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Frank Notes

Satish Chander

Energy Conservation in Indian Fertilizer Industry

Fertilizer production technologies have matured over the years. The present day technologies can give practically achievable efficiency in modern plants. Basic process technologies have been same for the last several decades. For example, synthesis of ammonia is still carried out through Haber-Bosch process invented in the beginning of the last century. However, there have been huge advancements in metallurgy, catalyst science and design of both static and moving equipment including reactors, heat exchangers, pumps and compressors. These developments have helped to increase the energy efficiency of fertilizer production manifold. Ammonia is an essential intermediate for production of all nitrogen containing fertilizers. Production of ammonia is highly energy intensive. Energy consumption in ammonia production has come down from about 15 GCal MT^{-1} in 1950s to less than 7.0 GCal MT^{-1} at present.

Indian fertilizer industry started its commercial journey from 1951 with an ammonia plant based on coke oven gas in Sindri. The second ammonia plant based on water electrolysis was commissioned at Nangal in 1961. Since then, plants were constructed continuously to meet the fertilizer demand after onset of Green Revolution. We still operate plants of 1960s' and 1970s' vintage. A large number of plants were commissioned in 1980s and 1990s.

The later generation plants were of single stream of large capacity. Therefore, 76 % of total urea production capacity is accounted for by plants commissioned in 1980s and 1990s. There was huge time lapse of almost 20 years when no new urea plant was commissioned after the year 1999. All the plants of vintage ranging from 21 years to 52 years have modernized in stages as the newer developments were available in any of the areas of fertilizer production technology. Modernization was necessary to prolong life of the plants and also to improve efficiency in order to stay in the business.

FAI has been documenting the journey of fertilizer industry through status papers, conferences and publication of papers in Indian Journal of Fertilisers. Latest developments in technology and equipment as well as latest practices in operation and maintenance of fertilizer plants have been adopted over the years. For example, low level heat which was earlier rejected to either atmosphere or cooling water is now recovered and utilized gainfully. Old equipment have been replaced with more efficient and reliable ones. High reliability of equipment enables the plants to run continuously without disruption which results in high operational efficiency.

Revamp of plants were also taken up for increasing capacity as well as energy saving. In ammonia plants, efforts were made to recover the heat from furnace flue gases to the maximum extent by installing additional heat exchangers and replacing old design heat exchangers with new efficient design. Carbon dioxide removal section has undergone significant changes by way of replacement of old packing in absorption tower with high efficiency packing, more efficient solvent and reducing regeneration energy by changing from single-stage regeneration to two-stage regeneration. Modification in synthesis converter design from axial to radial-axial flow, introduction of additional stage for synthesis and improvement in catalyst resulted in improved conversion per pass, reduced synthesis loop pressure and lower energy consumption in ammonia plant. Urea plants improved energy consumption by improving conversion efficiency in reactor by introduction of additional and/or improved designed trays, internal devices like vortex mixture and replacing old reactor

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with new reactor. Significant saving in energy has also been achieved by utilization of excess/waste steam in additional stages of decomposition and concentration in urea plants. As a result of several measures, there has been substantial reduction in power and steam consumption in urea plants.

Urea pricing policy has also given thrust to energy saving in urea plants. As mandated by the policy, the non-gas urea plants switched to most efficient feed natural gas. Presently, entire urea production capacity is based on natural gas as feedstock. Revision of energy consumption norms for urea plants in 2015 and in 2018 led fertilizer plants to further implement energy saving measures in the recent time. Three plants are changing coal based captive power generation to natural gas with gas turbines along with heat recovery steam generation systems. This will result in substantial energy saving in captive power and steam generation.

As a result of numerous energy saving measures, the average energy consumption of ammonia and urea plants has improved by more than 34% in last three decades. The energy consumption of urea plants has improved from 8.87 Gcal MT^{-1} urea in 1987-88 to 5.78 Gcal MT^{-1} urea in 2020-21. The best plants are operating at energy consumption of 5.0 Gcal MT^{-1} urea.

Phosphatic fertilizer plants with captive sulphuric acid plants have improved energy efficiencies by changing to improved technology and recovery & utilization of waste heat. All the sulphuric acid plants have changed from single absorption to double absorption thereby increasing SO_2 conversion and heat recovery. Additional heat recovery systems (HRS) have also been installed by two plants in the intermediate absorption section. Recovery of waste heat from various sections has been improving by replacing old heat exchangers with better efficient heat exchangers. In a recent development, a patented technology is on offer for heat recovery system using amine based propriety solution. The modification eliminates the requirement of intermediate absorption system thus making process from double absorption to single absorption. It is claimed that the process will increase the steam generation by 0.3 MT per MT sulphuric acid production. The removal of intermediate absorption section also reduces capital and operating costs.

Energy contributes a small part in complex fertilizer production, still plants are making efforts to reduce the energy consumption to improve efficiency and reduce cost. Efforts for reducing energy consumption in phosphoric acid plants are focused to reduce power consumption in rock grinding section, pumps, fans, blowers, etc. Modernization of phosphoric acid plant to a new process helped one plant to eliminate the requirement of rock grinding section. In complex fertilizer plants, change of technology to pipe reactor has helped plants to reduce moisture content in slurry and recycle ratio. This in turn has helped in saving fossil energy for recycle, drying and granulation of product. Complex fertilizer plants with integrated sulphuric acid plant utilize waste heat from sulphuric acid plant in drying. Waste heat available is also utilized to preheat cold ammonia before it goes to pre-neutralizer.

The energy conservation is a continuous process. Most of the plants have reaped benefits of high potential energy saving schemes by making huge investment in last few decades. A high level of energy efficiency has been achieved by the plants. Any further incremental saving in energy requires replacement of capital equipment with huge investment with small energy savings. The fertilizer industry has been optimizing resources to improve both efficiency and reliability.

The special issue of Indian Journal of Fertilisers has been devoted to the latest efforts of fertilizer plants for improving energy efficiency. The issue also consists of a paper by FAI which documents the efforts of ammonia and urea plants during last few years. ■