

- Cooler the estimated weight is 14.5 ton - C301
- Cyclone the estimated weight is 5 ton - F-501 with insulation
- Bag Filter the estimated weight is 13 ton - F 502 with insulation
- Trophy chain conveyor at Elevation 34,15 - H401
- Screw Conveyor starting from level 18.85 up to 20.35
- Bucket Elevator from elevation 20 up to 39 - H402.
- Various Chutes at various levels without insulation.
- Intake Air Filter.
- Intake air fans (V201 A/B/C).
- Pumps (P001 A/B).
- Exhaust air fans(V202 A/B).
- Valves including rotary valve.
- Intake Air Silencer X 702, Exhaust Air Silencer X 701, Distribution Bin x 801 and Magnetic Separator FO11,12 & 13.
- Instrumentation.
- GRP Pipes including Fittings and lamination works (the material will be loose material).
- C.S (1" , 2") Pipes and Fittings including supply material.
- Air compressor.

Section Six

Pre_ commissioning & Commissioning Stage:

The local contractor has carried out the scope of work under the supervision of equipment suppliers and the design engineering company: -

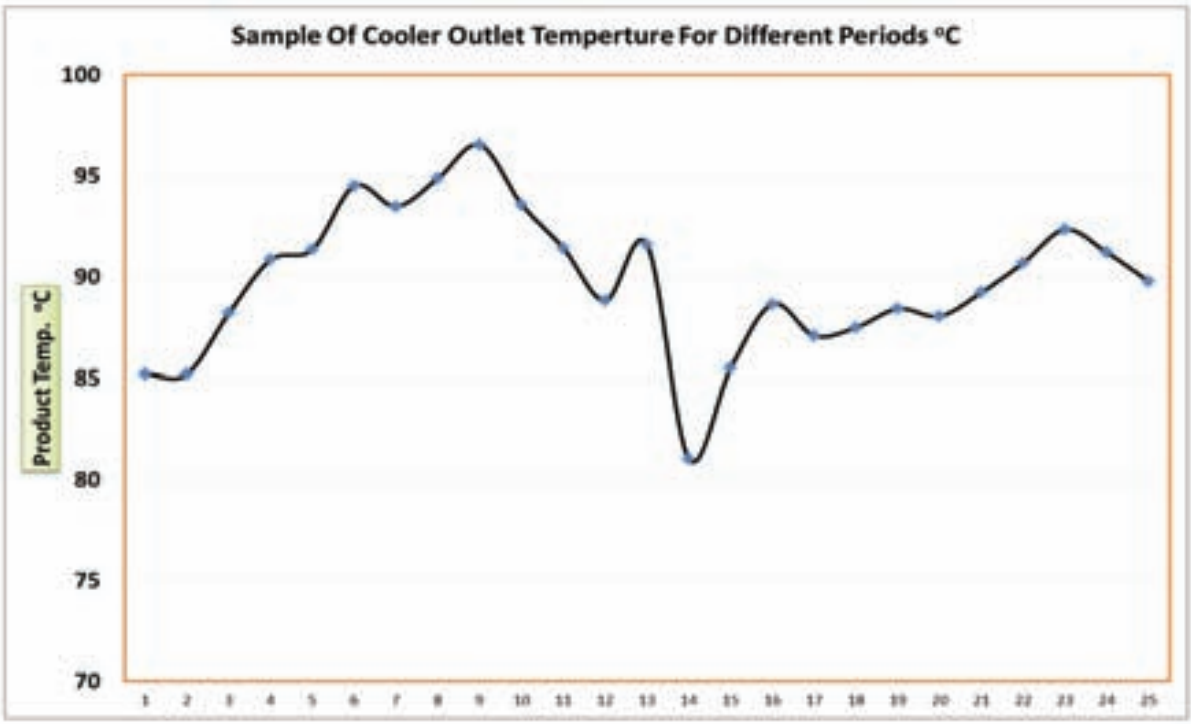
o Andritz/ cooler with all ancillaries.
o EMDE/ drag conveyer and bucket elevator.
o E&I: Matec.
o Ercosplan.

- During installation works, APC, equipment suppliers and the design engineering companies issued snag lists to ensure save and proper installation works.
- APC commissioning team had issued the takeover snag list to contractor on April 10th, 2016.
- Contractor had completed the commissioning snag list on May 10th, 2016.
- The wet commissioning of the cooler has been started on May 16th, 2016.
- The cooler system performance is satisfactory; it's working smoothly, there is not any major failure of the cooler system.

Performance Test Results

DESCRIPTION	Tag No.	UNIT	Run 1	Run 2	Run 3	Run 4	Run 5
Dryer Feed Rate	WI-4960	tph	184	185	193	193.5	176.1
Dryer Product Temp.	TI-6406	°C	202	204	205	207.5	206.9
Cooler Feed Temp.	TI-8420	°C	180	181	183	184.1	183.5
Cooler Inlet Brine Temp.	TI-8313	°C	56	55	55	53.07	52.34
Cooler Inlet Brine Flow Rate	FI-8312	m^3/h	272	276	284	284.6	290
Cooler Chamber 1 Outlet Brine Temp.	TI-8322	°C	76	75	76	74.68	72.87
Cooler Chamber 2 Outlet Brine Temp.	TI-8328	°C	68	67	67	66.05	64.85
Cooler Chamber 3 Outlet Brine Temp.	TI-8325	°C	63	62	62	60.43	59.43
Cooler Chamber 4 Outlet Brine Temp.	TI-8331	°C	60	59	59	57.41	56.51
Cooler Chamber 1 Outlet Product Temp.	TI-8419	°C	136	138	139	138	137.3
Cooler Chamber 2 Outlet Product Temp.	TI-8418	°C	0	0	0	0	0
Cooler Chamber 3 Outlet Product Temp.	TI-8417	°C	86	86	87	84.91	84.07
Cooler Chamber 4 Outlet Product Temp.	TI-8112	°C	77	77	77	74.78	73.68
Cooler Product Outlet Temp.	TI-8427	°C	74	74	74	71.75	70.67
Cooler Exhaust Gas Temp.	TI-8423	°C	123	124	125	125	123.4

• During start up, cooler product outlet temperature was relatively low, therefore two brine chambers have been closed to control the product temperature.



Conclusion & recommendations:

The project is successfully installed and commissioned during May 2016: -

- The new cooler has been operated based on best practices to cool HLP dryer product from 220°C to 100°C.
- The overall Equipment Effectiveness (OEE) has increased and thus less production losses.
- Dust content with end product and emissions of dust are also eliminated.
- Higher overall heat transfer coefficient.

Calendar

AFA Events

January 2017

- **23rd AFA Annual Fertilizer Forum & Exhibition**
  Arab Fertilizer Association (AFA)
  31 January-2 February, Cairo, Egypt

Non AFA Events

January 2017

- **Promoting Agriculture Technology to Improve Productivity and Net Returns for Smallholder Farmers**
  IFDC
  23-27 January, Accra, Ghana
- **IFA Joint Agriculture & Communication Meeting**
  IFA
  23-24 January, Rome, Italy
- **Frontiers of Potassium Conference**
  IPNI - International Plant Nutrition Institute
  25-27 January, Rome, Italy
- **Fertilizer Latino Americano 2017**
  CRU and Argus FMB
  25-27 January, Buenos Aires, Argentina

February 2017

- **Argus FMB NPK and Water Soluble Fertilizers India 2017**
  Argus FMB
  9-10 February, New Delhi, India
- **Argus FMB Africa Fertilizer 2017**
  Argus FMB
  15-17 February, Cape Town, South Africa
- **2017 IFA Production and International Trade Conference**
  22-24 February, Paris, France

March 2017

- **The 15th New Ag International Conference & Exhibition**
  New Ag International
  15-17 March, Berlin, Germany
- **2017 IFA Global Safety Summit**
  27-30 March 2017, Amman, Jordan
- **Argus FMB Asia Fertilizer 2017**
  Argus FMB
  29-31 March, Beijing, China

April 2017

- **Argus FMB East Europe Fertilizer 2017**
  Argus FMB
  21-23 April 2017, Budapest, Hungary
- **Argus FMB Added Value Fertilizers**
  Argus FMB
  24-26 April 2017, Miami, Florida

May 2017

- **4th International Symposium on Innovation and Technology in the Phosphate Industry**
  OCP
  8-10 May 2017, Benguerir, Morocco
- **85th IFA Annual Conference**
  22-24 May 2017, Marrakech, Morocco

October 2017

- **Argus FMB Europe Fertilizer 2017**
  Argus FMB
  18-20 October, Barcelona, Spain
- **2017 IFA Crossroads Asia-Pacific Conference**
  24-26 October 2017, Shanghai, China

November 2017

- **2017 IFA Strategic Forum**
  14-15 November, Zurich, Switzerland

UFC Manufacture for Urea Production

ANDREAS MAGNUSSON
Johnson Matthey
Perstorp, Sweden

JOHN PACH, KATE MCFARLANE, DARREN WARD
Johnson Matthey
Billingham, UK

Formaldehyde in the form of UFC-85 is used as an additive in the manufacture of solid urea. Formaldehyde is synthesised from methanol which is normally purchased on the open market and is priced accordingly. In most cases, the quantity of UFC-85 that is required by any individual site is too small to justify investment in small scale methanol production and in a UFC-85 plant. Johnson Matthey's skills in catalyst design, along with ammonia, methanol and formaldehyde process technology development have been used to create a new and cost effective method of synthesising small quantities of UFC-85 which allows a urea producer to make significant savings when compared to the alternative of open market purchases.

1. INTRODUCTION

Johnson Matthey is a leader in catalyst and process technology development for the ammonia, methanol and formaldehyde industries.

With a heritage in ammonia dating back to the first decade of the 20th Century, Johnson Matthey (JM) currently offers a range of high performance catalysts, leading edge technologies and diagnostic services to our customers.

Today's methanol industry is based almost entirely around the low-pressure technology and catalysts developed and commercialised by ICI in the late 1960s. Since the acquisition of this business, Johnson Matthey has continued to adapt and improve methanol technology.

Johnson Matthey's range of DAVYTM technologies offers design, licence and commissioning expertise. The combined skills and experience of catalysts and process design is ideally suited to the development of innovative syngas flowsheets.

Johnson Matthey is renowned for the development and commercialisation of FORMOXTM formaldehyde technology and catalysts and has supplied more than 20 million MTPA (as 37wt%) capacity to a wide range of customers since the late 1950s. To put this into context, global demand in 2015 was about 45 million MTPA. By carrying out both catalyst and technology (flowsheet) development in the same organisation, any catalyst development can easily be implemented in the flowsheet and vice-versa. Johnson Matthey typically acts as an Engineering and Procurement contractor during the project phase of new formaldehyde plants and assists during erection and commissioning. After start-up Johnson Matthey continues to support plant operation with an extensive technical support program.

Johnson Matthey has continuously improved the FORMOX formaldehyde catalyst and technology and today our customers produce more than four times as much formaldehyde in the same size reactor as in the early 1960s. This increase in production also comes with a considerably improved yield, less than half the power consumption and more than double the steam generation.

The production and use of these three chemicals is linked. Carbon dioxide, a by-product of the synthesis gas generation process for ammonia manufacture, can be usefully combined with product ammonia to synthesise urea, an important fertiliser and chemical product. Solid urea is manufactured as prills or granules and formaldehyde (in the form of urea-formaldehyde concentrate or UFC) is used to condition granular, and sometimes prilled, urea. One of the most commonly used grades of UFC is UFC-85, a mixture of 60% formaldehyde, 25% urea and the balance water. Formaldehyde is produced from the oxidation of methanol, which in turn is produced from synthesis gas.

Generally, the formaldehyde additive required for urea conditioning is purchased from a third party as the small quantities required for an individual ammonia/urea plant are below the economic limit that

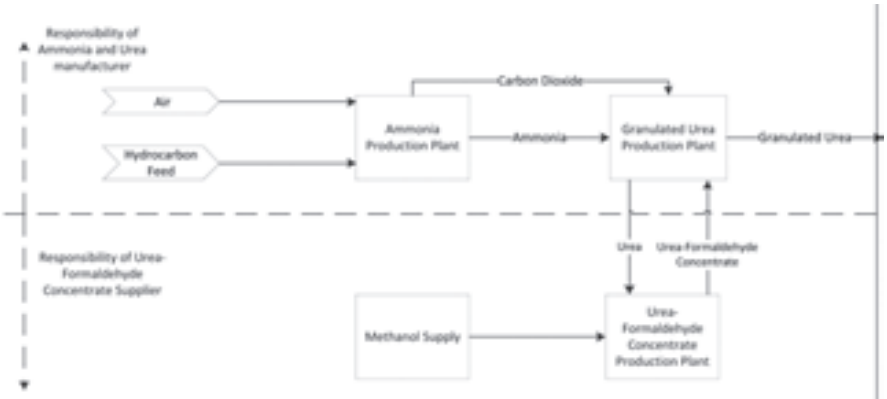


Figure 1: Standard arrangement of technologies

would justify investment in a stand-alone formaldehyde plant along with the associated methanol plant.

As a result, urea producers tend to purchase UFC-85 from third parties whose cost structure is based on the purchase (or opportunity cost) of methanol at market price which is normally at a considerable premium to the cost of the raw materials used to synthesise the methanol. The cost of the UFC-85 is then further increased due to transportation costs, the need to cover supplier overheads and return on investment criteria.

If an ammonia-urea producer could manufacture sufficient UFC-85 to meet their own needs in a plant that required only modest CapEx, using feedstock which otherwise only had fuel value and that could be operated with existing staffing levels, significant savings could be realised compared to the alternative of purchasing the UFC-85.

2. FLOWSHEET DEVELOPMENT

Using the knowledge and experience available across Johnson Matthey, a novel integrated scheme, which is the subject of patent applications, has been developed whereby the ammonia, methanol and UFC-85 production plants have been combined to provide reliability of supply as well as capital and operating cost savings.

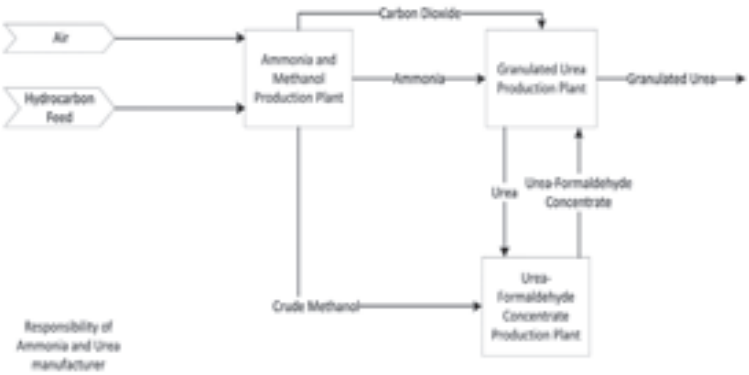


Figure 2: Arrangement of technologies when utilising the FORMOX integrated flowsheet from Johnson Matthey

The FORMOX integrated UFC process from Johnson Matthey uses the residual carbon oxides in the synthesis gas generated on the existing ammonia plant to produce methanol. This methanol can then be used to produce UFC for the urea plant. The bulk of the syngas remains and is then passed to a standard ammonia synthesis loop to produce the ammonia for urea production.

The scheme described here is proposed as a retrofit to existing ammonia-urea plants. However, it could also be conveniently applied to a new build project.

3. CO-PRODUCTION OF AMMONIA AND METHANOL

The first step in the integration of the three technologies is to produce methanol and ammonia on the same plant.

There are a multitude of flowsheet concepts for integrating ammonia and methanol production. Whilst some have been commercialised, others remain conceptual. This integration is possible as the syngas generation sections of ammonia and methanol flowsheets share many of the same unit operations and features, such as natural gas purification and steam reforming.

However, the purpose of the majority of the previously proposed co-production schemes was the bulk production of both ammonia and methanol. For example, ICI's METHAMM flowsheet would have been capable of producing 1100 mtpd of ammonia and 2200 mtpd of methanol.1

In the flowsheet considered in this paper for the provision of methanol for UFC-85 production the methanol requirement is much lower than the ammonia production rate. For example, a typical 2200 mtpd ammonia plant produces enough carbon dioxide to allow around 3500 mtpd of urea to be manufactured. Depending on the specific design of urea plant the UFC-85 requirement for this amount of granulated urea is 20-30 mtpd. To produce this much UFC-85 requires 14-21 mtpd of methanol. Therefore, existing co-production schemes for ammonia and methanol are not best suited to this application

3.1. Methanol Synthesis

The reactions involved in methanol synthesis are as follows:

$$CO + 2H_2 \Leftrightarrow CH_3OH \qquad \Delta H = -90.64\ kJ/mol$$

$$CO_2 + 3H_2 \Leftrightarrow CH_3OH + H_2O \qquad \Delta H = -49.67\ kJ/mol$$

$$CO + H_2O \Leftrightarrow CO_2 + H_2 \qquad \Delta H = -41.47\ kJ/mol$$

In commercial methanol production plants, the preferred conditions for methanol synthesis are:

- High pressure
- Moderate temperature
- Sufficient CO2 to synthesise the desired quantity of methanol

Based on this, there are three options to make methanol with syngas from the ammonia plant, as shown in Figure 3. The first (shown blue) uses gas from upstream of the shift section, the second (shown green) uses syngas from upstream of the methanator at the synthesis gas compressor suction pressure and the third (shown red) uses higher pressure syngas at an interstage pressure of the compressor, still upstream of a methanator.

Figure 3: Ammonia-methanol integration options

3.2. Upstream of High Temperature Shift (HTS)

In this flow scheme, the secondary reformer effluent is cooled and passed through a desaturator before being heated to methanol synthesis temperatures and fed to the converter. The product gas from the converter is cooled and the crude methanol separated. The unreacted gas from the separator is then re-saturated and heated back to the HTS inlet temperature before re-joining the standard flowsheet.

3.3. Upstream of Methanator – Low Pressure

In this flow scheme, the syngas that has passed through the shift section and the carbon dioxide removal system is heated before being fed to a methanol converter. The effluent from this converter is cooled and the crude methanol separated from the unreacted synthesis gas. The gas from the separator is then fed to the existing methanator feed/effluent interchanger and methanator.

3.4. Upstream of Methanator – High Pressure

In this flow scheme, the synthesis gas that has passed through the shift section and the carbon dioxide removal system is fed to the first stage of synthesis gas compression. The relatively high pressure synthesis gas is then heated before being fed to a methanol converter. The effluent from this converter is cooled and the crude methanol separated from the unreacted synthesis gas. The gas from the separator is then fed to a new high pressure methanation section.

3.5. Composition of Produced Methanol

The Johnson Matthey integrated FORMOX process allows formaldehyde to be produced from crude methanol. However, if the water content of the crude is too high, it is not possible to make UFC-85 without a concentration step (typically distillation). Products with a lower concentration of urea and formaldehyde can of course be made. The correct selection of methanol synthesis location within the ammonia plant allows crude methanol to be used directly in the FORMOX UFC-85 plant.

4. FORMOX INTEGRATED FLOWSHEET FROM JOHNSON MATTHEY

4.1. Ammonia Plant

The FORMOX integrated flowsheet developed by Johnson Matthey uses the residual carbon oxides downstream of low temperature shift and carbon dioxide removal to produce methanol. The choice between low pressure (compressor suction) and high pressure (compressor interstage) is assessed on a case by case basis.

In both cases, syngas is heated in a feed/effluent interchanger before entering a methanol synthesis reactor. The gas leaving the reactor is cooled in the feed/effluent interchanger and further cooled before the crude methanol is removed and sent to storage or the UFC-85 plant. The remaining gas passes through a methanator before being compressed to ammonia synthesis loop pressure.

4.1.1. Bypass Option

The production of methanol is limited by the amount of residual carbon oxides present in the gas stream exit the carbon dioxide removal system. In most cases this produces sufficient methanol to meet the UFC demand for an associated urea plant.

However, if the UFC and therefore the methanol requirement are higher than this limit allows, Johnson Matthey can design the flowsheet to incorporate a bypass around one or more of the HTS, the low temperature shift (LTS) and/or the CO2 removal system to increase the carbon oxide concentration inlet the

methanol reactor. It is important to choose the correct bypass location to minimise the impact on hydrogen production.

If using the bypass to synthesise more methanol, there will either be a reduction in ammonia make, or the feed rate of natural gas will need to be increased accordingly.

4.2. Urea Formaldehyde Concentrate (UFC-85) Production

Production of formaldehyde and UFC uses well established technologies. Johnson Matthey's FORMOX process employs mixed oxide catalyst technology due to its superior yield, high steam production and because it makes it possible to produce UFC-85 directly in the same plant.

The main principle is to partially oxidise methanol in the presence of air to form formaldehyde and water. The gas mixture of formaldehyde, water and air is separated in an absorption column in which water is condensed and the formaldehyde is absorbed into the water. UFC is produced when formaldehyde is absorbed into a urea solution which is fed to the column. The oxidation process consumes oxygen; hence oxygen needs

to be provided to the process and oxygen lean gas has to be removed. The oxygen lean gas contains traces of formaldehyde, methanol and carbon monoxide and is passed over a noble metal catalyst incinerator (emission control system or ECS) in which trace impurities are converted to carbon dioxide and water.

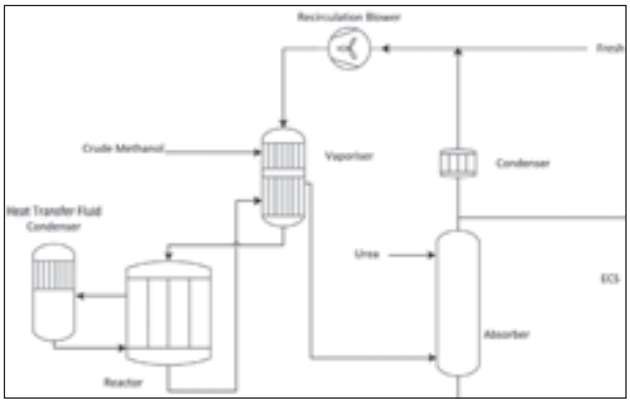
4.3. Ammonia and UFC Plant Integration

Standard FORMOX plants from Johnson Matthey are designed with flexibility in mind and either UFC-85 or formaldehyde can be produced on the same plant. However, if the plant is only required to produce UFC-85, it is possible to reduce capital cost by replacing the second stage of the absorption tower with a gas cooler/condenser.

The small UFC plant required for the FORMOX integrated flowsheet only takes up around a 200 m2 plot, meaning it can easily be situated alongside most ammonia plants.

The plant can be configured to produce UFC concentrations other than 85% and can be designed to operate with crude methanol. Although operating with crude methanol is uncommon, it is not a new concept. Further integration is also possible and is offered on a case by case basis. An example integrated UFC plant flow sheet is shown in Figure 4.

AbsorberFresh AirECSUFC-85CondenserRecirculation BlowerVaporiserCrude MethanolReactor



5. OPERATION

5.1. Ammonia Plant

5.1.1. Catalyst

The methanol synthesis section of the plant uses the KATALCOJMTM 51-Series of methanol synthesis catalysts. The high and stable activity of this catalyst allows methanol production to be carried out at low temperatures that minimise the formation of by-products such as high alcohols, hydrocarbons, aldehydes and ketones.

5.1.2. Reduction and Start-Up

The reduction of methanol synthesis catalyst is similar to the reduction of low temperature shift catalyst. Natural gas or nitrogen can be used as carrier gas and the reductant may be pure hydrogen or synthesis gas. Once the catalyst is reduced, synthesis feed gas can slowly be introduced to the bed and methanol produced.

5.1.3. Operational Considerations

It is inevitable that there will be small amounts of methanol and other by-products in the feed to the methanator. Johnson Matthey's proven KATALCOJM 11-Series catalysts reduce their concentration to levels suitable for the ammonia synthesis loop.

The methanol synthesis section can be isolated from the rest of the ammonia plant. This means that the ammonia plant can be started up using existing methods and the syngas which is generated during normal operation can then be used to reduce and start-up the methanol synthesis section.

The integrated scheme is designed to avoid issues associated with the reaction of ammonia with carbon dioxide to form ammonium carbamate and the reaction of ammonia with methanol to form trimethylamine.

The final change that may be encountered due to the addition of a methanol synthesis section is that the hydrogen recycle to the front end of the plant could now contain carbon oxides. As a result a nickel-molybdenum hydrodesulphurisation catalyst such as KATALCOJM 61-1T may be recommended.

5.2. UFC-85 Plant

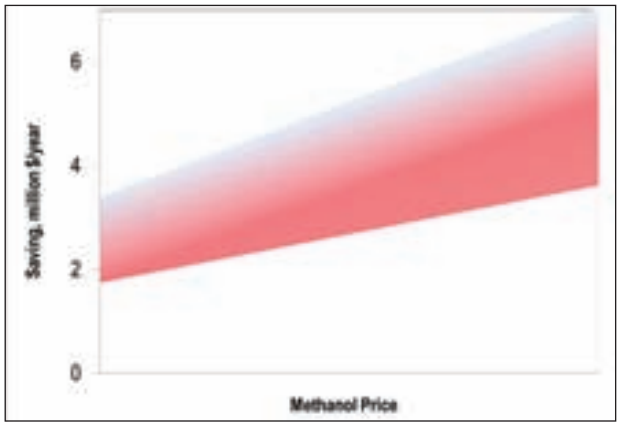
The UFC plant is of a proven standard design used in plants worldwide with minor adjustments to reduce capital cost by integration with the ammonia complex. However the capacity is lower than that of a normal FORMOX plant to match the UFC requirement for an individual complex.

The UFC plant is simple to operate which means that existing operators on the ammonia-urea complex will be able to manage the small UFC plant installed as part of the Johnson Matthey FORMOX integrated flowsheet. Johnson Matthey will provide training for these operators along with providing regular operating recommendations based on plant operating data to ensure optimal performance and reliable production.

Alongside this, the automated plant control and trip system is designed to maintain correct conditions in the reactor and absorber column to consistently give an in-specification product and safe operation.

Occasional UFC-85 plant shut-downs are required to replace the catalyst. The catalyst lifetime is dependent on the plant operating rate, but will be a minimum of 8 months. The change-out duration is around 5 days.

The UFC plant can be configured either to consume urea solution generated on the adjacent urea plant or to consume solution generated by dissolving solid urea.



Johnson Matthey's FORMOX UFC plant is designed to limit emissions to the environment via waste. There is no liquid or solid waste from the process as condensate is used to dilute urea solution or dissolve solid urea while the spent catalyst can be sent back to Johnson Matthey for reprocessing. Gaseous waste, in the form of tail gas, is treated in a proven proprietary emission control system ensuring that stack emissions meet any government requirements worldwide (including the new EU standards).

5.3. Crude Methanol and UFC Storage

The crude methanol storage system will follow standard, proven designs. In retrofit cases the urea plant would be likely to have an onsite UFC storage tank and this could be used to store UFC produced in the new plant.

6. BENEFITS

6.1. Running Costs

The major benefit of the FORMOX integrated flowsheet from Johnson Matthey is the reduction in the cost of purchasing methanol or UFC-85. The operating costs of the UFC-85 plant itself are minimal.

The range of potential savings that can be achieved using the integrated FORMOX flowsheet on a standard 2000 mtpd ammonia plant making around 3200 mtpd granulated urea are shown in Figure 5 below.

The figure uses a range of recent methanol prices for the assessment of savings. The lower range of savings in the figure relate to customers who already have UFC production facilities on site and would save only the cost of importing methanol to their UFC plant. The upper range relates to customers who import UFC so are paying additional a margin to the UFC producer and additional transportation costs. Further operational savings can be achieved but vary case by case.

6.2. Capital Costs

The capital cost of the process is competitive when compared to the alternative of purchasing UFC-85 at prices which reflect those of traded methanol.

6.3. Flexibility and Reliability

As the methanol synthesis unit can bypassed, there is no impact on ammonia plant reliability. Instantaneous methanol/UFC unit capacity and intermediate storage tank size allows sufficient inventory to be built up to cover a formaldehyde catalyst change without affecting ammonia or urea production.

6.4. Synthesis Gas and Ammonia Loop

In the case of a retrofit of an existing plant, the hydrogen content in the synthesis gas to the ammonia loop is increased and the methane content is reduced. This means that the retrofit may allow an increase in ammonia make or an improvement in efficiency.

$CO + 2H_2 \bullet CH_3OH$ Methanol production

$CO + 3H_2 \bullet CH_4 + H_2O$ Methanation

As shown by the reaction equations above, the production of methanol from carbon monoxide uses less hydrogen per mole of carbon oxide removed than the methanation reaction. Therefore, as some of the residual carbon oxides are removed by producing methanol it means that there are less carbon oxides in the methanator feed so less hydrogen is consumed overall than in a standard flowsheet. The second effect

is that because the methanator has less carbon oxides to convert there is less methane produced which results in a lower methane content in the loop.

On a typical 2200 mtpd ammonia plant using the FORMOX integrated flowsheet, the natural gas feed to the primary reformer can be reduced while still achieving the same production rate of syngas and ratio of hydrogen to nitrogen in that syngas. This also reduces the firing required on the primary reformer and gives a total natural gas saving of around 250 Nm3/h or 0.4% of the standard flowsheet.

6.5. Crude Methanol Usage

The flowsheet allows the use of crude methanol in the UFC-85 plant which reduces the capital and operating costs of the plant compared to stand-alone units that could be supplied.

6.6. Further Uses of Urea Formaldehyde Concentrate

Urea formaldehyde concentrate is not only used to stabilise granulated urea. On sites where more UFC can be produced than is required on the associated urea plant the surplus UFC could be sold into other industries.

7. CONCLUSIONS

Johnson Matthey has combined its knowhow in ammonia, methanol and formaldehyde production to deliver an innovative new way of producing UFC-85 which will generate significant cost savings when compared to the alternative of purchasing UFC-85 from third parties.

The FORMOX integrated UFC process, which is the subject of patent applications, is now offered commercially.

References

1 "Ammonia or Methanol: The choices", K.J. Elkins, Paper 9, IMTOF 1995, San Francisco

Opportunities to Improve Phosphate Beneficiation

By:
Scott Turner

Abstract

With the fluctuation in phosphate fertilizer prices, rock producers continue to seek new and innovative technologies to improve efficiency and reduce the unit costs of phosphate beneficiation. In recent years, Jacobs has proposed the use of a variety of advanced technologies to clients in the phosphate industry to address these concerns. This paper provides an overview of three technologies that exhibit great potential to improve the phosphate beneficiation process in the areas of water recovery, comminution, and flotation. Ultimately, laboratory and pilot plant test work is required to validate the suitability of each technology for specific ore bodies.

1. Introduction

In the mining industry beneficiation in extractive metallurgy, is any process that improves (benefits) the economic value of the ore by removing the gangue minerals, which results in a higher grade product (concentrate) and a waste stream (tailings).

Jacobs Engineering Lakeland (Jacobs) office Florida has been involved in the phosphate industry for over 30 years and having an onsite laboratory (metallurgical, pilot plant and a full chemical analysis laboratory) differentiates us from other engineering companies. Over the past 30 years Jacobs Lakeland has been involved in phosphate projects around the world including test work and engineering.

During that period of time, phosphate processing has undergone some notable changes. The easily beneficiated ores that required only washing with minimal flotation are being replaced by more complex and difficult to treat ores. Water conservation has become critical to the viability of a given deposit.

Most of our recent beneficiation projects involve ore deposits that are much more difficult to process than the ores that were mined and treated 30 years ago. There are three (3) problems that we have encountered on almost every new phosphate mining project that we have been involved with:

- Loss of phosphate values to the waste fines – todays ores are not liberated to the extent that previous ores have been, so that grinding to less than 300 micrometers is required. The comminution processes that we have traditionally used can lead to very high losses to fines.
- Flotation recovery (particularly carbonate flotation) – carbonate flotation has proven to be much more difficult than the phosphate / silica separations.
- Amount of fresh water makeup required by the process – the lack of available water resources and stricter environmental regulations are forcing producers to find much more efficient water recovery methods, than dumping wastes into a pond and recirculating the overflow, or merely disposing of the wastes with our water recovery.

Recently we have conducted phosphate beneficiation studies including test work on:

- Process water recovery
- High pressure grinding rolls (HPGR) in a phosphate beneficiation plant

In addition the above, Jacobs has knowledge regarding:

- Eriez column flotation technology

2. Process Water Recovery

2.1 Background

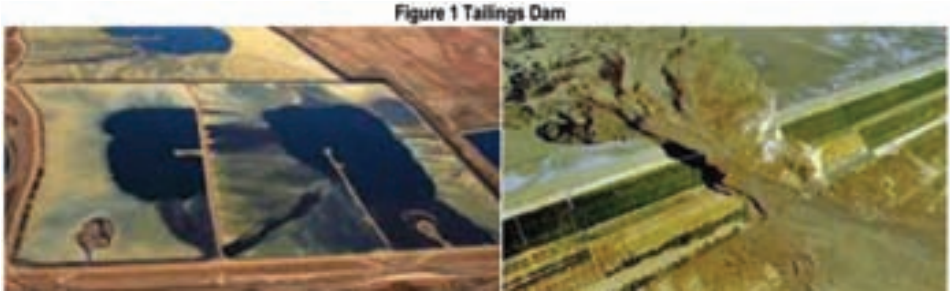
Many current operations use conventional thickeners to recover some of the process water and the underflow material from the thickener is pumped out to a tailings dam. Conventional water recovery systems are employed at the tailings dam. These systems could be a Penn stock arrangement, a floating pump and pontoon, or a simple gravity system. This method of operations is highly dependent on the ability of the material to separate, allowing the water to be recovered. Process water recovery from these types of operation can vary, typically total water recovered (thickener overflow plus tailings dam recovery) is not very high.

This mode of operation does not maximize process water recovery; the tailings facility requires a very large area to contain the material. The tailings facility may exhibit potential environmental issues and in some cases the tailings facility can fail resulting in damage to surrounding areas and even fatalities.

This paper will provide an overview of two process water recovery systems that maximize process water recovery, namely:

1. Soane ATA ™ and
2. Thickening and filtration

Figure 1 Tailings Dam



2.2 Soane ATA TM

This process comprises of three basic components: an activator polymer, a tether polymer and an anchor particle. The activator pol-

ymer is added to the tailings stream, causing the suspended fine particles to aggregate. Separately, anchor particles are coated with a tether polymer. When the two streams are combined the tether bearing anchor particles quickly bind to the aggregated fines producing two output streams, clean water and de-watered solids.

Jacobs conducted on site test work at an operation in the USA (confidential client). The test work involved setting up of the plant, operation and sampling.

Figure 3 Dewatered Product

2.2.1 Gravity Filtration (210 micron screen) Results

- Feed % solids of 5%
- Dewatered material was 50-55% solids by gravity (almost an instantaneous separation)
- Dewatered material was suitable for direct stacking

2.2.2 Mechanical Filtration (filter press)

Taking the dewatered material and subjecting it to a filtration stage highlighted the following:

- 80% solids was achieved
- High mechanical coherency
- Final dewatered product

The test work concluded the following points:

- Combines fines and coarse tailings into clear recyclable water and stackable tailings
- Eliminates fluid tailings ponds
- Maximizes water recovery and re-use
- ATA™ solids build strength quickly for easy storage (resistant to re-dispersion if exposed to water/rain)
- Allows for creation of trafficable landscape quickly to facilitate progressive reclamation

Soane ATA TM developed in house cost comparisons of current technologies available

2.3 Thickening and filtration

Phosphate metallurgical study test work typically will generate three process streams, namely:

- Final phosphate concentrate slurry
- Final phosphate tailings slurry
- Fine particle sized slurry material.

Operations have relied on large conventional ground thickeners for thickening waste streams as shown below

Recent test work and metallurgical studies carried out by Jacobs have introduced the hi-rate thickener and paste thickener to our clients. These types of thickeners are extensively used in other mineral processes.

2.3.1 Hi-Rate Thickener

The hi-rate thickener design has higher side walls than a conventional type thickener which allows the hi-rate thickener to process 5-10 times higher throughput than a conventional thickener of equal size. Due to the higher side walls, compaction is better resulting in higher underflow densities.

Recent test work of flotation tailings (212 micron) has shown that underflow densities of 70% solids are easily achievable using a Hi-Rate style thickener. Using mechanical filtration (vacuum filtration) of the underflow stream tests has shown that the filter cake can be as low as 20% moisture.

The Hi-Rate thickener has the following advantages over conventional large diameter thickeners:

- Smaller foot print.
- Above ground, easy access for maintenance of slurry pumps, piping and valves.
- Rake mechanism can be raised or lowered automatically or manually during operations. Lowering the rake mechanism can increase underflow densities. Raising the rake mechanism can decrease underflow densities and lower the torque measurement for the rake mechanism.
- Has in built auto dilution system.

2.3.2 Paste Thickener

The paste thickener uses a height to diameter ratio of greater than 1:1. This results in a much higher settled bed depth compared with other thickeners and allows for higher underflow densities especially for fine particles. These thickeners have been successfully used in preparing a paste mixture (thickened slurry plus cement) for back filling in an underground mining operation.

Recent test work of fine material (38 micron) has shown that underflow densities of 63% solids are easily achievable using a Paste thickener. Using mechanical filtration (plate and frame filtration) of the underflow stream tests has shown that the filter cake can be as low as 22% moisture.

The Paste thickener has the following advantages:

Table 1 Soane ATA Cost Comparison

Technology	CAPEX ($MM)	OPEX ($/ton tailings)
Tailings Pond	$50MM – $100MM +	$1.50
Thickening	$30MM (Equip) $30MM (Pond)	$4.10
ATA®	$10MM	$3.75

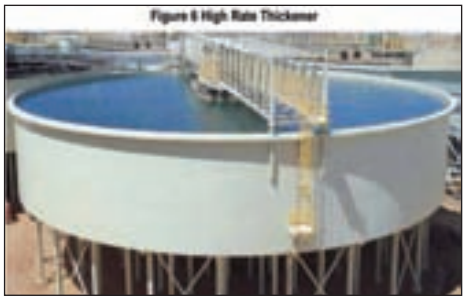


Figure 6 High Rate Thickener

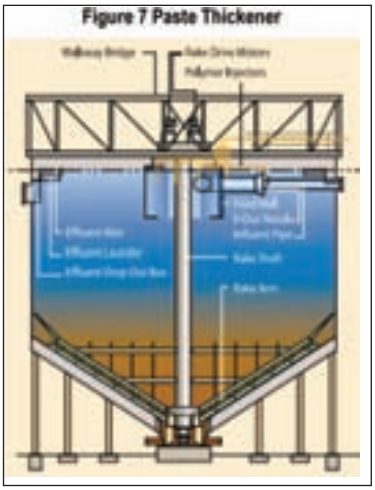


Figure 7 Paste Thickener

• Proven technology for settling fine particles.

• Above ground, easy access for maintenance of slurry pumps, piping and valves.

• Picket fences can be installed onto the rake mechanism to allow for better settling.

In summary Hi-Rate and Paste thickeners (with filtration of the thickener underflow) test work may result in 80% process water recovery. This increase in process water will reduce the overall size of the tailings facility and require less make up water to be provided. Additionally the area required for these types of thickeners is much lower than the area required for a conventional thickener.

3. High Pressure Grinding Rolls (HPGR)

3.1 Background

The HPGR uses high pressure inter particle comminution to grind various industrial minerals. It has been successfully used in the cement industry and more recently in the gold mining industry.

3.2 Phosphate Beneficiation Plant

Jacobs carried out metallurgical test work on a phosphate deposit comprised of soft and competent ore. It is well documented that generation of fine material by crushing and milling (-38 micron) effects the flotation process.

New phosphate projects require milling to liberate the phosphate mineral prior to flotation. Test work has highlighted that conventional processing result's in near size material reporting to the mill. This material ends up as fine sized material and is lost during de-sliming prior to flotation. This loss can be significant in both mass and recoverable phosphate.

Conventional milling circuit has been used in the phosphate industry. This typically comprises of a wet screening stage ahead of the mill. Screen oversize feeds a Rod Mill and screen undersize and mill product is classified (cyclones). Cyclone underflow is returned to the rod mill and cyclone overflow is de-slimed to produce a feed to flotation.

Jacobs decided to break with convention and develop a process that would minimize fines generation. The flow sheet developed was to remove smaller/softer particles early on in the process and produce a clean crushed ore oversize feed stock. This material would be processed through a High Pressure Grinding Rolls (HPGR) operating at different parameters than normally would be practiced. These parameters were coarser closed side setting, and low roll pressure.

The size fraction (-9+1mm) was tested using a laboratory scale HPGR at SGS Lakefield Canada. The HPGR parameters used for the tests were a coarser closed side setting in conjunction with low roll pressure. The objective of the test was to allow the clean oversize material to be broken using the natural grain boundaries without excessive breakage.

The results highlighted very little breakage on the larger particles (-9 to +2.36mm). At 2.36mm size almost 44% breakage had occurred and this trend continued.

The role of the HPGR was:

• Gently break the particles with generating too much smaller sized particles.

• This material would feed the mill and the mill discharge would be classified to produce the correct feed size for flotation.

• Smoother operation around the milling circuit by eliminating particle size fluctuations from the crushing circuit by simply changing HPGR settings.

• Smoother operation around the milling circuit by eliminating fluctuations in ore hardness coming from the mine.

4. Eriez Column Flotation

4.1 Background

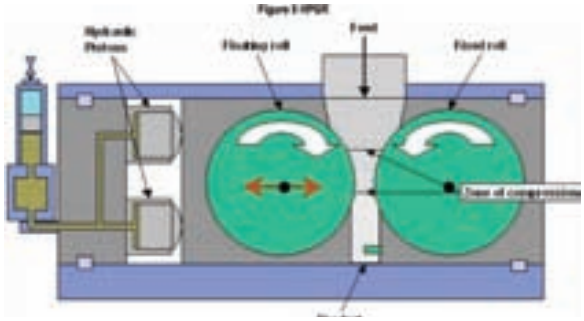
ERIEZ have developed a column cell that is currently being used in a number of commodities. The ERIEZ column has a unique sparging system and froth wash water. The ERIEZ column cell has successfully floated phosphate feed with fine particles. The mechanism which allows this to happen is:

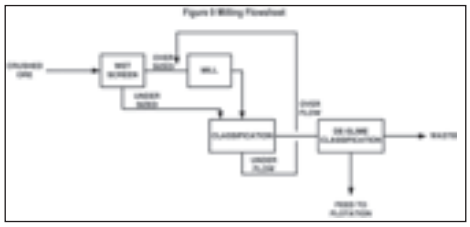
• Wash water over the froth (in reverse flotation this allows fine phosphate particles to separate from the gangue minerals).

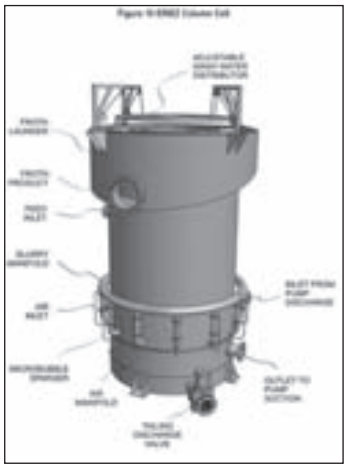
• Bubble size and mechanism for generating bubbles.

4.2 Flotation Test work

Jacobs is currently working on a pre-feasibility study including metallurgical test work for a phos-







phate project in North Africa. The flotation tests have excluded a de-sliming stage after milling and the particle size to the flotation includes fine material (150-0 micron). The test work has highlighted a potential selectivity problem for the silica flotation stage. The grade and recovery are good but have not met the requirements of the client.

Eriez have conducted silica flotation test work using their laboratory column flotation cell on -53+10 micron material. The test work results have indicated that using the column cell with a feed grade of @12.5% P2O5 produced a final concentrate of @33%.

With this knowledge and our close relationship with ERIEZ, Jacobs believe that the column cell bubble generation, longer retention time and wash water may improve the selectivity issue for the silica flotation stage. Jacobs have recommended that the client contacts ERIEZ to carryout test work using their column cell.

Table 2 ERIEZ Flotation Test Results -Feed

Test No.	Feed				
	P_2O_5 (%)	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)
1	12.33	62.86	1.23	0.66	17.32
2	12.43	61.87	1.12	0.66	17.34
3	12.91	60.91	1.09	0.68	17.98
4	12.09	62.90	1.18	0.66	17.07

Table 3 ERIEZ Flotation Test Results Non-Feed

Test No.	Non-Float				
	P_2O_5 (%)	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)
1	33.29	7.00	1.35	1.51	45.51
2	34.16	6.49	1.19	1.63	47.09
3	32.75	7.69	1.08	1.61	44.92
4	32.00	8.50	1.23	1.51	44.95

Table 4 ERIEZ Flotation Test Results Float

Test No.	Float				
	P_2O_5 (%)	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)
1	1.91	90.64	1.17	0.24	3.30
2	1.51	89.71	1.09	0.18	2.41
3	1.00	92.86	1.10	0.12	1.80
4	1.40	92.13	1.15	0.20	2.10

Table 5 ERIEZ Flotation Test Results

Test No.	Non-Float Yield	P_2O_5 Recovery	SiO_2 Rejection
1	33.22	89.7	96.3
2	33.46	91.9	96.5
3	37.51	95.2	95.3
4	34.94	92.5	95.3

5. Conclusions

Global phosphate deposits have differing characteristics and metallurgical test work is the basis for an engineering solution to achieve the optimum result. Based on test work it is possible that using the latest technology the following can be achieved;

- Increase overall process water recovery – results have highlighted that 80% of the process water can be recovered.
- High pressure grinding rolls (HPGR) in a phosphate beneficiation plant especially on clean coarse sized material can reduce the particle size without generating excess fines.
- Eriez column flotation technology – has the potential to improve selectivity of flotation feed that contains fine sized material (20 micron).

6. References

- EREIZ – column flotation test work results.
- Jacobs Pre-feasibility study - Silica Flotation test results.
- SOANE ATA TM
- Thickeners – Hi-Rate – Jacobs - Bankable feasibility test work report.

  Paste – Jacobs – Bankable feasibility study test work report.
- High Pressure Grinding Roll (HPGR) – Jacobs – Bankable feasibility report.

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