Indian Journal of Fertilisers **18** (6) : 530-531, June, 2022

Improving Reliability of Fertilizer Plants

Frank Notes

Dr. S. Nand

Fertilizer plants employ sophisticated technologies for production of a variety of fertilizer products. These plants operate under severe environment of high temperature and pressure and hazardous chemicals. There has been considerable increase in size, efficiency and reliability of ammonia, urea, acid and complex fertilizer plants worldwide over the years. Indian fertilizer industry has also come a long way since the first large scale fertilizer plant was commissioned in 1951 at Sindri. Industry has witnessed addition of large capacity since then and India is now the second largest producer of nitrogenous and phosphatic fertilizers in the world. Ammonia plants were commissioned with a variety of feedstocks like natural gas, naphtha, fuel oil and coal.

During the initial phase of development of industry, the major focus was on operation and achieving reasonable level of capacity utilization. After stabilization of operation of most plants in 1970s and 1980s, focus shifted to improvement of efficiency. Energy is feed as well as fuel for production of ammonia and urea. While, the new plants were designed for higher efficiencies, the older plants took the opportunity to embrace technological developments and underwent series of revamp and retrofit to improve their capacity and efficiency. Most old plants increased their capacity by 20-25% through debottlenecking exercise. Use of better materials of construction (MOCs), use of better catalysts, change of feedstock, optimization of process parameters, improved waste heat recovery, optimum use of waste heat and implementation of advanced process control systems resulted in much higher energy efficiencies of fertilizer plants than these were designed for. Continuous efforts towards modernization are reflected in ever-declining specific energy consumption. The energy consumption of ammonia and urea plants have improved by more than 34% over last 3 decades.

Reliability of plant equipment is an important determinant for achieving continuous operation and higher efficiency. Over the years, there have been improvements in design of equipment, better materials of construction and process improvements for higher reliability. At the early stage of development, the plants were relying on grid power supply. However, there were frequent disruption in supply and fluctuation in frequency, which affected the operation of large single stream machines. Any stoppage of a compressor or pump disrupted the production. Therefore, supply of reliable power was essential to maintain uninterrupted operation of continuous process fertilizer plants. To overcome the challenge, many plants installed captive power plants to eliminate dependence on grid power. These captive power plants were based on boilers fired with coal, naphtha or fuel oil to generate steam and ran turbo-generators. Later generation plants incorporated captive power plants from design stage itself. Simultaneously, there were significant developments in terms of reliability of Gas Turbo Generators (GTGs) for industrial application. Once reliability of GTG was established, ammonia-urea plants commissioned in late 1980s incorporated GTG along with co-generation of steam. This configuration provided highest thermodynamic efficiency. Plants commissioned in 1990s followed the same philosophy. More recently, a number of plants replaced their steam turbo-generators with GTGs with heat recovery and steam generation system. This single measure ensured continuous supply of power and there was no disruption in operation on account of this factor.

Another effort towards improving reliability was modification in the cooling tower. During 2005-06, cooling towers collapsed in number of ammonia-urea plants resulting in forced shutdown and loss of production. The reason for collapse of cooling tower was quality of wood used for structure during a particular period. After discussion within the industry and with experts, a number of measures were adopted. To reduce load on the cooling tower, the cooling tower pipeline header was brought down to the ground. A number of plants faced problems in the additional converter for ammonia synthesis. The problem was resolved by changing the design of the converter from hot wall to cold wall. In urea plant, change of materials of construction of stripper tubes from titanium to bimetallic has shown longer service

Reliability of plant equipment is an important determinant for achieving continuous operation and higher efficiency. There are numerous examples wherein fertilizer plants learnt from the experience and carried out modifications to improve the reliability of plant equipment.

life under corrosive conditions. There are numerous such examples wherein fertilizer plants learnt from the experience and carried out modifications to improve the reliability of plant equipment.

Repair, maintenance and replacement of equipment play an important role in improving the productivity and reliability of the plants. Plants have adopted improved NDT techniques that helped in identifying the problems in time and avoiding a forced shutdown. There has been change in the maintenance philosophy from breakdown maintenance to pro-active and condition-based maintenance. Further, due to better inspection tools, plants' management are now following reliability based maintenance to improve the life of the plant assets. It has been observed that many a times, deviation from the design of equipment or change in materials of construction have resulted in problems during the start up or during course of operation. Once such case study has been included in the current issue.

Continuous attention to causes of failures and remedial measures have helped to reduce both number and duration of forced shutdown. FAI carries out periodic surveys of downtime in ammonia and urea plants. The survey reports for downtime shows that loss of production time due to forced shutdown for equipment problems in ammonia plants was reduced drastically from average of 24.4 Downtime in Days per Plant per Year (DDPY) in 1987-1990 to 5.3 DDPY in 2017-2020 period. The urea plants also showed similar improvement wherein forced shutdown time due to equipment problems was reduced from 11.8 DDPY to 3.6 DDPY for the same period. This is a remarkable achievement considering that we continue to operate even 55 years old plants.

Complex fertilizer plants in India face a challenge of dependence on import of basic raw materials like rock phosphate and sulphur and intermediates such as ammonia, phosphoric acid and sulphuric acid. The quality of rock phosphate varies not only due to import from different countries but also from consignment to consignment even if it is from the same source. Variation in quality of rock phosphate poses a challenge for operators of phosphoric acid plants. Indian plants have learnt to operate by adjusting process parameters or by blending of different grades of rocks. A plant changed the phosphoric acid process from hemi-hydrate recrystallization to hemi-hydrate di-hydrate which can process rock from five different sources. In sulphuric acid plants, operational challenges have been overcome by improving conversion efficiency and improvement in the waste heat recovery. Complex fertilizer plants have optimized the process for various grades of products. The efforts have been made to reduce the nitrogen and P_2O_5 losses to the environment by scrubbing the gases in a multi-stage scrubbers and recycling the scrubbed liquor to the process. Use of improved MOCs for equipment, use of better NDT techniques and maintenance practices have also helped to achieve higher productivity.

Safety of plant and personnel is another challenge with operation under high temperature, pressure, hazardous chemicals, and handling of bulk materials. Any human injury or damage to equipment not only causes losses but is also demoralizing for the workforce. Analysis of safety data over last three decades shows that there has been reduction in injuries and also increase in accident free operating days. However, there is always scope for improvement by minimizing incidents causing injuries or damage to assets. Use of proper personal protective equipment, following standard operating procedures, identifying and removing unsafe conditions and change in at-risk behaviour have been focus areas for improved safety performance.

FAI provides opportunities for exchange of information through seminars, workshops and group discussion exclusively for improving safety and reliability of fertilizer plants. Professionals engaged in various functions of fertilizer production are encouraged to document their success stories for the benefit of large fraternity. The June 2022 Special Issue of Indian Journal of Fertilisers is one such attempt to document some recent experiences and key learnings in operation and maintenance of fertilizer plants. It is hoped that this will benefit all those engaged in design, construction, operation and maintenance of fertilizer plants.■