

**Highlights of the FAI International Conference on Fertiliser Technology
held in New Delhi during April 12-13, 2007**

The FAI International Conference on Fertiliser Technology was held in Delhi during April 12-13, 2007. It was attended by over 150 delegates from India and abroad. Delegates from fertiliser companies, technology suppliers, engineering companies and academic institutions attended the Conference.. The conference was inaugurated by Dr. J S Sarma, Secretary (Fertilisers), Government of India. Mr. T. R. Chaudhry, Managing Director, Kribhco Shyam Fertilisers Ltd. & Chairman, FAI Technical Advisory Committee also addressed the participants.

Dr. Sarma in his inaugural address pointed out that the farmer is the key for growth of agricultural and rural sectors. The farmer has to be provided with inputs at reasonable prices including fertilisers. Government is making sure that fertilisers are available at reasonable prices to the farmer. He also pointed out that there was a large variation in energy efficiency of fertiliser units. It offered scope for improvement in energy efficiency. He said that government wanted to encourage the growth of the industry and improvement in energy efficiency of fertiliser plants. He assured that government would take all the additional urea production from the fertiliser plants. Dr. Sarma further mentioned that he has invited suggestions to remove impediments in the policy for growth of the industry. He wanted that the Conference should help to identify the areas for further developmental work and issues related to fertiliser sectors.

Earlier, Mr. Chaudhry, in his address, pointed out that sizes of ammonia and urea plants have been scaled up during last few years. There are number of plants of the size of more than 2000 MTPD ammonia and more than 3000 MTPD urea commissioned or under construction in various countries.

He requested the policy makers to facilitate the construction of new plants within the country. He expressed the hope that the situation of gas supply would ease by 2008. The construction of new plants and revamp or retrofits of existing plants are necessary to avoid technological obsolescence. Mr. Chaudhry pointed out that Indian companies were capable of supplying upto 90% of equipments to fertiliser plants.

Mr. R C Gupta, DDG, FAI in his welcome address underlined the fact that Indian industry was world class in terms of capacity utilisation, on-stream efficiency and energy efficiency. However, there are continuous developments in the technology and simultaneously there is demand for more efficient fertiliser products. The Conference would help to take stock of new developments and share experience of their incorporation in the new and existing plants. He hoped that the Conference would provide opportunity to the plant personnel to update their knowledge and would provide the feedback to the process licensors and engineering companies.

Dr. S. Nand, Director (Technical), FAI proposed a vote of thanks. He mentioned that fertiliser industry was striving hard to upgrade itself continuously and achieve efficiency in production comparable to the best plants in the world. He thanked Dr. Sarma for inaugurating the Conference and for his words of

encouragement. He also thanked all the speakers and sponsoring organizations who responded enthusiastically for the Conference.

In all thirteen papers were presented in four technical sessions. A brief resume of papers and recommendations emerging out of the presentations and discussions are given here.

In the first Session on **“Emerging Technologies and their application in Ammonia Plants”** was chaired by Mr. H. S. Karangle, Director (Technical), Rashtriya Chemicals Fertilisers (RCF) Ltd., Mumbai. Three papers were presented, two by the process licensors namely, Haldor Topsoe and Ammonia Casale and one by IFFCO, one of the large manufacturers of ammonia and urea in India. Mr. S Erik Nielsen of Haldor Topsoe presented the first paper titled “Latest Developments in Ammonia Production Technology” which included high flux primary reformer with pre-reformer, HTER-p (Haldor Topsoe Exchange Reformer), and S-300 and S-50 converters. Pre-reformers help to reform high hydrocarbons ranging from gas to naphtha and the catalyst absorbs sulphur components in the feed. It ensures the sulphur free operation of reformer which in turn allows much higher heat flux in the reformer. In general, the reformer size can be reduced upto 25% in natural gas (NG) based plant by incorporating an adiabatic pre-reformer.

The exchange reformer unit can be operated in parallel with the primary reformer and typically around 20% NG gas feed can bypass the primary reformer. Haldor Topsoe have also introduced 3-bed radial flow converter-named, S-300. This

can also be used alongwith S-50 converter. The configuration is called S-350 synthesis loop.

Mr. Nielsen then presented the revamp and retrofit of 7 ammonia plants in India which helped to increase the capacity and improve energy efficiency of these plants. There were numerous retrofit measures incorporated in these plants. The installation of S-50 radial flow converter, further purification of synthesis gas and modification of primary reformer were the prominent measures implemented. He also presented the experience of exchange reformer installed in Sasol Synfuels plant in South Africa.

Mr. Nielsen further mentioned that it was possible to design large sized plants of the capacity of 4000-5000 Metric Tonnes per Day (MTPD). Based on the investigations made by his company, he concluded that the conventional configuration can suffice to design plant of capacity upto 4000 MTPD. HTER and the pre-reformer would be key elements in keeping the reformer size as low as possible. He advocated for a different concept for still larger plants. This included use of auto thermal reformer (ATR) which is fired with oxygen produced in an air separation unit (ASU). Nitrogen produced in the ASU is used for nitrogen wash of processed gas up-stream of the synthesis compressor. In this scheme, size of ammonia converter can be minimized due to inert free gas. The energy consumption is slightly higher for the ATR scheme compared to the conventional scheme mainly due to energy consumption of the ASU. However, there is a benefit to be derived in the capital investment in the ATR scheme. During the discussion the author further informed that cost of HTER is of the same order as a pre-reformer. The catalyst

volume in S-300 converter is about 80% of that in S-200 converter of earlier generation.

Stefano Iob of Ammonia Casale presented a paper titled “Ammonia Casale Technologies and Case Histories”. After successful commercialisation of axial-radial ammonia converters, the company applied the concept to shift converters and pre-reformer reactors. The axial-radial flow in shift converters reduces the pressure drop and minimizes the possibility of cake formation in the top part of the catalyst bed. Casale have so far installed more than 400 axial-radial reactors world wide. The company also developed an advanced secondary reformer burner with superior mixing and reduced flame length. The ammonia wash system developed by Casale ensured high purity synthesis gas going to synthesis gas compressor. Casale also developed a pseudo-isothermal ammonia synthesis converter. New design is based on the use of plates in the axial-radial catalytic bed to remove the reaction heat while it is formed. This is a very efficient design and can help to build mega capacity ammonia plants.

Mr. Iob presented the case history of a recently revamped plant. This plant was based on C F Braun design and was relocated from USA to Trinidad in 1994. The design capacity has been increased from 830 STPD to 1050 STPD. Modifications included installation of pre-reformer, revamp of primary reformer, up gradation of CO₂ removal system, and installation of hydrogen recovery unit. Braun purifier was idled. Ammonia converter internals were changed to Casale iso-thermal basket design. A number of propriety items of Casale design were installed. Casale are also involved in construction of new ammonia plant of capacity of 2050 MTPD in

Iran. The company is involved in technology licensing, basic engineering package, supply of proprietary items and assistance in detailed engineering, commissioning and start up. It was obvious from the presentation that Casale have expanded its basket of technologies and proprietary equipments in recent years.

The third paper in the first Session on ammonia technology was presented by Mr. A. K. Maheshwari, General Manager of IFFCO, Aonla Unit. The paper titled “CO₂ Recovery from Flue Gases of Primary Reformer” described the planning and execution of CO₂ recovery project. Urea is a major nitrogenous fertiliser in India accounting for 82% of total nitrogen application. The demand for urea is outstripping the supply. Prices of urea in International market have been high for last several years. Therefore, every effort is being made to maximize production from the domestic plants. However, due to availability of only lean natural gas, there is a shortfall of CO₂ to convert all the ammonia produced to urea and hence the need for additional CO₂. The option for CO₂ recovery of flue gases was found to be more attractive than the alternative use of Naphtha as feed to the reformer. The IFFCO project is based on Mitsubishi Heavy Industries (MHI) CO₂ recovery technology which employs proprietary KS-1 solvent as CO₂ absorbing media. The project has capacity of 450 MTPD CO₂ with a turndown capacity of 40%. The process employs structured packing in the flue gas water cooler and CO₂ absorber. A specialized proprietary demister has also been installed after washing section. The LP steam and cooling water are the major utilities required. The flue gas is extracted from the discharge of ID fan of primary reformer. The project was commissioned within the contractual period of 21 months. The facility is operating successfully and the consumption of various utilities is within the specified limits.

The second Session on **“Improving Productivity and Reliability of Acid & Complex Fertiliser Plants”** was chaired by Dr. S. Nand, Director (Technical), Fertiliser Association of India (FAI), New Delhi. The first paper titled “Improving Reliability and Productivity in Acid and Complex Fertiliser Plants” was presented by Mr. T. P. Srivastava of Paradeep Phosphate Ltd., Paradeep (PPL). The plant had performed poorly in the past with low capacity utilization of phosphoric acid and complex fertiliser plants. Its management control was transferred from the government to joint venture company with shareholding from Government, Chambal-Zuari Group and OCP, Morocco. A number of measures were implemented in sulphuric acid, phosphoric acid and Di-ammonium Phosphate (DAP) plants. These measures included installation of additional equipments and replacement of some old equipment in all the three plants. As a result, the capacity utilization of phosphoric acid plant improved from 47% in the year 2002-2003 to 93% in the year 2006-2007. The capacity utilization of fertiliser plants improved from 63% to 108% during the same period. Simultaneously, it resulted in better environmental parameters including reduction in SO₂ and SPM emissions, and zero effluent discharge. Nitrogen recovery efficiency of 98.5% has been achieved in the complex fertiliser plants. The plant is an excellent case study of a manner in which small investment but a lot of thinking and innovation could turn around the performance of a plant to achieve high production and efficiency levels.

Second paper in the session was presented by Mr. N M Kantak of Zuari Industries Ltd., Goa (ZIL). ZIL is a manufacturer of urea, DAP and complex fertilisers. One of the grades of complex fertilisers manufactured by the company has

high urea content. The paper covered the experience of retrofitting the unit producing this grade with a pipe reactor. Use of pipe reactor in dryer affected the output of the plant adversely. The retrofit was supposed to increase the throughput from 35 metric tonnes per hour (MTPH) to 50 MTPH of 28:28 grades. However, it became difficult to achieve even the original production rate. Finally, the pipe reactor was excluded and plant was restored to use the conventional pre-neutralizer. Systematic modifications in various equipments including use of dry air for drying helped to achieve the production rate of about 45 MTPH. The author opined that while pipe reactor was quiet successful in manufacture of DAP and some NPK grades, use of pipe reactor in making NPK grade with high urea content posed problems due to low critical humidity of such products..

The third paper in the Session was presented by Mr. S. Srinivasan on 'Improving Productivity of DAP/NPK Fertiliser Plants at IFFCO, Kandla'. There are six streams for manufacture of complex fertilisers at Kandla with a combined capacity of 0.9 million tonnes of P_2O_5 . The latest two streams were added in 1999 using dual pipe reactor process. The focus of the paper was on the modifications made in these two streams to optimize production and raw material efficiency. The mole ratio of P_2O_5 in dryer pipe reactor (DPR) was changed from 1.0 to 1.05 and the length of pipe was increased by 600 mm which helped to reduce the built up of material in dryer. The problem of built up of material in dryer was also reduced by reducing the height of spiral flights by 200 mm. This in turn resulted in higher process efficiency and reduced down time for cleaning. A number of small modifications were carried out in other sections of the plant including granulator, screening and scrubbing sections.

The author also dwelt on problems faced in procurement of inputs like ammonia and phosphoric acids. Use of alternative raw materials was explored in order to maintain production and reduce the cost of production. For example, use of Ammonium Bi Sulphate (ABS) solution helped to replace urea and fillers in DAP and NPK fertilisers. The quality of granules also improved. Similarly, use of spent sulphuric acid also helped to eliminate use of urea in urea based fertilisers. Use of Mono Ammonium Phosphate (MAP) was also made due to non-availability of sufficient quantities of phosphoric acid. In actual operation, it was found that 15-20% P₂O₅ could be derived from MAP and rest from the liquid phosphoric acid. Use of alternative inputs required changes in process parameters and optimization with these new materials. The fertiliser plant was successful in maximizing production and reducing the cost of fertiliser products by use of alternative raw materials.

The third Session on “**Ammonia Technology – other topics**” was chaired by Dr. S. Chandra, Jt. Adviser (Technical), Department of Fertiliser, Government of India, New Delhi. Papers presented in the session included reliability of critical equipments in ammonia and urea plants, coal gasification and recovery of heavy metals from spent catalyst of ammonia plants. The first paper on “Improving Reliability of Critical Equipment in Ammonia and Urea Plants” was presented by Mr. Gajanan Sadekar of L&T, Mumbai. L&T is a giant engineering company manufacturing a number of critical static equipments for fertilisers’ plants. Mr. Sadekar discussed the influence of design and engineering, material of construction, fabrication and use of non-destructive techniques for inspection on reliability of various equipments. He discussed influence of these parameters on critical equipments like reformed gas boiler, synthesis loop boiler, ammonia synthesis

converter, stripper in urea plant and urea reactor. He argued for strong interaction between designers, fabricators and plant operators to improve the reliability of critical equipments in ammonia and urea plants.

Mr. Anindya Chowdhury of Shell India Pvt. Ltd., New Delhi presented “Technology for Coal Gasification for Manufacture of Hydrogen and Synthesis Gas”. He presented the details of design of gasifier, process parameters and composition of product gas. The experience of Shell India was limited to gasification of coal having low ash content. However, he mentioned that the gasification runs for high-ash coal (as available in India) were simulated. The results showed that the composition of gas obtained is similar to that obtained from low ash coal. Product gas contained very little methane which is favorable for production of ammonia. Mr. Chowdhury opined that either beneficiation of high ash-Indian coal or blending it with low ash imported coal is the possibilities for gasification plants in India. He assured that the present day coal gasification technology can deliver the hydrogen or synthesis gas at very competitive cost when compared with other fuels including natural gas. He informed that a large number of gasifiers have been constructed and are under construction for production of hydrogen and synthesis gas, in China and elsewhere.

The third paper of the session was presented by Professor K.D.P. Nigam of Indian Institute of Technology, New Delhi on ‘Extraction of Nickel from Spent Catalyst’. He presented the methods available for extraction of metals including acid leaching, roasting and electrolysis. After analysis of various methodologies, nickel extraction was carried out using EDTA as reacting agent in the laboratory. Effects of various parameters like time of digestion, concentration of EDTA, particle size of

catalyst and solid-liquid ratio were studied. Results showed a recovery of upto 92% nickel from a primary reformer catalyst. The work on optimization of process parameters and efforts to use other chelating agents is in progress.

The fourth Session on “ **Emerging Technologies and their Application in Urea Plants**” was chaired by Mr. V. K. Sharma, Director (Technical), National Fertiliser limited (NFL), NOIDA. The session had four presentations from major technology licensors. The first paper titled “Snamprogetti’s Urea Technology Reliability through Built-in Features and New Developments” was presented by Mr. Alessandro Gianazza of Snamprogetti. He described advantages of ammonia stripping technology. The presence of excess ammonia prevents corrosion and hence requires less passivation air meaning safer operation. Another characteristic of Snamprogetti’s Urea Technology is presence of a medium pressure section which provides the flexibility and reliability in high capacity plants. Due to separation of ammonia from carbonate solution in MP section the plant can operate with a wide range of temperatures of ammonia feed. The technology also provides a flexible steam system. The introduction of two carbamate condensers allows removing the constraint between pressure of steam and condensation of high pressure gases. This gives the flexibility to the steam system and also to the whole plant. The plant layout in this technology provides for lower reactor elevation due to use of a high carbamate ejector as driver of high pressure loop circulation and by the adoption of kettle type carbamate condenser. The layout provides for easier maintenance, simpler operation resulting in higher plant reliability.

Mr. Gianazza also underlined the fact that technology provides for zero tolerance in gaseous effluent emissions and use of treated processes condensate as boiler feed water. He presented the concepts of de-concentrator and pre-decomposer which have been used to revamp the urea plant for higher energy efficiency and higher production capacity. He also presented the concept of OmegaBond™ advance tubing for the stripper. The concept is now well documented by Snamprogetti in the literature. This material is less susceptible to corrosion and would result in longer period life (more than 25 years) of stripper.

The second paper of the Session was presented by Mr. M. Al-Tarazi titled “Stamicarbon Innovation in Urea Plants”. At the outset, he underlined the fact that Stamicarbon had been involved with the evolution of urea production technology for a long time. Recent innovative developments at Stamicarbon have been pool condenser, pool reactor, concepts of double stripper, medium-pressure add-on and Safurex®. In the simplest concept of More-in More-out the plant is revamped by installation of high efficiency reactor trays and addition of heating and condensation capacity. In the medium pressure circulation add-on concept, urea solution leaving the urea reactor is partly sent to the existing HP stripper and partly sent to a medium pressure recirculation section. The medium pressure recirculation section operates typically at about 18 bar. In yet another concept called the double-stripper concept, a parallel HP stripper is added in the synthesis. The urea solution leaving the urea reactor thus partly sent to the existing stripper and partly sent to the new parallel operated HP stripper. A stripping plant can also be de-bottlenecked with a pool condenser.

Stamicarbon and Sandvik have developed a duplex stainless steel named Safurex[®] exclusively for the urea and melamine processes. The material has high corrosion resistance to carbamate solution and high resistance to chloride induced stress corrosion cracking. Stamicarbon have applied all these concepts for revamp of a number of urea plants worldwide. For example, the plant at IFFCO, Kalol in India was de-bottlenecked from 1065 MTPD to 1200 MTPD in 1997 using more-in and more-out concept. Another plant at Saskferco in Canada was revamped with the capacity increase from 2000 MTPD to 2850 MTPD with the double stripper concept. A conventional urea plant at PIC in Kuwait was de-bottlenecked from a capacity of 1065 MTPD to 1750 MTPD using Pool condensers. Mr. Al-Tarazi pointed out that revamped plants not only had higher capacity but also had attained ammonia and utility efficiency levels to the current standards.

The third paper in the Session titled “Recent Achievements and Advances in Urea Technology” was presented by Mr. G. Nishikawa of Toyo Engineering Corporation. He presented the latest technology of his company named ACES21[®]. The major features of this technology are: reduction in the number of equipments in the synthesis loop, installation of the reactor on the ground and operation of synthesis section at lower pressure. He went on to present the salient features of the process in detail. The process employs a vertical sub-merged carbamate condenser (VSCC), a kind of bubble column reactor with boiler tubes. It provides for high velocity and appropriate gas holder in the bubble column. The baffle plates distribute gas bubbles in the column effectively. The operating conditions in the synthesis section have been optimized with N/C ratio at 3.7 in the reactor, reactor temperature of 180-182⁰C and pressure of 150-152 barG. These conditions give high CO₂ conversion efficiency of

63-64%. Toyo have also developed in collaboration with Sumitomo Metal Industries Ltd., a new duplex stainless steel DP28W™ for urea plant. The material has high mechanical strength and high corrosion resistance. A unique heat integration between the HP stage and MP/LP stages helps in reducing the energy consumption in the process. The process is also flexible for various configuration of utilities. The continuous on-line analysis of urea in treated process condensate is also provided to monitor the quality of water after deep hydrolysis. Urea analyzer was developed jointly by Toyo and Mitsui Chemicals.

Mr. Nishikawa also mentioned that the technology was first used to debottleneck a 1620 MTPD plant to 2460 MTPD urea production capacity. A first complete new urea plant based on ACES21® technology was commissioned in Indonesia with a capacity of 1725 MTPD in the year 2006. He informed that Toyo have also been awarded to license the technology for 2100 MTPD urea synthesis unit and 2640 MTPD spout bed granulation unit in Trinidad. More recently, Toyo have been contracted to license technology and perform basic engineering to build a 3250 MTPD urea plant in Iran.

The last paper of the fourth Session was presented by Mr. A Scotto titled “Urea Casale Technologies and Industrial Experiences in Urea Field”. Mr. Scotto described in his paper a portfolio of technologies available with Urea Casale. The notable technologies developed and commercialized in the past are Casale-Dente High Efficiency Trays, Casale High Efficiency Hydrolizer ,High Efficiency Combined (HEC) Process and Vapor Recycle System (VRS) Process. These technologies have been applied in a number of plants to increase the capacity and

improve the efficiency of urea plants. The latest developments at Casale include is Split-Flow-Loop™ and Full-Condenser™ Concepts for revamping of CO₂ stripping plants. Mr. Scotto presented a theoretical background behind these developments. The Full-Condenser™ concept improves the existing high pressure carbamate condenser (HPCC) by changing the falling-film configuration to the more efficient bubble-flow configuration. According to this concept, the condenser operates as a sub-merged condenser with natural circulation. Further the new configuration of the high pressure loop has been developed, called the “Split-Flow-Loop™”. In this concept the HPCC is practically a total condenser and only the amount of vapour that actually condensed in this equipment will go to the condenser. The rest of the vapours by-pass the condenser and go directly to the reactor. This concept increased the stripping efficiency and the CO₂ conversion in the reactor. These two concepts can increase the capacity of CO₂ stripping plants with very low investment.

Mr. Scotto then presented the case studies of actual revamp of urea plants. A notable amongst them is a CO₂ stripping plant in Ukraine revamped first to increase its capacity from 1000 MTPD to 1350 MTPD and then further increase in its capacity to 1500 MTPD. The plant is now operating after the latest revamp since 2003. Another urea plant using ammonia stripping technology was revamped from 1500 MTPD to 1590 MTPD in Russia in 2005. A further revamp of this plant to increase its capacity to 2000 MTPD is under implementation and will be completed in 2008. Revamp of these plants and a number of other plants using Urea Casale technologies have not only helped to increase the production capacity significantly but also reduced the specific consumption of ammonia, steam and power.

Concluding Session of the Conference was a panel discussion. Panelists were Dr. S. Chandra, Jt. Adviser (Technical), Department of Fertiliser, Govt of India, Mr. V. K. Sharma, Director (Technical), NFL, Dr. S. Nand, Director (Technical), FAI and Mr. R. D. Mall, Vice President (Operations), NFCL. First issue, discussed was modernization of Indian fertiliser plants. A number of fertiliser units have prepared revamp/retrofit projects with the help of technology licensors. However, there has been significant inflationary pressure on the cost of equipment and engineering services during past two years. In addition, the pricing policy environment for fertilisers in the country is not very encouraging for attracting investment. These factors have slowed down the modernization of plants in spite of large volume of natural gas being available in near future from domestic sources. In view of the widening gap in demand and production of fertilisers in the country, it is hoped that policy environment would change to encourage investment in new and modernization projects.

The second important issue discussed was problem of availability of trained manpower. A need was felt for providing intensive training covering fundamentals and hands-on training to various categories of freshly recruited manpower. While companies, individually would have to take care of their training needs, a collective effort for the sector in this direction is also necessary.

[The full text of the papers presented during FAI International Conference on Fertiliser Technology along with the other details is available as hard copy in FAI, New Delhi on payment of Rs.500/- per copy]