

1 9 9 8

T e c h n i c a l

C o n f e r e n c e

D i s c u s s i o n s

Marrakech, Morocco
28 September - 1 October

INTERNATIONAL FERTILIZER INDUSTRY ASSOCIATION
28, rue Marbeuf - 75008 Paris - FRANCE
Tel: +33 153 930 500 Fax: +33 153 930 545/6/7 - Email: ifa@fertilizer.org
Web: <http://www.fertilizer.org>

CONTENTS

WELCOME ADDRESS BY S.H. MADANI	<i>i</i>
WELCOME ADDRESS BY M. KSIKES	<i>ii</i>
<u>PLENARY SESSION: "GENERAL I"</u>	1
<u>PLENARY SESSION: "GENERAL II"</u>	6
<u>PARALLEL SESSION: "NITROGEN"</u>	12
<u>PARALLEL SESSION : "PHOSPHATE"</u>	18
<u>PARALLEL SESSION: "ENVIRONMENT"</u>	24
<u>PARALLEL SESSION: "PHOSPHATE/POTASH"</u>	28
PAPER 11 Environmental and energy optimization with cold production (chilled water) in an existing ammonium nitrate plant F. Galindo and S. Corton , Fertiberia S.A., Spain	35
PAPER 29 Coûts de la protection de l'environnement à Lovochemie : nettoyage d'un site pollué <i>Environmental costs in Lovochemie: cleaning-up of a polluted site</i> P. Svarc , Lovochemie a.s., République Tchèque	43
PAPER 33 Phosphate technology for the next millennium R.L. Hemmings, C.J. Felice and M.W. Huang , Raytheon Engineers & Constructors Inc, United States	61
PAPER 34 Policy of JSC Apatit in improving its apatite concentrate for consumers' needs A. Gorbachev and V. Golovanov , JSC Apatit, Russia	68
<i>Paper presented at Jorf Lasfar visit:</i>	
• Réhabilitation des unités phosphoriques de Jorf Lasfar, une concrétisation du savoir faire interne <i>Revamping of the Jorf Lasfar's phosphoric units, an implementation of internal know-how</i> A. El Fakir and A. El Belghiti , Groupe OCP, Maroc Phosphore, Morocco	76

WELCOME ADDRESS BY S.H. MADANI

Chairman of the Technical Committee

Honourable host, Mr. Ksikes, Ladies and Gentlemen.

On behalf of the Technical Committee, I wish to express my special thanks and sincere appreciation to OCP which has so kindly invited us to this lovely and gorgeous ancient city, where we will have opportunity to enjoy its warm hospitality and witness the artistic talents of Marrakech through its architecture and craftsmanship.

As some of us recall, last year we celebrated the 50th anniversary of the Technical Conference in another lovely and historic city, Sevilla. For this conference, to have such a long continuity and faithful following through this intensive participation, it must serve a useful purpose. In this context, I am proud and wish to congratulate the management of some 85 member companies in 41 countries for their wise decision to send participants to this conference. As stated in the mission statement to be presented to the Association's Council next November in New Delhi: "The Committee will actively promote the development of efficient, responsible production, storage and transportation of all plants nutrients in a sustainable manner". Over the last fifty years, this mission, representing the core goal of the Technical Conference, has remained largely unchanged. Perhaps, the only significant shift is towards environmental sensibility and safety in the workplace.

This conference continues to be the platform for our engineers to exchange information as well as an important source of technological innovations. For the many young engineers who are gathered here today, and to those who are here for the first time, the Technical Conference should be the source of inspiration in which your company has invested by your participation. So I would like to call all of you assembled here, for further development towards the Committee's activities. As you are fully aware we have completed a decade of globalization of the economy, still there are many activities we can do together: benchmarking of emission and energy consumption, incident reporting, fertilizer standardization, regulations on transportation and storage, and so forth.

We need not wait for a regulation to be imposed before we call the Secretariat to convene a working group on that particular regulation. So you and only you can convince your management that the activities would be beneficial to your company or to your society. Therefore, when called upon for information and co-operation in our future activities, we hope you would respond actively to our appeal.

Before I conclude, I would like to express my deep gratitude once again for our host, OCP, for its warm welcome and generosity, also I would like to take this opportunity to thank the authors of papers, and the members of the Editorial Board for all their excellent efforts. And I wish to thank the members of the Technical Committee and Sub-Committee, the Chairmen of Sessions and their rapporteurs, for sparing their valuable time to make this conference such a success. Finally, to all the participants, thank you for your continuing support, wishing you an excellent deliberation.

May I now invite Mr. Ksikes to present his welcome address.

Your excellency, the floor is yours.

WELCOME ADDRESS BY M. KSIKES **Directeur Commercial Délégué, OCP, Morocco**

Your Excellency Mr. Sameh Hussain Madani,

Ladies and Gentlemen,

It is a great pleasure for me to welcome you at this new session of the IFA Technical Conference. A warm welcome also to Morocco and to the prestigious city of Marrakech. Here we are, ready to spend a few days together in this splendid setting of The Palmeraie discussing and exchanging our knowledge and experiences in the fields we are concerned with. This is certainly most rewarding and enriching for the fertilizer technicians we are!

Fertilizer Production and Environment

This conference, which is unique in its kind as it gathers such a great number of experts and scientists from all over the world, has no other ambition but review the technological status of the fertilizer sector and make a maximum of players benefit from the latest innovations. Of course, we are talking here of the fertilizer sector in its broadest meaning, that which starts with research and production of raw materials and ends with distribution and application of the final product, including the numerous intermediate activities and concerns.

In our sector of activity, we cannot any more be content with just producing and selling! It is our duty to follow and evaluate the impact of our actions. It is our responsibility to supply the farmer just as it is the farmer's responsibility to feed us. Therefore, we should walk hand in hand so that we can advance. We all are truly concerned with contributing to feed people, but contributing in the safest and most ecological way. Environment protection is a concept that should be present in the mind of every leader in the industry whenever he has to make a decision, especially when such decision has to do with the future developments of the industry.

However, we must remain careful so as to avoid excesses! No doubt, our sector is determined to preserve environment and observe any discipline required in this respect, but we must keep in mind that it first has the vocation and, more than that, the duty to contribute with fertilizers in meeting the food requirement of an ever growing world population. The United Nations Fund for Population reported less than a month ago that the planet population will reach 6 billion by mid-99. Also, it goes without saying that, just like any other economic activity, to survive and expand, our industry must be efficient and profitable!

World Trade of Fertilizers

After many years of profound disturbances followed by a period of great efforts of restructuring and readjustment to the new climate resulting from globalization of the economy, the fertilizer industry seemed to have found the path towards a certain equilibrium. The world trade of fertilizers and their raw materials is still short of the good performances achieved in the past, but prospects are relatively promising. However, we have to learn from history and remain vigilant. It is essential that, in such a turbulent world, any new investments be made in the best thought and the most responsible manner in order to avoid such excesses that bring about chaotic situations.

The Moroccan Economy

1/ Phosphate

These brief general observations being made, I would like, Ladies and Gentlemen, to give you an idea about the Moroccan economic policy before saying a word about OCP Group's policy in terms of investment and partnership.

2/ Agriculture

Agriculture is a key sector in the Moroccan economy; according to the harvests of the year, it generates 10 to 15% of the GDP and employs around 40% of the total workforce. Morocco is a net exporter of fruits and vegetables and a net importer of cereals. Fisheries, which - as you all know - is part of the agricultural sector, is of crucial importance for Morocco; it employs more than 100,000 people and its exports accounted for 800 million \$ in recent years, which represents 17% of foreign trade revenues.

3/ Industry

In 1995, the industrial sector represented about 19% of the GDP and is steadily growing at a pace of 2 to 3% per year. The first national industry is phosphate processing, followed by oil refining, cement, food processing, textile, wood and paper, metals, rubber, plastics and vehicle assembly. As an example, the growth of the garment industry during the last decade is attributable to the competitive cost of labour, to the proximity of European markets and to a temporary admission system, which allows duty-free imports.

Foreign investment

It is a prevailing opinion that the Moroccan economy at this point of its history is characterized by a more and more concrete opening and transparency. These are the main qualities sought by international investors who are interested by a country like ours. As far as we are concerned, we think that flows of foreign capital are a necessity for the developing countries since local savings capacity remains well below the investments needed.

Moreover, we are aware that the globalization challenge for the developing countries will depend in the coming years upon their capability to attract foreign investments.

Foreign investments in Morocco increased from \$ 77 million in 1984 to approximately \$ 400 million in 1996. In our view, this is still not in line with the Moroccan potential and the numerous assets and advantages offered by the country such as:

- the proximity of Europe which is *per se* a great advantage,
- the transparency which is increasingly evident in the government's policy in terms of national economy,
- the restructuring of the Treasury and the return to macro-economic balance,
- a greatly expanding national market, a well developed and modern banking system,
- a skilled and competitive workforce.

Foreign funds invested in Morocco come from various sources. In the period 1993-95, France was ranking first with more than \$ 424 million, i. e. nearly 27% of the country's total foreign investments. Great Britain was second with \$ 251 million (16%), followed by Switzerland, the USA, the Netherlands and some Arab countries of the Middle-East. By sectors of activity, foreign investors are clearly first interested by banks, industries and holdings, these three sectors having absorbed 70% of foreign investments between 1993 and 1995.

Indeed, by European standards, foreign investments in Morocco are rather modest with around \$ 400 million in 1996. They accounted then for a quarter of global investments. It is clear that privatization, an extensive program launched in 1993 and which is still going on with success, offers a wider choice to potential investors and play a crucial role in attracting foreign funds. During the period 1993-95, privatization operations attracted nearly one third of the total foreign investments made in Morocco.

Under its policy of encouraging investment, the government elaborated and promulgated an "Investment Charter" in 1995. The Charter is a document which presents all incentives offered and states the measures designed both to simplify the administrative procedures to benefit from the advantages granted. It also provides for generalization and harmonization of such encouraging measures as well as their automatic attribution to all investors, independently from the sector and site selected.

A foreign investor has many reasons to be interested by Morocco. One of the country's main features is its political stability which ensures the durability of its institutions and facilitates the opening of its liberal economy on the external world. In addition, its unique and strategic geographic makes it a special commercial and financial place and a natural bridge between the Western world and the African countries. For its part, the Moroccan market is the most important and the most promising one in the Maghreb with 32 million people, or potential consumers, projected for 2000. More than half of this population is already living in urban areas, and requirements to be met are still considerable. Here are a few indications: one car for 43 people, one TV set for 18 people, one telephone set for 68 people.

OCP Group: A policy of partnership

As for OCP Group, the biggest company in the country and in the region, it has - as you can imagine - a paramount role to play in the promotion of the national economy. To fulfil what it considers as its duty, it endeavours to be as active and dynamic as possible in bringing in foreign capital. Nevertheless, it is also motivated by other considerations, the most important of which are the acquisition of know-how and the setting up of long lasting alliances with consumers. This is why we have basically opted for the partnership solution. Our two major projects illustrating such policy are:

- 1/ Emaphos, or Euro Maroc-Phosphore, a unit of 120,000 tons P_2O_5 per year purified phosphoric acid built in Jorf Lasfar as a joint venture with Belgian and German partners. The unit, which costed 50 million dollars, is running since March 1998.
- 2/ Imacid, or Indo Maroc-Phosphore, which is currently in construction and of which we share the capital with our Indian partner Chambal, a member of the Birla Group. This is a plant of 330,000 tons P_2O_5 per year phosphoric acid which is due to be on-stream by the middle of next year. The cost of the project is 230 million dollars.

Of course, our co-operation with the external world will continue to smoothly develop as we are seeking to widen it further.

In this respect, allow me to mention other examples :

- Our agreement with Grande Paroisse, France, for tolling 600,000 tons per year of phosphate rock,
- Our 10% participation in a granulation project in Pakistan, which will be exclusively supplied with Moroccan phosphoric acid,
- Our agreement with a leading Brazilian company for the promotion of our phosphate rock as a direct application product,
- A promotion campaign for Moroccan DAP to be used by the Chinese farmers.

Ladies and Gentlemen, during the few days you are going to spend in Morocco, you will have the opportunity to get acquainted with our company and our country but also with our people. It is my hope that, before you leave, you will have had better and more acute idea of both our economic and social environment and our culture.

I wish you all a very fruitful and pleasant stay.

PLENARY SESSION: "GENERAL I"

Chairman: S.H. Madani, Jordan Phosphate Mines Co., Jordan
Rapporteurs: K. Halaseh, Jordan Phosphate Mines Co., Jordan
A. Vuori, Kemira Agro Oy, Finland

PAPER 1 The OCP Group: its ready ability to adapt and meet customers' needs
A. El Houari, A. El Alouani and A. Arafan, Groupe Office Chérifien des Phosphates,
H. Boudou, Groupe OCP, Phosboucrâa, **A. El Fakir and J. Amharech**, Groupe
OCP, Maroc Phosphore, Morocco

Q - V.P. Kaushik, Duncans Industries Ltd., India

What is the "Value Addition" by giving colours to products like black or cream?

Ans. As I have said, some farmers have been accustomed for many years to use fertilizers. They are used to a particular type of fertilizer and its origin, which has a specific colour. These farmers do not understand exactly what is in the fertilizer but recognize the colour. When they are supplied with DAP with a clear colour, which they are accustomed to one with a darker colour, for them it is not DAP. They are not going to have it analyzed before using it. In order to obtain market share in areas where farmers react in this way, it is necessary to colour our product.

Q - B. Christensen, Kemira Agro Oy, Denmark

How do you meet customer's requirement on environmental friendly (low Cd) products? Do you have technology or is it due to various phosphate qualities?

Ans. Today there are no known economic or industrial processes for eliminating cadmium from these fertilizer products. Hence the low cadmium products which we put on certain markets are produced from phosphate rock which is low in cadmium.

PAPER 2 Organic and organo-mineral fertilizers in Europe - past, present and future
F. Samec, Grande Paroisse SA, France

Q - A. Van Brempt, Kemira International Services, Belgium

In the proposal of DG III Working Group, the nitrate N content cannot be higher as 1.5%. On which criteria is this safety limit defined:

- a. *Product safety investigations?*
- b. *Other considerations?*

P.S. Actual legislation for mineral ammonium nitrate based on fertilizers do not impose a limit on organic matter as far as the ammonium nitrate content is below 45%.

Ans. Thank you for that question. I can tell you one thing: there has been a "heated" debate on this subject but I will not point a finger to anybody.

You have quite rightly stated that with the nitrate fertilizers the DG III has stepped in order to ensure safety of straight nitrate fertilizers and since there will be the possibility of mixing nitrate-containing products with organics, which are basically reducers, this is basically a very unsafe undertaking. Now what I can tell you needs to be confirmed by more research; personally, I have run some research on mixing ammonium nitrate with organics and my testing shows very clearly that when the ammonium nitrate content goes over 10% of the whole product, there is something which I call "strike-a-match effect" meaning that if the mixture is heated above 170° Celsius, it just starts burning and you can't stop it. It may happen at even lower concentrations or temperatures. Such findings have to be

confirmed because what I did was just exploratory. All this unfortunately goes against some ideas which are current in some circles because people just do not think of the disposal of manures where there are processes which inherently transform existing nitrogen in those products into nitrate nitrogen by oxidation and the amount of the latter may go up well over 4.5% nitrate nitrogen. Now, if you multiply that by the right coefficient you can see how much equivalent ammonium nitrate you have. This is a very dangerous product. I hope you are satisfied and if you need more, I can tell you more but privately.

Q - F. Kabbaj, OCP, Morocco

My question concerned sewage slurry; the alternative to spreading is recovery of the nutrients. I understand that there is some research on this. I should like to know what stage it is at, and the costs.

Ans. The question is interesting but there is no simple reply. Effectively, there is a great deal of research and my company is working in particular on the recovery of P_2O_5 . There is also work on the recovery of nitrogen. The question is, once the N and P_2O_5 are recovered, what to do with the remainder, which represents 80% to 90% and which has to go somewhere. The regulations in Europe do not allow the residues to be disposed of in discharges, hence they have to be applied one way or another. On the other hand, if one wishes to recover the sludge as such with a view to authorized spreading, it cannot be transported or stored except as stabilized sludge, and for that it is treated with quick lime. Now any chemist will tell you, which you know well, that if you have soluble P_2O_5 and you add lime, you make something which is as "armoured" as phosphate rock. In other words, not of much use. Hence, in my view, these methods are not practicable, since the cost would be very high.

Q - E.H. Kendili, OCP, Morocco

My question concerns organo-mineral fertilizers. When you talk about these products there is thus part which consists of a support.

Ans. I will try to answer by saying simply "Sorry for the reply but there is no support in the sense that there is practically no inert material, unless you consider organic matter as being inert". There is, however, the case of certain fertilizers which the Italians and the English have tried to have classified as organo-mineral fertilizers through denomination as "organic" and which are based, for example, on peat. Normally peat does not contain organic nitrogen; it is practically an inert material and is not used as a fertilizer. The English have tried and we have said 'no' since, for such products, which are a support, there is another classification. In other words, for these to be called organo-mineral fertilizers, the organic part must supply nutrients, and the mineral part must supply nutrients but an inert fraction is not allowed for.

PAPER 3 Production synergy - fertilizers and chemicals - GNFC experience
G.K. Parikh, K.M. Jani and G.C. Shah, Gujarat Narmada Valley Fertilizers Co. Ltd.,
India

Q - A. Al-Harbi, SABIC, Saudi Arabia

Your integrity in the plant is one of the best example I have seen. My question is: The cost of ammonia plant is quite high, what is the justification here?

Ans. Yes, actually as I told you, the losses are on account of the problems of the plant. So, the problems of the ammonia plant had to be solved. At that time, may be as I showed you on one of the slides on the chronology on which the plant is installed. So, that time, I mean, we did not have all the planning for the manufacture of the chemicals, but the inherent plant problems, because if you see this partial oxidation plant rarely goes to the capacity utilization of a hundred persons, which we made possible by such kind of improvements, and with such kind of improvements, we could also save a lot of energy and a specific consumption of may be steam and power and all other energy consumption also improved substantially, so that also reduced the cost of the production of ammonia.

Q - A. Basit, Fauji Fertilizer Company Limited, Pakistan

1. Did you install "Purge Gas" and hydrogen recovery units during the revamp?

Ans: Our ammonia manufacturing process is based on partial oxidation of fuel oil. For removal of impurities of methane and CO, we have liquid nitrogen wash unit which generates pure synthesis gas for ammonia synthesis. Hence installation of purge gas and hydrogen recovery unit does not call for during revamp.

2. What was the problem with synthesis gas compressor recirculate stage? To what extent it reduced the NH₃ back end production?

Ans: During systematic plant bottlenecks study, it was observed that synthesis section loop pressure was remaining high because of insufficient circulation. Circulator capacity was increased by modifying impeller of synthesis gas machine. After modification, ammonia production improved by approx. 40-50 MTD because of decrease in synthesis unit loop pressure.

3. What was the useful life of LTS catalyst even with the "S" soot problem?

Ans: In our CO Shift Unit we use BASF sulphur active catalyst in 3 beds. The pressure drop of 1st bed used to increased to almost 2.5 bar which would warrant a shutdown for screening/replacement of the catalyst after every about 5-6 months of operation. The activity of the catalyst remains quite good, but we have to stop the plant for attending to 1st bed catalyst only.

Q - M. Ksikes, OCP, Morocco

GNFC urea-NH₃ project. In view of the market conditions and the subsidy paid by the Indian Government on urea, what is the viability of this project in the event of a reduction or suspension of this subsidy?

Ans: Viability of ammonia/urea projects is definitely based on the subsidy given by the Government for urea manufacture. Viability would be really a question in case if subsidy is either withdrawn or reduced.

PAPER 4a Phosphate testing for the evaluation of raw material suitability and project feasibility
P.A. Smith, Prayon-Rupel Technologies S.A., Belgium

Q - D. Crerar, United Kingdom

1. For a new phosphate rock, the amount available for testing may be limited; how much is required?

Ans. The amount of phosphate is function of the length of test, i.e. the amount of phosphoric acid needed for further tests as acid concentration - acid clarification - TSP / GTSP - phosphogypsum study. A limited available phosphate will of course lead to a restricted study. The minimum requested amount of phosphate is 400 kg to allow to run a test during two weeks and get significant information.

Q - 2. What is the charge for each test?

Ans. The test cost is constituted by about 55% of manpower sweat, about 40% of analytical effort and the balance represents the utilities consumption and the hardware maintenance. The cost itself can be modulated if additional tests are carried out with different conditions (other process, other phosphate, ...) and also in function of the commercial context; usually the test cost can be deducted from the process fee at the project contract signature.

Q - A. Van Brempt, Kemira International Services, Belgium

1. By using organic additives as crystal habit modifier (CHM) for improving the filterability, have you seen any impact on the granulation ability in DAP/MAP production (on product quality) and/or production rate?

Ans. It is not easy to determine the split of the organic CHM passing respectively in the liquid phase and in the solids phase during the phosphoric acid production. Our past industrial experience with igneous phosphate showed that about [20-30]% of a specific CHM was sticking to the solid phase and the rest was staying in the liquid phase (the phosphoric acid). Several phosphoric acid plants use continuously organic additive as CHM since many years and they have never told us having encounter problems during fertiliser granulation: in fact the addition of CHM is very small, few PPM of active product, and this has no influence when, for instance, comparing with MgO % in concentrated phosphoric acid.

Q - 2. *Can you say something concerning severe abrasion problems with some rocks in the dry part (milling, etc.) requiring the use of special construction material in this section?*

Ans. Indeed some phosphate rocks (mainly some Chinese phosphates) contain high silica level, up to 14% SiO₂ total. Therefore, the mill supplier must take that factor into account for the mill design. The wet grinding seems to give less abrasion than dry grinding, but safety measures must be taken for designing the ground phosphate slurry tank + agitator and the feed pumps to the Reaction section. Rubberlined mild steel and chromium cast steel are common material for that purpose. The phosphate extraction at buffer silo bottom can be an extraction belt or a rotary valve (with flexible steel tip blades bolted on the cast steel vanes to insure the proper tightness without risk of seizing if too coarse material is present).

Q - B. Christensen, Kemira Agro Oy, Denmark

1. *What kind of lab/bench scale test do you do prior to the pilot test?*

Ans. When a new phosphate study is requested, we first submit it to a complete chemical + grain size distribution analysis ; eventually we submit it to a specific microscopic analysis by the Geologic Department of Liège University ; we can also submit the phosphate sample to our specific reactivity test. The comparison of these information with our former data allows us to foresee the general behaviour of the phosphate and to prepare the pilot test equipment and procedure accordingly in order to optimize the test.

Q - 2. *What is the P₂O₅ through-put (kg/h) in the pilot?*

Ans. The through-put in the pilot plant is usually 1 kg P₂O₅/hour, but this rate can be modified to adopt other process criteria, such as retention time.

Q - 3. *What analysis is done on-line?*

Ans. There is no "on-line" auto-analyser, but the sampling frequency and the list of analyses to be performed are tabulated: the operators run the routine controls (SO₄%, solids %, filtrate density, ...) at site and prepare the samples to be analyzed by the Central Lab.

Q - J.B. Peudpièce, Grande Paroisse SA, France

Can you simulate at pilot scale the ability (and the energy consumption) of phosphates during grinding?

Ans. The specific characteristics for (dry or wet) grinding of a phosphate are determined by the mill suppliers who have the adequate equipment for such an evaluation, and that latter is function of the final grain size distribution that we request.

PAPER 4b Technology transfer - Achieving successful project execution in a changing world
J.A. Hallsworth and C.R. Fawcett, Kvaerner Process Technology, United Kingdom

Q - B. Christensen, Kemira Agro Oy, Denmark

Please rank (with your experience) the main pitfalls/problem areas which may arise between licensor/basic Eng. Co./detailed Eng. Co./Client/Contractor in major projects?

Ans. It is very difficult to rank pitfalls in order of their likely occurrence because each project is different and problems which are most evident on one project may be absent on another. However the following, in our experience, are often encountered:

1. Schedule delays due to over-ambitious targets and unrealistic expectations, e.g. in so-called 'fast track' projects. Many issues can lead to delays, starting first of all with failure to make the contract effective on time (government clearances, financing arrangements, release of down payment etc.). This then puts pressure on the project from the very beginning.
2. In the fertilizer sector, many licensors have cut their staff and resources 'to the bone' and function with a small number of experienced but overworked specialists. The same is true to some extent with contractors and clients, so that they also rely on relatively few key engineers with real depth of relevant experience. So, even though technology transfer systems are much more advanced than in the past, they need to be because of the demands on key project personnel. This situation can lead not only to schedule delays as outlined above, but also to a failure to detect and act upon errors or misunderstandings without resort to re-work or compromise decisions.
3. Starting detailed engineering early can result in higher costs as changes in the basic engineering package have more influence the further into a project they are made. A well defined basic engineering package can avoid wasteful expenditure later on in a project.
4. Whenever projects involve detailed engineering contractors and/or clients with limited experience of the technology (a surprisingly frequent occurrence), there is a need for effective technology transfer, training and supervision. If this is not foreseen within the terms of the contract (e.g. by provision for additional services at per-diem rates) there is a danger that deficiencies will occur."

PAPER 4c Turn-key projects - Tailoring a turn-key project to meet the clients objectives
G. Davister, SNC Lavalin Europe, Belgium

No question.

PLENARY SESSION: "GENERAL II"

Chairman: A. El Houari, Groupe Office Chérifien des Phosphates, Morocco
Rapporteurs: A. Bourass, Groupe Office Chérifien des Phosphates, Morocco
 M.A. Chaoui, Groupe Office Chérifien des Phosphates, Morocco

PAPER 5 Flexibility of the BASF nitrophosphate process
 T. Meyer and R. Nitzschmann, BASF AG, Germany

Q - D. Crerar, United Kingdom

0

1. *CaO : P₂O₅ ratio of 0.22 is mentioned. What is the corresponding water solubility fraction? Is it the best possible ?*

0

1. *What is the lowest N:P₂O₅ ratio that can be obtained ? How is SiO₂ removed?*

Ans. 1. I take these two examples for calcium to phosphate ratio of 0.22. We would end up at water solubilities of, say, 70 or 75%. You can't tell precisely because this also depends on the minor elements contained in the rock phosphate, but somewhere around 70% and up of water solubility. With a calcium to phosphate ratio of 0.6, it would probably be 50%, 45%. I have to guess at that end a little bit but considerably lower.

Ans. 2. When we want to manufacture an NP (17:28), it depends very much on the type of rock phosphate. Now, besides sand and insoluble matters, rock phosphate contains other salts coupled with iron, aluminium, whatever is in the rock phosphate. What we call the ballast factor - it is the ballast amount - in the rock phosphate is very low, we can produce a little bit higher or, the other way around, lower N:P₂O₅ ratios. What I would say 17:27 is close to the limit. In Antwerp, with a special mixture of phosphate, we produce 18:28, for example. But this is somewhere at the limit.

Q - B. Christensen, Kemira Agro Oy, Denmark

1. *With respect to actual produced mix, how high can you maintain the utilisation rate of the capital intensive NP-solution unit?*

2. *With respect to the performance of the CN unit, which type of phosphates are difficult to process?*

Ans. 1. Your first question was about investment costs related to utilization, run time factor or something like that. Of course, from a production point view, we would like to produce only one product, the whole year on. Mr. Patwa, from GNFC, is in this lucky position. They produce NP 20:20 the whole year, but the fact is, today, the market demands this kind of flexibility, the market demands what kind of grade it wants. And we have to react to this flexibility.

Of course, let's say if we cool down very much and we have a very low calcium to phosphate ratio, the capacity of the crystallization may be at its limit and later on in the granulation, the capacity is not fully used. So, every unit has, at one time or another, a little bit over capacity or is at its limit. This is right, it is not a full line 100 % use of the equipment. But this is what we have to deal with today.

Ans. 2. Concerning the P₂O₅ content of phosphate rocks, we don't have to be that high. Of course, if we want to do an NP 20:20 or an NPK 16:16:16, something like that, we have to have low, what we call, ballast in the rock phosphate which we carry through the process. But, generally, from a P₂O₅ point of view, any kind of phosphate is processible. What we have more problems which is, for example, magnesium causing high viscosity or 'jellous' consistency of the NP acid/slurry, during processing. This, we are working on right now. We are re-designing the equipment to manage this kind of thick slurries. So, we, more often, have a close look on magnesium, as well as iron-aluminium a little bit. But we always look very closely to magnesium content.

Q - P. Suppanen, Kemira Agro Oy, Finland

1. You presented a nice process water balance with no liquid effluents. Have you executed this kind of system somewhere? or only calculated?
2. What are the temperatures in those "hot scrubbers"?

Ans. 1. We have not yet built this kind of plant as a total concept. But, I showed the two extremes. We have full condensation of any type of vapour, that is the maximum amount of liquid effluents. On the other end, no liquid effluent. But this is a modular system. For example, the NO_x scrubbing system, we did it with use of ammonia. So, during NO_x scrubbing, you produce an ammonium nitrate solution which you can recycle. We have done this at Agrolinz Melamine Company in Austria. I showed the scrubber here for NPK granulation, scrubbing at the same time the vapours and the granulation air. We have realized that in Ludwigshafen, in our plant, which evaporates the whole lot of water at that point. So, the single part of it, we have built it.

Ans. 2. If you scrub pure vapour, it's about 100 to 105, to 110°, depending on where it comes from. If we include an amount of air - whatever amount - it can go down to 65°, something around that. It depends on the amount of air.

Q - M. Dhabi Skali, Maroc Phosphore, Morocco

1. What are the physico-chemical characteristics specific to NP and NPK fertilizers produced by nitrophosphate route compared with those produced by sulphuric acid route?

Ans. NP/NPK fertilizers are granulated in the BASF nitrophosphate process from a slurry which already contains all of the material (i.e. neutralized NP-acid, potassium salts, trace elements, additives). No solids are added during granulation. Therefore, each granule is very homogeneous and contains all of the nutrients in the specified composition. The granules are round and within very well defined size distribution. In addition, the granules are coated. All of this results in free flowing fertilizers with very low caking and dusting tendency. NPK fertilizers from the sulfuric acid route (via MAP or DAP) are often granulated by adding potassium and other salts during granulation. These granules tend to be inhomogeneous and show more edges which leads to caking during storage and to dust during handling.

2. What are the limitations of the nitrophosphate route compared with the sulphuric route for phosphate in the production of fertilizers?

Ans. Almost all commercially available phosphate qualities, even low grade rock (meaning low in P₂O₅ content), are suitable for the nitrophosphate process. Since calcium is removed by controlled crystallization of calcium nitrate, rather than precipitation of gypsum, trace elements from the phosphate usually does not cause filtration problems. Concerning viscosity problems during NP-acid neutralization, the limitation for MgO is the same as for neutralizing phosphoric acid. Fe₂O₃, Al₂O₃ improve to some extent the physical quality of the final product.

PAPER 6 Technology upgradation by breakthrough innovations - GNFC experience with nitrophosphate Odda process
M.R. Patwa and M.I. Shamsi, Gujarat Narmada Valley Fertilizers Co. Ltd., India

Q - A. Van Brempt, Kemira International Services, Belgium

1. I have a few questions for you about the ammonium nitrate synthesis and your ACB column: why are you moving about all the reaction heat and why are you not using it to concentrate a little bit more your AN solution ?

Ans. This concentration of AN depends upon the vacuum and particularly this ACB column is operating at atmospheric pressure. We don't have facility of providing vacuum system. In order to produce AN of higher concentration, we have to provide a vacuum pressure unit and that facility is not available in our ACB column. Therefore, we are making only 60 to 65% AN in this column. We have a separate unit of concentrating the same from 62-94% in vacuum evaporation unit.

Q - 2. *OK, you kept completely the nitric acid injection on the top of the column. Is there a particular reason to that ?*

Ans. Presently, the nitric acid line is only available because nitric acid cleaning is required to do in ACB column as it contains AN having some very fine lime particles. It is better to put it at the top to have more space available for the reaction, instead of putting it in the middle or in the bottom.

Q - 3. *Related to this question, do you have an idea about the losses on top of the column in Nitric N?*

Ans. We measure the ammonia content in the outlet gases of this ACB column. It remains less than 170 mg/Nm³. It is less than the pollution control board requirement. It remains well within the prescribed limit of emissions. As such, a sufficient capacity is available for scrubbing ammonia, in order to have complete reaction of NA and ammonia in this column. This outlet gas further goes for scrubbing with water in another column.

Q - B. Christensen, Kemira Agro Oy, Denmark

You have explained the impact of Al₂O₃ and Fe₂O₃ in the CN crystallization. Have you studied the influence of MgO in the rock?

Ans. No, we have not studied. However I can say that it does not have any influence on CN crystal growth. Generally MgO results into higher viscosity of the mother liquor i.e. NP Acid.

PAPER 7 Flexibility and environmental performance of Kemira's mixed acid NPK process
H. Kiiski, Kemira Agro Oy, Finland

Q - A. Zantout, QAFCO, Qatar

Regarding temperature and water content of final product, are they steady or variable?

Ans. We naturally have a target to cool the final product down to 30°, and you can be sure that there are fluctuations caused by the season. For example, in the winter time when it is minus 30° outside, we don't have cooling problems. In the summer time, when there is plus 30°, the cooling capacity may become a bottleneck although we normally are able to keep it. To the moisture content, that is of course a question related to analytical methods. If we talk about free moisture, the target is between 0.1 and 0.2% measured as Karl Fischer extraction method. Using the direct Karl Fisher method, the result is something between the real total and real free moisture resulting in a moisture content around 0.5%. The classical oven method would give a result around 0.8.-1.0% moisture. Therefore, it is important to mention the methodology involved.

Are you facing caking problems in your bulk halls? If yes, how do you control them?

Ans. Caking is something that we, from time to time, realize. In our formulations we are using a lot of sulphates. Those are very critical to the final moisture content and the temperature of the final product. In case of observed caking, the actions are quite straightforward: try to cool better, try to reduce the free moisture content, apply more coating, etc.

PAPER 28 GPIC's integrated approach to safety, health and environment management
Yousif Abdulla Yousif, Gulf Petrochemical Industries Co., Bahrain

Q - A. Zantout, QAFCO, Qatar

Do you conduct Mock drills on routine periodical bases for your emergency contingency plan? If yes, what are the types of communications/methods you are implementing?

Ans. We have two drills per year. One is announced and the other is not. The announced one is just really to prepare people. They may forget about how the plant is beautiful and running without a stop because our plant runs for two years continuously. We have a system as follows. First, I'll touch up on the operation side. The operator goes to the training centre simulator and such simulator is only available in the state. We have spent a lot of money in it. Believe me, it pays back. If you have a smooth running operation. Your operators, if you have a problem, tend to confuse themselves, but we run a training programme for them. Every month, they go and trouble shoot and by this simulation the supervisor will create a case for them and see their behaviour. This is one aspect. To go back to your question, the announced drill, we have done it now over 12 years of operation. It's been successful but all the time you find new things to improve. And that's the pretty about having an announced drill. We have the communication system you asked about. We have bleep system, we have ratio system. The ratio system is available inside the unit, inside the offices, and we have, in our procedure, regulated sounds where people have to listen and to educate themselves to listen and not to panic. We have done it now so many times, it's been successful. In case of real emergency, on the main centre, which the General Manager, always, on that slide I showed you, is available. The main controller will take his permission to activate a direct link between us and our fire brigade of the government, as well as the refinery fire brigade, because we have a refinery in Bahrain 65 years old. They have experience with fires and emergencies. If we need their help, they are there. And this is part of the ministry understanding between their industry to cooperate in case of emergency but on the call-out bases. Do I answer your question?

PAPER 8 The steam heated fluidized bed dryer - a new energy saving drying process
N. Raschka and K.D. Müller, Kali und Salz GmbH, Germany

Q - A. Arafan, OCP, Morocco

1. *What is the typical particle size distribution of the feed?*

Ans. The typical particle size diameter is $d_{50} = 0,23$ mm. The main quantities have a diameter between 0,1 and 0.5 mm.

2. *What are the shape and the characteristic dimensions of the fluidized bed dryer?*

Ans. The type of construction of the fluidized bed dryer is rectangle with a base surface of 10 m^2 . The height of the fluidized bed is approx. 2 m.

3. *What is the duration of operation before a shutdown for process or maintenance reasons?*

Ans. The duration of operation is between 14 and 21 days, before a normal shutdown for repair.

Q - M. Benmakhlouf, OCP, Morocco

1. *What is the temperature of operation of the fluidized bed and the temperature of the gases emitted to the atmosphere?*

Ans. The temperature of the fluidized bed is approx. 180°C . The emitted gases to the atmosphere have a temperature of approx. 30°C for the clean gas, an approx. 170°C for the flue gas.

2. *What is the total energy output of the drying facility of KCl for each fluidized bed?*

Ans. For the drying of KCl, we have an energy consumption of 86 kWh/t . With a heat recovery by hot water production, we can save additional 44 kWh/t . The rest of 42 kWh/t is lost with the hot KCl (approx. 29 kWh/t) and the emitted gas and wash water (12 kWh/t).

PAPER 9 Modernization of Kribhco's fertilizer plant
P.P. Singh and J. Singh, Krishak Bharati Cooperative Limited, India

No question.

PAPER 10 Energy optimization of a high monopressure nitric acid plant
F. Galindo and S. Corton, Fertiberia S.A., Spain

Q - B. Christensen, Kemira Agro Oy, Denmark

1. *Who supplied the simulation programme?*

Ans. The simulation programme was made by Mrs. Galindo who is present here and it is a completely in-house development. She developed different subroutines for different programmes which were linked together when we needed to have this particular simulation. As the arrangement of equipment varies from plant to plant, the programme has to be adapted for each plant changing the order of the subroutines.

2. *Does the model include the kinetics of the NO oxidation in the various cooling stages?*

Ans. Yes, it was clearly shown in the slide but Mrs. Galindo can report in more detail.

Mrs. Galindo - Of course all the reactions are simulated.

3. *Can you quantify the results of the projects in terms of US\$/t nitric acid?*

Ans. These are the results of only one of the plants, for the first term of 1998. I apologize, it is in Spanish. But, you can see in the first column the actual results and in the second the forecast results when the project was approved. You can see the unit cost per ton of nitric acid produced was reduced by the propane consumption, the saving in electric energy, you have the increase in cost due to the raw water to the cooling tower, and then you have the savings in ammonia consumption to the nitric acid plant, and the potential saving with which we credit the project for having to consume less ammonia in the catalytic reduction unit also. Here, you can see the figure of investment only considering the energy investment. The project is split in 2 parts: the energy recovery one and the environmental one. But, even if you put the two together, the payback is two and a half years. I think it is a good payback.

Q - A. Basit, Fauji Fertilizer Company Limited, Pakistan

As you mentioned in your presentation, the cooling water temperature was lessened by 12°C. Would you like please to mention what modifications were carried on the cooling tower to achieve this 12°C temperature reduction?

Ans. We didn't modify the cooling tower, what we did was to replace a system based on closed circuit of water which was cooled by air coolers and completely remove the system and install a cooling tower system. And the temperature was reduced by about 12°C.

Q - M. R. Patwa, GNFC, India

1. *Are these catalysts in-house developed or imported from other countries ?*
2. *What is the specific consumption of catalyst per ton of WNA ?*

Ans. 1. The catalyst is imported from another country.

Ans. 2. Well, I wouldn't know, because it depends on the NO_x outlet, but it is a quite normal consumption. You may find it in the literature. It is almost stoichiometric. A little more, but not at all important.

Q - P. Orphanides, Greece

You mentioned that the new exchanger you have modified. On the shell side, the upper part, you have a counter-current flow and then, on the lower part, you have a co-current. That means the outlet of the process gas side is not at the end of the exchanger but at the beginning. The tail gas is coming in from the bottom side.

Ans. This is the flow of the process gas all in this direction. The outlet of the process gas is to the right.

Mr. Orphanides - OK, it's split into two parts. It is clear now. Thank you.

To complete the answer: the outlet process gas temperature is different in the upper part from the lower part. The exchanger works as two exchangers (one counter current, above; another co-current, below). The two streams are mixed at the outlet.

PARALLEL SESSION: "NITROGEN"

Chairman: S. Stalin, SPIC, India
Rapporteurs: S. Nand, FAI, India
 B. Swaminathan, FAI, India

PAPER 11 Environmental and energy optimization with cold production (chilled water) in an existing ammonium nitrate plant
F. Galindo and S. Corton, Fertiberia S.A., Spain

Q - S. Nand, FAI, India

What is the energy saving with incorporation of absorption refrigeration system?

Ans. Mr. Corton replied - the net energy is 320 KW compared to a mechanical refrigeration unit because the steam was available from waste heat recovery.

Q - J. Rennotte, Kemira SA/NV, Belgium

What is the nitrogen content in effluent before and after the process modification?

Ans. Mrs. F. Galindo replied - the ammonium nitrate content in effluent before the modification was about 1% which came down to 500 ppm after the modification.

To a further question from Mr. Rennotte, Mr. Corton said that part of the effluent is sent to nitric acid plant and pH is adjusted, if required.

PAPER 12 Saskferco urea plant revamping
Pan Orphanides and Peter Orphanides, Orphanides Consultants, Greece

Q - A. Cadet, FERTIL, U.A.E.

What was the total investment cost for this revamping?

Ans. Approximate cost for revamp of both ammonia and urea plant was less than 30 million dollars.

Q - V.P. Kaushik, Duncan Industries Limited, India

Is the modification of trays in the urea reactor proprietary to Stamicarbon or was it developed in-house by Saskferco?

Ans. Yes, the modification is proprietary of Stamicarbon. The change in internals provides for better mixing and avoids the liquid bypass.

Q - Anonymous

i. If the conversion has improved, what are the steam savings?

Ans. The conversion of CO₂ remains the same and the steam consumption remains the same or somewhat lower.

ii. *What type of high corrosion material of tubes was used?*

Ans. There was no change in the original tube material which is 25-22.2.

iii. *How about product quality?*

Ans. Product quality remains same. Biuret content is about 0.8-0.85 percent and moisture content of 0.2-0.25 percent.

Q - A. Al Habib, PIC, Kuwait

i. *After the modification do you have two streams of urea melt feeding the granulation plant?*

Ans. There is only one stream coming to granulation plant but a new header was installed for larger flow.

ii. *Did you replace the urea reactor trays by new HET trays or did you modify the existing trays?*

Ans. Same trays were utilized in the urea reactor.

iii. *What is the content of hydrogen in CO₂ in your plant and do you have hydrogen removal unit?*

Ans. The design for hydrogen content in CO₂ is 0.7% but the actual figure in operation is about 0.5%.

Q - M.F. El-Sayed, Arab Fertilizer Association, Egypt

What is the contamination load of urea and ammonia in the water stream before and after the revamp?

Ans. Hydrolyser in urea plant had the extra capacity and there was no modification carried out in it. The original specifications of 1-2 ppm of ammonia and urea in effluent are maintained.

Q - S.O. Abu Bakar, Petronas Fertilizer (KEDAH) Sdn Bhd, Malaysia

i. *Had the number of trays for the urea reactor to be increased since the vapour load from the HPCC has increased?*

Ans. During the start-up of the original plant, lower conversion efficiency than design was achieved due to too many holes in the trays. Some of these holes were closed. These holes were opened during the revamp.

ii. *Do you have to run both the urea melt pumps?*

Ans. The urea melt pump remains same and there is only one pump.

Q - H. Al-Mannai, QAFCO, Qatar

i. *Who provided performance guarantees for the revamp plants?*

Ans. Uhde and Stamicarbon provided the performance guarantees for ammonia and urea plants respectively.

ii. *Do you experience any problem with the atomization fan capacity? Do you use the original fan or you have an additional fan?*

Ans. An additional fan for atomization had to be provided.

Q - T.R. Chaudhry, IFFCO, India

What is the consumption of steam per tonne urea before and after the revamp and the free ammonia content in the product?

Ans. I don't have these figures available with me.

Q - R.P. Pillai, IFFCO, India

How much improvement in the efficiency has been achieved by using enriched passivation air? Is there any safety hazard due to less nitrogen?

Ans. Two things have been done simultaneously:

- a. Modification of trays in the reactor
- b. Use of enriched air for passivation with 34% oxygen.

The conversion of carbon dioxide remaining 60%, there is huge increase in the throughput with these measures. While there are no separate figures for contribution of the two measures available but the two measures may be contributing 50% each to the improvement in efficiency. The safety of operation has been ensured by keeping outside the explosive limit for the gas mixture.

Q - P. Knudsen, QAFCO, Qatar

How long is the granulation operated in between the washing?

Ans. It is about 3 months.

Q - A.A. Jama, QAFCO, Qatar

What were the parallel modifications done in the ammonia plant to increase capacity to 1850 tonnes per day?

Ans. This will be included in another paper. But briefly, installation of pre-reformer and syn gas dryer and fine tuning of a lot of smaller things were carried out in ammonia plant. To a further query from A. Jama, the speaker informed - the internals of synthesis gas machines were changed to improve its efficiency but no change was carried out in process air compressor.

Q - A. Al-Mahfoud, SABIC, Saudi Arabia

Since you have a number of equipments in parallel, do you face any operating difficulties?

Ans. A flow measuring device for measuring split flow between the two strippers was thought of but no need was felt during the operation of the plant. There is no reported problem for splitting the flow between the two strippers.

Comment from H. van Baal, Stamicarbon: Operating instructions were rewritten. For example; the original section was started up first and then only parallel section was started. No sophisticated measurement devices were added for monitoring the flow. The author added - there are examples of 4 parallel strippers running in the industry.

Q - S.O. Abu Bakar, Petronas Fertilizer Sdn. Bhd, Malaysia

Has N/C meter been installed in the revamped plant?

Ans. Standard N/C measuring device in Stamicarbon urea plants continues to be there.

PAPER 13 Counter-current flow radial ammonia synthesis reactor
S.P. Sergeev, I.I. Podolsky and M.O. Shlonsky, GIAP, Russia

No question.

PAPER 14 Economics of co-production of methanol in an ammonia/urea complex
Syed Othman Abu Bakar, Petronas Fertilizer (Kedah) Sdn. Bhd., Malaysia

Q - S. Stalin, SPIC Limited, India

Was it necessary to reduce the air to secondary reformer to get proper CO/CO₂ ratio for methanolation?

Ans. There was no change in air to secondary reformer. A provision has been made for bypassing HTS, LTS or CO₂ removal section to adjust the CO/CO₂ ratio.

Q - V. Kaushik, Duncan Industries Limited, India

i. What is the cost of methanol plant?

Ans. The EPCC contract for the project has been given on lumpsum turnkey basis at the cost of 250 million dollars.

ii. What is the cost of methanol produced as a co-product versus ethanol produced in a dedicated methanol plant elsewhere?

Ans. Total cost of co-production of methanol is about 6 percent of the total cost.

Q - K.M. Jani, GNFC, India

i. Would it be more economical to divert the purge gas from synthesis loop or methanol plant for the manufacture of ammonia than using it as reformer fuel?

Ans. The purge gas quantity is very low hence it is used as fuel in primary reformer. Moreover, natural gas was very lean and there was not enough CO₂ available. Therefore, there was no use producing additional ammonia.

ii. The capacity of methanol plant is 200 TPD or 400 TPD?

Ans. The methanol plant capacity is only 200 TPD but design capacity can go up to 400 TPD with high pressure co-production. The difference will be size of the reactor.

PAPER 15 Prediction of decomposition behaviour of fertilizers containing ammonium nitrate
A. Vuori, I. Tähtinen and T. Saijonmaa, Kemira Agro Oy, Finland

Q - J.B. Peudpiece, Grande Paroisse SA, France

i. Can you comment about the effect of decomposition the reactions giving HNO₃ and NH₃ which is endothermic and limits the effects of other reactions? Have you measured N₂O formation?

Ans. We are only measuring initial rate of decomposition, when no secondary reactions are there. Initial rate measurement is enough for classification of fertilizers for safety.

ii. Can you give wall temperature of DSC cup?

Ans. In pressure reactor, temperature difference between middle of reactor and the jacket is about 2°C. The accuracy of temperature measurement is 0.1°C.

PAPER 16 Revamp experience of 1725 MTPD urea plant
A. Basit and S. Hasan Shah, Fauji Fertilizer Company Limited, Pakistan

Q - A. Al Habib, PIC, Kuwait

Can you please elaborate on your execution strategy carried out i.e. whether it was in two turn-arounds and what was the duration between the turn-around?

Ans. Modification was carried out in two turn around and the duration between the two turn around was about one year and 9 months.

Q - V.P. Kaushik, Duncan Industries Limited, India

i. For running the new reciprocating CO₂ compressor in parallel with centrifugal compressor, you have installed restriction orifices. What is the pressure drop caused by such orifices?

Ans. There is a pressure drop of just 2 psi for each orifice. There are 10 restriction orifices.

ii. How the additional chilling load for suction chilling of synthesis gas has been achieved?

Ans. Chilling duty is provided by ammonia on shell side with synthesis gas on tube side in a simple heat exchanger.

Q - A. Cadet, FERTIL, U.A.E.

For the second phase revamp (increase in the capacity by 42% of the design), will the prilling tower not cause a limitation?

Ans. There is a lot of margin in prilling tower. We have operated prill tower up to 142% load while recovering urea from the solution from bagging section.

Q - K.M. Jani, GNFC, India

i. How about revamping your second plant built in 1993?

Ans. There is very little margin available in the new plant. Therefore, no study has been done to revamp this plant.

ii. Do you have enough CO₂ available from ammonia plant?

Ans. There is 8.9% CO₂ in feedstock. Therefore, there is no limitation in availability of CO₂. During the second revamp ammonia plant will also be debottlenecked and more CO₂ will be available with more ammonia.

iii. Was the revamp programme carried out with complete in-house expertise or you had engaged some consultants for doing this? What was the fee for such consultancy?

Ans. The revamp was a joint effort by Snam & Fauji Fertilizers. Engineering was carried out by Snam.

Q - Pan Orphanides, Orphanides Consultants, Greece

i. What is the steam pressure in the new pre-decomposer?

Ans. It is a low - medium pressure steam (LMS) of 5.7 ATA used in the pre-decomposer. LP steam is upgraded to LMS by a thermo compressor.

ii. What will be the steam pressure in the new medium-high pressure decomposer in the second revamp?

Ans. : Operating pressure will be 90 kg in the high pressure decomposer. Medium pressure steam of 26 bar will be used. To a further question on the material of construction.

iii. What will be the material of construction of stripper?

Ans. The urea stripper was replaced by bimetallic tube stripper in 1996. In second phase revamp, old titanium tube stripper will be used in medium stage.

Q - T.R. Chaudhry, IFFCO, India

Will you please elaborate on Benfield condensers and temperature of CO₂ you are getting in condensers?

Ans. We are getting a temperature of 45-50°C. We have two condensers in parallel but only one is being operated due to operational problems and therefore there is temperature variation in summer and winter.

Q - H. van Baal, Stamicarbon, Netherlands

Who provides the technology for the 90 bar section?

Ans. Snamprogetti, Italy

Q - A.A Jama, QAFCO, Qatar

i. What are the changes planned in the ammonia plants? Kindly elaborate.

Ans. We will add another small ammonia converter and add purge gas recovery unit.

ii. How do you intend to increase ammonia plant capacity, while decreasing the operating pressure of the synthesis loop?

Ans. The synthesis loop pressure will be reduced and the capacity will be increased simultaneously by the addition of another converter.

Q - A. Zantout, QAFCO, Qatar

Why did you select reciprocating compressor for your revamp in spite of the fact reciprocating compressor have more maintenance cost and downtime than centrifugal compressors?

Ans. Surplus power was available and hence reciprocating compressor was added. We did not have any unusual downtime due to reciprocating compressor.

Pan Orphanides added - we also considered reciprocating compressor for our revamp but cost of building/civil work/structure was quite a lot compared to the cost of booster for centrifugal compressor. Moreover, running the reciprocating machine oil free is not without problems.

Mr. Basit added - in our case we were not confident at that time to up rate the centrifugal machine and did not want to take risk with the machine.

PARALLEL SESSION: "PHOSPHATE"

Chairman: V. Astley, IMC-Agrico Company, United States
Rapporteurs: A. El Houari, Groupe Office Chérifien des Phosphates, Morocco
 B.M. Blythe, Jacobs Engineering Group Inc., United States

PAPER 17 Substantial capacity enhancement in a di-ammonium phosphate plant
S. Stalin, R. Muthu Manoharan and C. Chockalingam, SPIC, India

Q - A. Jbel, Maroc Phosphore, Groupe OCP, Morocco

Is the system of maintenance developed your care or installed by a company? If it is the latter, could you provide the name and the coordinates of the company?

Ans. Maintenance system was developed by our own company.

Q - M. Erraji, Maroc Phosphore, Groupe OCP, Morocco

Could you give us the breakdown of the impurities contained in the acid that you used?

Ans. Phosphoric acid analysis is given below:

	% w/w
P ₂ O ₅	54.0 – 54.7
CaO	0.02 – 0.06
Fe ₂ O ₃	0.24 – 0.35
Al ₂ O ₃	0.13 – 0.17
MgO	0.20 – 0.35
Sulphuric acid as H ₂ SO ₄	1.50 – 1.80
F	0.22 – 0.29
Solids	0.15 – 0.22

Q - M. Dhabi Skali, Maroc Phosphore, Groupe OCP, Morocco

1. *Could you indicate with precision the dimensions of the granulator of the unit? Has its rotation speed been modified?*

Ans. Granulator Specification:

	DAP – I	DAP – II
Length	7.6 M	6.0 M
Dia	3.8 M	3.0 M
RPM	8	9

The rotation speed of the granulator has not been changed.

2. *With the use of a pure phosphoric acid, do you use an inert for correcting the grade of P₂O₅ for the DAP produced ?*

Ans. Sulphuric acid and gypsum are used to control grade.

3. *Could you give us a comparison of the physical characteristics of the DAP produced by the first unit with a tubular reactor and the second unit without tubular reactor (granulometry, sphericity, hardness, etc.)?*

Ans.

	<u>DAP - I</u>	<u>DAP - II</u>
<u>Crushing Strength:</u> 2 mm granule (kg)	2.5 – 3.2	2.5 – 3.2
<u>Size Distribution:</u>		
+ 3.35	7 – 10 %	11 – 16 %
- 3,35 + 2	70 – 73 %	72 – 75 %
- 2 + 1	20 – 24 %	11 – 15 %
- 1	0.5 %	0.5 %

Q - J.D. Crerar, United Kingdom

With increased reaction capacity, I expect the load on the dryer will have increased. What has been the effect of product moisture content? The mole ratio of 1.62 seems very low. What is the N and P₂O₅ content of the product DAP?

Ans. There was no need to modify the dryer since there is already a in-built cushion on capacity. Before the capacity increase, there were occasions where the burners had to be switched off intermittently during low loads, or that low capacity burners were used. With acid strengths of 52 – 54 %, the dryer functions

normally. However, using our own acid with low strengths of 48 to 49 %, then the dryer becomes a limiting factor. Overall, no modification was necessary.

The mole ratio of the granulator exit material is 1.65 – 1.68. The addition of sulphuric acid provided the grade corrections and the analysis of the product showed 18 to 18.5 % N and 46 to 46.5 % P₂O₅. There is no change in the mole ratio after the increase in the capacity.

Q - M.R. Patwa, GNFC, India

How much increase of on-stream factor of capacity utilization SPIC could retrieve because of better management of maintenance system?

Ans. The efficiency of the maintenance system is related to the equipment upkeep and the ability to spot problem before failure occurs. However, these factors are hard to quantify.

Generally, the DAP/nitrophosphate plants are geared for 300 operating days per year instead of 330 days for urea and ammonia. Are you achieving the capacity by operating for 300 days or more?

Ans. Before the decontrol of phosphatic fertilizers in India, we were operating on 330 to 340 days per year since the emphasis was on production. It also indicated better maintenance practice. After the decontrol, the plant is no longer operated for 330 days per year even though it is possible to do so.

The

on stream days are decided by the market economics.

Q - A. Van Brempt, Kemira International Services, Belgium

Have you seen any negative effect on DAP product quality with the use of 100% Jordanian imported acid?

Ans. We found that the physical strength is slightly less since the acid used is very pure. However, this strength is well within the accepted norm.

What is the max water content you tolerate in your DAP final product, and are you applying any coating or anti dustiness treatment to the final product?

Ans. Though the water content of 1.5 % maximum is allowed as per FCO specification, the water content of the product is about 0.5 % to 1.2%. No anti-caking or coating agent is used. The product is in succession stored, bagged and despatched to customers. No complaints were received from the extensive marketing network of distributors and farmers with respect to caking.

PAPER 18 Caking mechanism of phosphatic fertilizers and its control at GNFC by the application of anticaking agents and their mode of actions

R.K. Sharma, Gujarat Narmada Valley Fertilizers Co. Ltd., India

Q - A. El Fakir, Maroc Phosphore, Groupe OCP, Morocco

- *What is the normal value of tendency to cake for granular DAP? And how to monitor it? Do you have done some test results?*
- *What about caking in the ship and the effect of unloading time at ports? Relative humidity of air? Do you have some tests results with and without additive agents?*
- *What do you think about coating by fuel oil?*

Ans. - Granular DAP may go to caking tendency only, if granules are exposed to humid atmosphere having % RH more than 85.0 for long time. The CRH of DAP is 82.5%.

- DAP does not require coating of anticaking agent. We have done hygroscopic experiments and studies for ANP/ CAN/ SSP but not on DAP. SSP does not absorb water at 90% RH for 120 hrs. in humidity cabinet at 30°C.
- To avoid caking in ship, the application of anticaking agent at 0.10 % w/w dose level is advisable if need be and product should be unloaded at 85% RH(max.) at port. No test results of DAP are available, but DAP being the product having high % CRH (82.5%) is quite safe against caking.
- Fuel oil coating, may lead for autoignition, due to thermal degradation of the product during long time storage, hence not advisable to be use as coating material.

Q - F. Kabbaj, OCP, Morocco

Optimization of the temperature of storage and moisture content of the product could be the response to the caking problem?

Ans. Optimization of the storage temperature is 40°C and moisture content of the product should be 0.5% maximum. These two parameters will be helpful partly to overcome the caking in short duration of the storage.

Q - A. Van Brempt, Kemira International Services, Belgium

Having you found a commercial available coating agent (on an economical acceptable cost) which in the same time gives you:

- a. *a sufficient anticaking protection and*
- b. *a protection against moistening from the air, with a real "visible result" on fertilizers (NPK and CAN) stored in bulk.*

Ans. We have developed vendors for liquid anticaking agent, which are economically competitive. The product price is approx. 1.5 \$ per Kg.

- a. The product gives more than 50% anticaking efficiency against crushing load at 0.05% w/w dose level.
- b. The liquid anticaking agent also gives, the reduction in moisture absorption up to 25% on ANP/CAN product during bulk storage by having coating at 0.1% w/w dose level. We have studied the reduction in hygroscopicity in our laboratory.

Q - B. Christensen, Kemira Agro Oy, Denmark

Have you studied the impact on caking related to:

- the slurry preparation and full salt conversion
- the amount of impurities in the raw materials (esp. P_2O_5 rock)

Ans. It is the inorganic salts that make the bulk of construction of the product. When the moisture enters the bag of fertilizers, it goes through the solubilization stage. If the impurities can be controlled at the digestion stage and the moisture at final stage of production and temperature control during quality check at bagging then, we can get by without the use of anti-caking agent.

However, even by taking care of inorganic salts and impurities generation at digestion stage, product moisture at final stage and temperature quality control at bagging stage, the product may still go for caking tendency due to its storage pressure and development of high contact area among granules. Therefore a moderate application of anticaking agent at 0.05% w/w dose level work with the mechanism where it provides liquid film on particle surface, minimize contact area, control abrasion, modify crystal growth and its behavior, help in inhibition of dissolution and crystallization of salts, modify bond tensile strength and reduce capillary adhesion between granules/ particles.

Q - D. Dhiba, CERPHOS, Morocco

1. Which accelerated test do you use to evaluate the quality of anticaking agents?
2. Did you check the results obtained with those issues from long test (more than 1 month)?
3. What is the upper limit of caking tendency (measured in kgf) for ANP/CAN and DAP that make risk of caking very serious?
4. How much it costs to treat 1 tonne CAN or ANP with liquid coating?

Ans. 1. The accelerated test method is only one where caking tendency of the product under test, is accelerated in humidity cabinet at 80% RH and 30°C. This method is basically used for the acceptability of the commercial lots and for research work. I have authored the paper on "Accelerated test method" and submitted it to W.D. Rutland of IFDC in February 1998. The copy of this paper is available to IFDC clients.

2. No, but we go by storage test method some time to correlate the anticaking product efficiency. We are having regular feedback from the marketing department about the product flowability in field.
3. The limit is decided by individual industry for its products. At GNFC we have specified minimum 50% efficiency against, crushing load in Kg on ANP/CAN products at 0.05% w/w application of ACA. When the product is stored in humid area/ place, to its high CRH value, it develops fast cake and become lumpy/ non flowable after long time of storage.
4. It depends on the geographical conditions of the country, but 1 Kg/MT is the suitable dose level which cost about 1.25 \$/Kg approx. in the Indian market.

PAPER 19 Phosphate recovery from low grade rock at Eshidiya mine - Development of Phase II
A. Ghosheh, D. Amara and L. Dabbas, Jordan Phosphate Mines Co. Ltd., Jordan

Q - A. Chegali, Maroc Phosphore, Groupe OCP, Morocco

For phosphate rock beneficiated by washing and flotation, what are the yields in terms of weight and P_2O_5 obtained?

Ans. In the washed phosphate for producing 68-70% BPL, the weight recovery, the efficiency from the feed to the beneficiation is 59%. The TCP recovery is 65% and for the floated phosphate rock, from the feed to the beneficiation, the weight recovery is 56% and the TCP recovery is 62%.

PAPER 20 The effect of extraneous soluble ions in igneous rock phosphate on crystallography of gypsum dihydrate and thus phosphoric acid production
A. Kruger, Institute of Applied Materials and **R. Fowles**, Foskor Ltd., South Africa

Q - F. Kabbaj, OCP, Morocco

What is the influence of the presence of the 3 elements; fluorine, aluminium and silica?

Ans. Mrs. A. Kruger: The addition of silica and fluoride would definitely increase the precipitation of the hexafluorosilicate. And, I'm not sure whether the precipitation of the hexafluorosilicate would be preferred rather than formation of aluminium fluoride complexes. But I think if we increase the silica content, it would lower the fluoride content so the aluminium would increase the density and viscosity a bit more. Mr. Fowles would like to comment on that.

Mr. R. Fowles: We looked at aluminium and fluoride specifically because it forms both cationic and anionic complexes but the positive effect of aluminium would be to a degree "nanified" by the formation of the hexafluorosilicate if there was sufficient around the complex with the aluminium.

Q - M. Mhaouer, CERPHOS, Morocco

Magnesium has an effect of increasing the viscosity of the acid. Could you tell us what is the extent of this increase, what are the measurements and for what level of P_2O_5 in the acid?

Ans. I'm not really sure how much the acid viscosity was increased but, in the case of aluminium, it was quite dramatic because we really had to struggle to filtrate the sludge. We did not really measure the viscosity but it definitely increased the acid viscosity with the addition of magnesium and aluminium.

PAPER 21 Operating experience of processing low grade Jordanian phosphates in the manufacture of WPA production
K. Halaseh and H. Dukhgan, Jordan Phosphate Mines Co. Ltd., Jordan

Q - E. Bahgeçül, Toros Fertilizer & Chem. Co. Inc., Turkey

What is the MgO content of your phosphoric acid?

Ans. The MgO content in the phosphate rocks is 0.2% to 0.3% and in the 52% phosphoric acid, it ranges from 0.22% to a maximum of 0.25%.

PAPER 22 Phosphogypsum: possible hazardous waste or a resource?
A. Davister, Belgium

Q - F. Kabbaj, OCP, Morocco

Mr. Davister, I should like to refer to the first alternative you mentioned concerning discharge into the ocean. You said that the only small disadvantage that there may be is the acidity due to the fluorine which comes in the form of H_2SiF_6 . Is it not true that it comes in the form of sodium and potassium fluosilicate and in consequence the solubility is very low and is dispersed as the other elements are; in consequence even this may not be a disadvantage.

Ans. I am in complete agreement with you within the limit of the content of sodium and potassium in the phosphate. It is transformed into insoluble fluosilicate. If there is a deficit of alkali, then you will have a small amount of acidity which will be neutralized.

Miss Kabbaj: *A second question please. What is the amount of phosphogypsum made use of in the world, as a proportion of the total produced?*

Ans. I do not know at a world level. As regards the last phosphoric acid plant still operated by Prayon in Europe, I ask my colleagues who are more familiar with the present situation, but I believe they make use of more than 50% of their gypsum.

Mr. A. Bourgot (Prayon Rupel Technologies S.A.): Effectively, since the beginning of the 1970s, at present we sell about 600 000 t/year which is used for the manufacture of injected plaster and the remainder used by cement producers as an additive for cement. The quantity of phosphogypsum used or sold as a merchant product has always been low. The only real example is in cement production as a retardant additive or as a raw material in the manufacture of plasterboard. This is apart from Japan, where there are three Central Prayon plants which are in normal operation and which make use of 100% of their phosphogypsum production. In Japan, there is no space for storing phosphogypsum, and Japan also imports phosphogypsum; especially from Philphos. If I remember rightly, it is processed and washed and dried also in Korea to produce a merchant product.

Q - D. Fam, Industries Chimiques du Sénégal, Senegal

Do you have experience of mixing phosphate rock with gypsum to promote the solubilization of phosphate rock. At present in Senegal, it is a method which is used to make use of the gypsum and this has had considerable success with farmers who cannot afford to pay for NPK fertilizers.

Ans. I do not have personal experience of this mixture, but I can compare it with "phyper" (a mixture of gypsum and household waste); the sulphate in the gypsum favours the growth of the bacteria best known in metallurgy, especially in that of copper, where the presence of sulphur maintains colonies of bacteria which can solubilize the phosphate. They produce sulphuric acid from the pyrites to dissolve the copper, and must have the same action with phosphate rock. This certainly merits study unless you already have practical results, which would be interesting to know about.

Q - E.J. Chupungco, Philphos, Philippines

What is the economics of producing cement clinker from phosphogypsum using sulfur as part of the energy requirement and sending the SO₂ gas into the existing acid plant (1,000 TPD H₂SO₄). Cement clinker in the Philippines cost about US\$ 10.00/mt.

Ans. I am sorry that I cannot give a precise answer to your question. In fact, as the production of clinker from phosphogypsum has been discontinued for many years, I have not up to date figure for that operation. Anyway, the fact that you intend to mix sulfur with the gypsum to supply part of the energy will be a positive factor, provided you do not need to compensate for the loss of steam production by generating steam from another fuel. On the other hand, the cement price of US\$ 10.00 per MT is not very high and it will hardly pay for the processing costs.

PAPER 23 Superphosphate fertilizer plant optimization

M. Husein, Y. Kodradi and A. Kholik, P.T. Petrokimia Gresik (Persero), Indonesia

No question.

PARALLEL SESSION: "ENVIRONMENT"

Chairman: D. Wagner, BASF AG, Germany
Rapporteurs: T. Meyer, BASF AG, Germany
 R. Nitzchmann, BASF AG, Germany

PAPER 24 Environmental management within the OCP Group
H. Hakim, Groupe Office Chérifien des Phosphates, Morocco

No question.

PAPER 25 Removing of harmful substances from waste gases from the production of the NPK fertilizer
J. Havlicek, W. Posledni and J. Kilian, Research Institute of Inorganic Chemistry Ltd., Czech Republic

No question.

PAPER 26 Energy consumption and greenhouse gas emissions in fertilizer production
G. Kongshaug, Hydro Agri Europe, Norway

Q - L. Scheers, BASF Antwerpen NV, Belgium

Did your calculation for nitrophosphate include the conversion where CO₂ is consumed?

Ans. No, this process section is not included. The Nitrophosphate process requiring the lowest energy consumption is able to deliver the Calcium Nitrate melt as raw material to a new plant. The question is however, very relevant for this kind of analysis. A parallel example is the gypsum waste from phosphoric acid plants. The most energy efficient plant can discharge the gypsum in the sea. However, this does not comply with the BAT process related to environment. We should in the future combine the BAT processes related to energy and environment.

Q - A. More, British Sulphur Publishing, United Kingdom

Mr. Kongshaug remarked that urea is a less significant source of CO₂ emissions than other nitrogenous products because the carbon dioxide is incorporated in the product. However, when the urea is applied to the soil, the carbon dioxide is released during hydrolysis in the soil. So the CO₂ ends up in the atmosphere, anyway: just a little later.

Ans. Yes, that is correct. Bear in mind that this paper cover the processes manufacturing the fertilizer products and not the application. The data from this study should be included in a Life Cycle Analysis. During application urea will release all bounded CO₂.

Q - A.A. Jama, QAFCO, Qatar

Per capita energy consumption and contribution of nations to global warning - was this considered in your paper?

Ans. No, only the processes as defined in the paper. Fertilizer production represents only 1.2% of global energy consumption and global CO₂ emission. This number is so low that it is not necessary to make any study of per capita energy consumption for nations. Each region or country can however, be benchmarked against the given BAT numbers.

Final comment from G. Kongshaug:

Due to a programming mistake related to the database, all numbers for and derived from Potassium Chloride (MOP) in the tables have been divided by 0.6. Thus, some lines in Table 9-12 (refer to pages 285-287 of the 1998 Technical Conference Proceedings) have to be corrected:

Table 9 - Accumulated Energy Consumption for Building Blocks and Some Fertilizer Grades

		"Old" tech.	Av. Europe	Modern tech.	"Old" tech.	Av. Europe	Modern tech.	Feed energy	Feed CO ₂
MOP	0-0-60	4.0	3.0	1.5	0.27	0.20	0.10	0.00	0.00
Derived products									
PK	22-22-0	3.5	2.4	-0.7	0.23	0.15	-0.05	0.00	0.00
NPK	15-15-15 Phosph. acid	10.2	6.9	3.1	1.10	0.93	0.30	4.37	0.25
NPK	15-15-15 Nitrophosphate	8.5	6.7	4.9	0.87	0.80	0.40	3.45	0.20
NPK	15-15-15 AS/TSP/MOP	9.4	6.0	1.2	0.59	0.36	0.04	4.13	0.24
NPK	15-15-15 Urea/TSP/MOP	11.4	8.8	5.8	0.48	0.30	0.10	4.27	0.24

Table 10 - World Energy Consumption and CO₂-eq. Emission from Production of Fertilizers

Building block	World cons.	Specific energy		Total energy cons.		Total CO ₂ emission	
		World	"Best"	World	"Best"	World	"Best"
	mill. t K ₂ O	GJ/t K ₂ O		mill. GJ/yr.		mill. t CO ₂ /yr.	
MOP	18.8	5.9	2.5	110	47	7.4	3.2
SOP	2.0	3.4	-1.3	7	-3	0.5	-0.2
Total K₂O	20.8	5.6	2.1	117	44	8	3
Total	134	32.2	20.2	4427	2711	272	116

Table 11 - Global Energy Consumption Today and for Different Scenarios

134 mill. t N+P ₂ O ₅ +K ₂ O	GJ/yr	% of today
BAT 1968	4953	114
World today	4327	100
European standard	3700	86
BAT 1998	2711	63

Table 12 - Energy Consumption and CO₂-eq. Emission from the European Fertilizer Producers

	Europe cons.	Specific Energy		Total energy cons.		Total CO ₂ emission	
		Europe	"Best"	Europe	"Best"	Europe	"Best"
	mill. t	GJ/t nutrient		mill. GJ/yr.		Mill. t CO ₂ /yr	
Total N:	10.7	40.3	32.2	431	344	56.6	26.2
Total P ₂ O ₅	2.7	3.4	-8.9	9	-24	0.6	-1.6
Total K ₂ O	5.4	4.6	1.8	25	10	1.7	0.6
Total	18.8	24.8	17.6	465	330	58.7	25.0

Since energy consumption for K₂O is very low compared to total energy consumption, this correction does not have any effect on the final conclusions.

By sending your E-mail address to gunnar.kongshaug@hydro.com, an updated version of the paper can be mailed to you.

PAPER 27 Selecting the right fertilizer from an environmental life cycle perspective
J. Kuesters, Hydro Agri Europe, Germany and **T. Jenssen**, Hydro Agri Europe, Belgium

Q - F. Samec, Grande Paroisse SA, France

When considering Figure 1 and looking on the soil acidification potential of airborne ammonia and sulphur dioxide, one cannot escape the fact that prior to soil deposition of the two compounds, a neutralization will occur in the air in presence of water vapour forming ammonium sulphite later oxidized to sulphate. Therefore,

adding the individual initial soil acidification potentials would in fact result in double-counting if the prior neutralization is not taken into account. Does the Eco-indicator 95 method you have used avoid this double-counting?

And if I may, question two goes back to Table 5, on one hand, all percentage numbers are given with two digits after the decimal point and, on the other, all are relatively small and in the same range. Could you give us the uncertainty range for these figures so as to be able to estimate the real value of any differences one may note with respect to the fertilizers considered? In other words, how meaningful are those numbers.

Ans. Okay, I agree with your last statement. That is a little bit tricky. You should carry out sensitivity analysis. For example to look, how the system reacts. We do this, but it is not shown here.

For the first question, it was the NH_3 emission, the contribution to acidification and nitrification is similar.

Reply: The idea is the following: SO_2 acidifies soil, okay, fine with me, no problem. NH_3 , I am talking about NH_3 gas, is said to acidify soil. Basically, chemically NH_3 ,.... okay. Do not talk about that. Take just simply NH_3 and SO_2 . When you put that in air with some water, this neutralizes out and does not give you the combined effect NH_3 acidification and SO_2 acidification in soil. So in the system is there something to avoid this type of double counting?

Ans. No. I must say this is not our system. This is state of the art. We choose the best one. It has a lot of errors in it, we know that, and not only we are working on it, but other research groups. There are new projects working on this issue. So it is a relatively new discipline. I would say this is just the start; it is not perfect. That is clear.

Q - I. Kruus, Kemira Agro Oy, Finland

I was wondering: Did you consider wheat field as a CO_2 -sink in your analysis? It does not appear to be so from your presentation. Could you comment please?

Ans. Actually it should be included, yes. Because the soil is a sink for CO_2 , so you can balance the emissions out. To which amount I cannot say yet. It has to be calculated. But this is not done so far. We will do that also.

Q - J.L. Bovens, Kemira Agro Oy, Netherlands

Can the cattle slurry be considered at the same level than other products? Slurry is a waste and should deserve some credits for usage.

Ans. That is not my opinion, because you apply it and you have the environmental effects, whether you get rid of it or not, the environmental effect is there, and you have to consider it. You cannot consider a benefit or something like that, I would say. I forgot to mention, that for example if you look here at this figure for slurry only the application is considered. The production of slurry, the animal (...?...) and so on, is not considered here. So if you would consider that, you may come up with a much more higher column there.

Ans. The only way to avoid production is to have no cattle. So I think the production is there. But the effect that you have a waste there. Okay, if you do not apply it, you do something else with it.

Q - Yes, but what would you do?

Ans. So it will be detrimental in another way. So if we want to make a real comparison between these different factors we should at least give a positive effect from an environmental point of view on the fact the waste is not there any more.

Q - Otherwise what are you going to do with it?

Ans. I will think about it.

Comment: G. Kongshaug, Hydro Agri Europe, Norway

Let me give a comment to the last question. There are several applications for slurry. You can utilize the energy, dewatering the slurry and to burn it. By introducing eco-indicators you can compare the alternative applications by using the slurry as fertilizer.

PAPER 28 GPIC's integrated approach to safety, health and environment management
Yousif Abdulla Yousif, Gulf Petrochemical Industries Co., Bahrain

This paper was presented on Tuesday afternoon 29 September, see Plenary Session "General II".

PAPER 29 Environmental costs in Lovochemie: cleaning-up of a polluted site
P. Svarc, Lovochemie a.s., Czech Republic**Q - Anonymous**

In your presentation, on the transparency, you have cited phosphate among the toxic elements which are found in the waste deposits. Is it really the phosphate which is toxic or the accompanying impurities?

Ans. As regards the classification of deposited substances, there are classifications which define what can be stored only in protected storage sites. Phosphorus is considered to be a substance which can affect the health of the inhabitants of the region when it contaminates river water which is used to provide water for the inhabitants. Phosphate is not classed as a toxic substance but in the ecological audit it is classified as among the substance which must be eliminated in future.

Q - A. El Fakir, Maroc Phosphore, Groupe OCP, Morocco

a. You have taken action to reduce SO₂ in the furnaces? What have you done for ammonia and HF?

Ans. To eliminate SO₂, last year we had a construction project for a sulphuration unit, but when the exact investment costs were calculated over a period of 15 years, we came to the conclusion that we can operate our furnace with natural gas injection first to dilute the SO₂ at the chimney outlet because at present limits we are at the level of 3000 to 3200 mg SO₂/m³. The limit fixed as from next year is 2500. That is to say that if we use about 8% to 10% natural gas, we can reach 2500 with the automatic measure, and regulate correctly the volume of gas. As regards the elimination of ammonia and HF when the much stricter limit is in force, from the first of January next year (01.01.99), we are in the process of constructing gas washing facilities in the production of NPK in two parts:

- the first is an acid washing unit which, I believe, will be finished in the coming weeks.
- we are working intensively on alkaline washing, to eliminate ammonia and especially HF to limits which are defined as 10 mg HF/m³ and 50 mg NH₃/m³.

b. You are in the course of proceeding for ISO14000 registration? What is the procedure? Do you have someone to help you to obtain this certification?

Ans. We are going to start the procedure next year. We do not think that we shall be accompanied by consultants. I do not know whether you have another experience, but we find consultants are a little too exacting. We will rather use the experience of companies which have already obtained ISO 14000. As with ISO 9002, we began with the establishment of an internal environmental audit, accompanied by annual objectives and the preparation of the necessary documentation. In the case of ISO 9002, for which we obtained registration in 1996 for CAN, the documentation was approved by a certifier. We are starting a complex study on the impact of our activities outside the plant, on the health of the inhabitants of the region. To simplify the bureaucracy we will add the ISO 14000 documents to the existing ISO 9002 documents. We aim to obtain ISO14000 certification, as well as recertification for ISO 9002, in 2001.

PAPER 30 Benchmarking of emissions from nitrogenous fertilizer plants: Indian experience
B. Swaminathan and M. Goswami, The Fertiliser Association of India

No question.

PARALLEL SESSION: "PHOSPHATE/POTASH"

Chairman: B. Christensen, Kemira Agro Oy, Denmark
Rapporteurs: A. Haddad, Arab Potash Company Ltd. Jordan
 W.E. Oelius, Kemira Agro Pernis B.V., Netherlands

PAPER 31 Policies and concepts for improving plant performance at Indo-Jordan Chemicals Company Ltd. (IJC), Jordan
B.K. Verghese and V. Ganesh, Indo-Jordan Chemicals Co. Ltd., Jordan

Q - P. Orphanides, Greece

What was the reason you put it in the Exhibit 2 "Reliability Analysis" relatively low Reliability Index for the Acid Towers System, which is static system, what you have expected and have you done any thing specific to increase that?

Ans. Based on our past experience with similar plants which have had problems with materials of construction in respect of certain equipment such as Drying Tower Mist Eliminator, Acid coolers etc. in the Acid Tower System, we have taken due care to improve the reliability factor by going in for improved material of construction with marginal additional investment. Incidentally, the Acid Tower System mentioned in Exhibit-2 includes the Acid Tower Circulation pumps, Acid Coolers and the Acid Piping in the section.

Q - D. Crerar, United Kingdom

Please include in the "Report of Discussion" the monthly data on capacity % Vs. Design and On Stream Factor, how it developed from initial start up as was shown on the overhead slides?

Ans. I presume that you are probably asking the basis of computing the performance factor on the monthly basis. It is easier to comprehend when somebody talks on these figures on the annual basis, because he knows the name plate annual capacity. In our case the name plate capacity of phosphoric acid plant is 700 MT P₂O₅/day and the annual capacity, as specified clearly by the contractor, is 224,000 MT P₂O₅ on the basis of 320 days of operation in a year leaving 15 days for annual turnaround, 24 days for filter washing (2 days per month with 5-6 of cycle of filtration) and 6 days for breakdown maintenance. While computing the performance factor on a monthly basis, we do reckon the annual capacity of 224,000 MT P₂O₅ and spread it for 350 days after knocking off only 15 days annually thus based on the actual number of days in the respective month multiplied by the daily average capacity. As indicated herein, the performance factors have crossed 100% mark within a few months of commissioning the plant.

Month	Capacity utilization	On-stream factor %	On-stream efficiency %
Jan.'98	101.67	93.92	108.25
Feb.'98	109.72	92.67	118.40
Mar.'98	100.83	86.36	116.76
Apr.'98	103.00	89.12	115.59
May '98	102.90	95.43	107.78
Jun.'98	110.27	97.40	113.22
Jul.'98	112.17	96.57	116.16
Aug.'98	115.94	97.45	118.98

As I explained during the presentation, it is our concept of going in for two parallel streams of filtration which has enabled us achieve such high on-stream factor.

Q - A. Van Brempt, Kemira International Services, Belgium

I'll try to make a conclusion to myself and may be I'm not right:

I have a little bit feeling that you have an over-designed plant or you are running your plant at about 10% below the nominal capacity or the capacity that you could do and this is the main reason why the reliability is a lot improved. From the figures you have mentioned you can see over-capacity, am I right or wrong?

Ans. Perhaps you thought it is easy for me to answer whether it is just 'right' or 'wrong'. I would rather

like to say that you are right and wrong. As I did mention during my presentation, there were a few equipment and sections where we had deliberately created a cushion in terms of capacity which of course did increase marginally the investment too. But more importantly, we had taken due care in terms of improving the plant reliability/the on-stream factor and I think that it is this judicious decision which has enable us to present this performance factor proudly.

Therefore, the statement that the plant design with over-capacity is the main reason for improved reliability is not correct. It is the combination of improving the reliability in respect of certain critical equipment such as the PA filtration and also creating the required capacity cushion in a few selected sections/equipment, say for example, Sulphur Melting (to take care of the adverse climatic conditions and variations in the moisture content in the sulphur) that has enabled us to achieve a fairly high level of capacity utilization as well as the on-stream factor.

Q - G. Aviram, Rotem-Amfert-Negev, Israel

Did you check some other processes of WPA before selecting the Hydro-Agri HH process, and what were the reasons and advantages of this selection?

Ans. Yes, the other processes considered during Techno economic evaluation stage of the Bids are Dihydrate process and Hemihydrate process.

Considering the location and the techno-economic factors governing the project, the following factors/advantages weighed in favour of single stage Hemihydrate process:

1. Lower investment cost.
2. Flexibility in rock feed.
3. Lower total water consumption per year
4. Lower operating cost.

PAPER 32 Thermal processing of a phosphate rock with a very high organic matter content and exploitation of calcined Y2 phosphate rock

A. Arafan, Groupe Office Chérifien des Phosphates, **M. Erraji**, Groupe OCP, Maroc Phosphore, **E. Hassani and A. Chik**, Groupe OCP, CERPHOS, Morocco

Q - P. Becker, France

Are the percentages of solids indicated in % weight or in volume? The improvement of the reduction of the content of solids of 32 to 35% seems to me unusual?

Ans. These percentages are by weight. We have better results despite a reduction in the time of stay, which is considerable, but there is a kinetic of crystallization which allows us to obtain better crystals and in consequence, a better productivity.

Q - E. Kacen, Rotem-Amfert-Negev, Israel

What is the process of black phosphate (Y2) until it is "sold" to the chemical plant? Can you tell in detail from the time to when it begins the attack to "become acid". Do you wash it or burn it or directly burn. After the mine, you grind it but at what size?

Ans. The flow-sheet for the processing of black rock (y2) is as follows:

Preliminary treatment:

- Underground mine extraction, by planing, in the presence of water (water table)
- Sieving to remove stones, 90 mm.
- The discard is stored as sterile reject.
- The sieved material is stored before being removed by mechanical bucket and transported by belt conveyor (several km).
- Sieving (30 mm), the discard is disposed of, the sieved material is homogenized and stored.
- The material is taken by mechanical bucket to feed the calculation plants.

Calcination:

- Drying to 0.5% residual water, at 125°C
- Sieving, 6 mm, and pneumatic classification, 90 microns
- Material above 6mm and below 90 microns is eliminated and stored as discard
- The calibrated rock, - 6 mm + 90 microns is calcinated at 750°C.
- The calcination eliminates the organic carbon and reduces the proportion of CO₂ and undesirable elements.
- The calcined rock, of grade 74/75% BPL, is air-cooled and recycled in the process.
- The rock is stored in a hangar then sent by train to the Safi phosphoric acid plants.

There is neither washing nor crushing at mine level. At Safi, before acid attack, the rock is ground, 100% at about 160 microns

PAPER 33 Phosphate technology for the next millennium

R.L. Hemmings, C.J. Felice and M.W. Huang, Raytheon Engineers & Constructors Inc., United States

Q - P. Smith, Société Chimique Prayon-Rupel SA, Belgium

We were quoted two plants of over 1000 t/d but both are double stream processes. How is the plant designed for 2000 t/d?

Ans. The design consists of a single reactor, but so far no plant with a single reactor for 2000 t/d has been built. The clients should determine the reliability they want for the filtration system which can consist of two filters with 75% capacity or three filters with 50% capacity each.

Q - P. Becker, France

How long will the shaft be in the 2000 t/d unit?

Ans. It will be 60 ft if installed from the top like in the smaller units. There are however some second thoughts about the shaft design and an agitator from the bottom (as used in very large PVS plants) is under investigation.

Q - E.J. Chupungco, Philphos, Philippines

Can we use an ammonium sulphate crystallizer (165.000 tpy) to produce phosphoric acid by the Raytheon process.

Ans. It can be done.

Q - A. Alouani, OCP, Morocco

Aspen plus has been created to use oil refinement and its use in the phosphate industry has created problems with the database. What kind of approach has been used to establish the right database?

Ans. The powerful simulation program, ASPEN, has its roots in the petrochemical industry. However, over the past several years, ASPEN has recognized the importance of other chemistries, and has developed thermodynamic models and component data banks that deal with ionic species. For the phosphate chemistry simulation, we used this basic model, identified the available ionic species, and input properties where none were available within ASPEN. Then, we fed many observations taken from operating plants into the model to verify the simulation behavior. The results presented show the degree to which we have been successful in the simulations, where our model predicts behavior within a few per cent of actuality.

PAPER 34 Policy of JSC Apatit for improving of apatite concentrate consumer's properties
A. Gorbachev and V. Golovanov, JSC Apatit, Russia

No question.

PAPER 35 Combustion of solid sulphur and calcine in a fluidized bed roaster for the production of sulphuric acid
E.J. Chupungco, Jr., Philippine Phosphate Fertilizer Corporation, Philippines

Q - S. Stalin, SPIC, India

In a conventional sulphuric acid plant you get sulphur sludge discharged from the filter. This sludge is still rich in sulphur. Can this be used in the developed process?

Ans. If crushed to 5 mm use of all sulphur sources is possible as long as the inert does not harden in the roaster. We are looking for sulphur sources containing 30 to 50% S, which can be used directly.

Q - P. Suppanen, Kemira Agro Oy, Finland

Could you explain the difference in steam production with the feeding of calcined compared to the original process.

Ans. The steam production is 10 to 15% lower because of the lower roasting temperature.

Q - D. Crerar, United Kingdom

Is the calcined completely recycled, or does it have a definite lifetime?

Ans. It is recycled as long as the size is within the fluidized bed roaster operating mode. The fines from the cyclones are sold to the cement industry.

PAPER 36 Compaction, revamp and expansion - Experience and performance
J. Amira and I. Daqour, Arab Potash Company Ltd., Jordan

Q - A. Van Brempt, Kemira International Services, Belgium

a: *What means "the post treatment plant" on granular potash for improving hardness and other quality parameters?*

Ans. APC has made several comprehensive studies regarding post treatment process of its granular product in order to enhance the hardness and prevent degradation of the granules. This process includes hydrothermic process to improve the granular strength of the material. The purpose of the post treatment process is to ensure that granular material produced is capable of withstanding multi-handling operation without being degraded or dust generation. Most post treatment plant does include a dry polishing drum to get rid of the sharp edges of the granules and destroying the

substandard material and make the final granule approximately round. Chemical agent such as water is used as binding agent during the post treatment process and in prior of drying.

So, you don't have dust when you ship to over seas, and the quality also will become good, therefore, you don't have customer complains.

b: Was the revamp of your compaction plant performed in cooperation with Koppert, or by your own?

Ans. It was a common effort between Koppert and ourselves.

Q - B. Christensen, Kemira Agro Oy, Denmark

How do you achieve the feed temperature of 110-120°C, since you didn't mention any preheating? Do you take it from the drying system in the potash operation?

Ans. We have done extensive studies with higher and lower temperatures and we achieved the best results at 110 and 120°C, otherwise, if you go beyond that, it will cost you too much money to bring the temperature up, and also will not get a good granule, it will disintegrate. So, how we control this temperature, then you have the recycle ratio, you can put some fresh feed to maintain this temperature. So you can have fresh feed to the compaction circuit. The heat comes from the dryer and then you control the temperature.

Q - E.J. Chapungco, Philphos, Philippines

a. Do you control the particle size of the MOP prior to compaction?

Ans. We control the particle size by screening, and you can change the screen mesh. But sometime the customer requirement to have a super blend, then we have to change the screen meshes, and not the compactor itself.

b. How long will the MOP resource from the Dead Sea last considering that APC and DSW are mining the area at high rates?

Ans. The Dead Sea is about 750 km², 55 km length, 15-17 km width, and the depth of the brine is about 300-360 m. So the reserve is for more than 200 years.

Q - S. Titkov, Russian Research & Development Institute of Halurgy, Russia

Do you add any reagents in granular products for anti-dusting effect?

Ans. We don't add any reagent or binding reagent when we produce granular potash, but de-dusting oil is being added in Aqaba prior of shipment to overseas.

PAPER 37 Production of grained free-flowing potash fertilizers (KCl-standard) from finely-disseminated sylvite ores

S.N. Titkov, Ju.V. Boukcha and L.M. Pumkina, Russian Research and Development Institute of Halurgy, Russia

Q - K. Müller, Kali und Salz, Germany

a. What kind of crusher do you suggest for the wet crushing of the potash ore?

Ans. Roller.

- b. *If you separate your potash into coarse and fine fraction, and put the final fraction into the granulation, then you will end up with a very high amine content in the feed for granulation. What would be the amine content in the feed for granulation?*

Ans. The current technology for floatating sylvite (KCl) from polydisperse ore suspension of - 1.5 (1.2) mm size (combined flotation of all KCl size fractions from ore) provides for treatment by the collector of coarse sylvite grains in presence of its fine-grained fractions (under 0.2-0.3 mm). Considering ability of KCl fractions (size under 0.2 mm) to make sorption of significantly greater quantity of amine than it is needed for their floatation, it is necessary to maintain the collector consumption at floatation at higher level than it is needed to provide floatation of each from these sylvite fractions. In order to provide the required sorption amine coating on the surface of coarse grains, when clayey slimes are present in floatation feed, such a technology of KCl treatment with collector results in even greater consumption of reagents. Due to that, of course, a fine-grained fractions (- 0.2 mm) of KCl concentrate content high quantity of amine (in middle after drying 120 - 200 g/t, but may be till 500 - 8000 g/t). When we put fine KCl fractions to granulation with such amine content we have many difficulties in process of granulation and must specially prepare these KCl to granulation.

This is developed by us at the Institute of Halurgy Technology as separate floatation provides:

- the separation of grind ore to coarse size fraction (+ 0.2 mm) and to fine-grained size fraction (- 0.2 mm);
- the separation of KCl flotation from coarse size fraction of ore and from fine-grained size fraction of ore.

Separate floatation circuit takes account of differences in the structure of sylvite and halite aggregates in coarse and fine-grained fractions in sylvite floatation feed and allows:

- to floatate under reagent conditions that are optimal for every size fraction of KCl;
- to isolate already at the beginning of the production process the major quantity of fine-grained KCl;
- to obtain after floatation the main quantity of floatation concentrate with minimum content of fine-grained fractions. Checking classification of such concentrate is done at high efficiency and less expenses.

Fine-grained concentrate floatated under lower consumption of the collector than in case of combined floatation contains lower amount of amine (40-80 g/t before drying), thus facilitating its further processing of agglomeration and granulation.

Q - J. Amira, APC, Jordan

What is the final chemical quality of the product obtained during the fine floatation?

Ans. 95-96% KCl.

PAPER 38 Inception and design of the world's largest phosphoric acid plant
D.W. Leyshon and B.M. Blythe, Jacobs Engineering Group Inc., United States and
T.N. Jaggi, Oswal Chemicals and Fertilizers Limited, India

The rock for this 1000 t/d plant will be delivered from a new mine in Syria, 3 sources in China and Kola.

Comments made by Mr. A. Davister:

I agree with you when you compare the crystallization cycles of the monotank processes with the multi-compartment tank processes, with an advantage for the latter. But, as a former director, in charge of the technical developments with Prayon, I am upset by the comparison that you establish between the multi-compartment tanks by Prayon and Jacobs.

First: This comparison is based on the crystallization curves by Pierre Becker as if these had taught you the crystallization rules and you use them in a wrong way. See figure 6 page 374, the curve AB1 heads to the north; what is that for a reactor where in the slurry is pulsed so fast that it has no time to react? Our physical chemistry professor taught us the curves fifty years ago and they were accounted for in our developments when I joined Prayon five years later. In fact, these curves are a section in a three dimensions diagram whose third dimension is the temperature.

Second: It is with the knowledge of this diagram that Prayon has progressively developed its reactors pending the possibilities offered by the technical developments in the fields of materials and equipments. Among other things, it is with that aim that we have developed and used the low level flash cooler that you have later on initiated. And we have completed its function by the action of agitators developed through extensive full size testing; they give a complementary flow together with a cross flow while ensuring a surface multi function providing mixing, cooling and degassing. Such a tool is worth much more than the best "of the shelf" agitator. And the combination of the low level flash cooler with the Prayon agitators secures an excellent control of the crystallization conditions, because while the Ca content of the slurry increases, simultaneously the SO₄ content decreases. As a result the curve AB1 of figure 7 page 374 that you have used to describe the Prayon process is wrong; in fact this curve bends very early to the North-West in such a way that it stays quietly under the spontaneous nucleation curve.

Third: When you boast about choosing filters which are not "proprietary equipments", you deprive your customers of the experience that plant operators like Prayon can incorporate in the design of the equipments, and in the case of filters, I will mention among others the fast drainage cells; these were developed by Prayon for its hemihydrate filtration but the fall out was a considerably enhanced performance in the dihydrate filtration.

As a conclusion: You should not make comparative argumentation; in doing so you put figures on others processes which miss their target as they do not apply to the up to date Prayon technology. This does not improve the credibility of your paper.

Remark by Mr. B.M. Blythe:

The design engineers working for me did the basic and detailed design of 17 Prayon phosphoric acid processes. On their expertise I rely. – We don't use agitators like the Prayon agitator system. One of the reasons Oswal chose Jacobs was the license fee charged by Prayon for their agitator system. We use simple pitch blade turbines.

Q - P. Becker, France

Is there a wet grinding storage? Can the wet grinding section be bypassed? This will be necessary with Kola since it will give problems in the wet grinding section and grinding is not necessary.

Ans. There is a wet storage in between the grinding section and the plant. There is a conveyor for bypassing which was originally put in for the use of Togo rock but can also be used for Kola.

Comment by Mr. A. Davister

You have suggested that it was a rational choice by Oswal between the two processes but I think the assembly should know that the two processes both received a letter of intent and the choice was later made on other aspects.

Remark by Mr. B.M. Blythe: I found out that Prayon had also received a letter of intent. The negotiation exercise was an experience and an educating thing.