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Reducing Environmental Footprint from Fertilizer Production

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India is the second largest consumer and third largest producer of fertilizers in the world. During 2020-21, India produced 37.7 million tonnes and consumed 67.7 million tonnes of fertilizer products. The production of fertilizers requires various natural resources like natural gas, rock phosphate, sulphur and potash. In addition to processing these raw materials into fertilizer products, industry also procures intermediates like ammonia, sulphuric acid and phosphoric acid for production of fertilizers. Therefore, there is storage of large quantities of these chemicals. Manufacturing processes involve operation at high temperatures and pressures and treatment of various hazardous chemicals in various steps of production. Therefore, impact of fertilizer production on environment is an important consideration.

Fertilizer industry has always been sensitive to the impact of its activities on environment. Over the years, a number of measures have been taken by the fertilizer plants for resource conservation and minimizing impact of production processes on environment. There have been continuous revisions of standards for emission, effluent discharge and solid waste disposal to ensure safer environment. These measures included both intervention through process improvement and also implementation of end of the pipe solutions. Fertilizer industry has always been meeting standards prescribed by regulatory authorities at any given time. Plants have also adopted voluntary environment standards as responsible corporate citizens. As a result of these efforts, the emissions and effluent discharge to environment have been reduced substantially.

Ammonia is the key intermediate for producing nitrogen based fertilizers. Production of ammonia is responsible for about 2% of world energy consumption and 1% of global CO_2 emissions. Natural gas is used as the feedstock for production of ammonia and consumes almost 80% of the total energy consumption of a fertilizer product. In the initial stages of development of industry in India, ammonia plants were based on a variety of feedstock viz. natural gas, naphtha, fuel oil and coal. Over the years, some naphtha, fuel oil and coal based plants were closed and other naphtha and fuel oil based plants switched to natural gas as feedstock. Fuels in some of these plants were also replaced with natural gas. The change in feedstock along with other measures such as modernization of old plants including replacement of old equipment with energy efficient equipment, process modifications, utilization of waste heat including low level heat and improved operation & maintenance practices have resulted in significant improvement in efficiency and reliability of ammonia and urea plants. Weighted average energy consumption of all ammonia plants in the country has been reduced from 12.48 Gcal MT^{-1} in 1987-88 to 8.18 Gcal MT^{-1} in 2020-21. Urea plants have improved their weighted average energy consumption from 8.87 Gcal MT^{-1} urea to 5.78 Gcal MT^{-1} during same period. This translates to an estimated saving of more than 7.5 million metric tonnes (million MTs) of oil equivalent per year at present level of production. The energy efficiency improvement also translates directly into reduction in GHG emission. The carbon dioxide generation from ammonia plants has been reduced from 3.61 MT CO_2 per MT ammonia in 1987-88 to 2.0 MT per MT ammonia in 2020-21 *i.e.* reduction of almost 45% during last 34 years' period. In addition, non-renewable energy such as solar and wind, are also being utilized directly or through renewable purchase obligations determined by the state governments, thus further reducing environment footprint of ammonia and urea plants.

Ammonia, phosphoric acid and muriate of potash are the major inputs for production of complex fertilizers. Any escape of these raw materials to environment has to be minimized. The complex fertilizer plants have improved the raw material recovery efficiency. The average nitrogen use efficiency improved from 93.0% in 1992-93 to 97.8% in 2019-20 and from 94.0% to 97.5% for P_2O_5 during the same period. The improvement in raw material efficiency means reduction in losses of ammonia and phosphoric acid to the environment. These improvements were possible by optimization of process conditions and

For reducing environmental footprint, Industry has adopted the principle of sustainable development and gone much beyond regulatory compliance.

recovery & recycle of inputs from the emission and effluents. Efficient operation and improved maintenance practices have further improved the raw materials use efficiency.

Water is an important natural resource used in fertilizer plants as cooling medium and raising steam for process and power generation. The fertilizer plants have made tremendous efforts to reduce the water consumption by adopting technologies for treating effluents and making it suitable for reuse as boiler feed water and make-up water in cooling towers. This helped in reduction in fresh water consumption and waste water discharge from the fertilizer plants. As a result, the raw water consumption in the ammonia-urea plants was reduced from 12.6 M^3 MT^{-1} urea in 1990-91 to 6.2 M^3 MT^{-1} urea in 2019-20. The raw water consumption in complex fertilizer plants has also reduced from 11.4 M^3 MT^{-1} P_2O_5 to 5.1 M^3 MT^{-1} P_2O_5 during the same period. This translates into estimated saving of more than 170 million KL of fresh water every year.

In order to monitor the emission and effluents on 24-hour basis, CPCB has mandated the industry to install online monitoring system with feeding of data on real time basis to servers of CPCB and SPCBs. Industry has complied with this mandate. Industry has always gone beyond compliance with the standards prescribed by the central and state regulators with respect to emission, effluent discharge and solid wastes disposal to the environment. International voluntary standards like ISO 14001 have been adopted for continuous improvement by almost all major fertilizer companies. The fertilizer industry now is gearing up to meet the requirements under Plastic Waste Management (PWM) Rules, 2016 as amended in 2021. In case of fertilizer industry, PWM Rules require recycle of all the material used in bags for packing fertilizers. There are a few practical challenges in value chain and hence in implementation of PWM Rules. Industry is engaged with the government in addressing these issues.

Phosphogypsum is a byproduct of phosphoric acid plants. There is generation of 4.5 to 5 MTs of phosphogypsum (PG) for every MT of phosphoric acid produced. There is annual production of about 8 million MTs per annum of PG which has to be stored at plant site following all the guidelines prescribed by the CPCB. Fertilizer industry is making all efforts for its gainful utilization as part of circular economy. It can be utilized in construction materials such as cement, gypsum board, road construction, etc. PG is also used in agriculture as soil conditioner for alkaline soils or as a source of calcium and sulphur. During 2019-20, 65% of about 8.5 million MTs of phosphogypsum generated was utilized. The cement accounted for about 63% phosphogypsum utilization. Further 14% and 23% was used in agriculture and building materials, respectively. There is huge accumulation of legacy stock at some sites. The Department of Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India set up a Working Group for achieving circular economy in gypsum. The Working Group has submitted a report and suggested strategy for increasing use of phosphogypsum in agriculture and manufacture of cement and building materials. Road construction also offers a great potential. Policy initiatives required for the same have also been suggested. We hope that the recommendations of the report are implemented to facilitate transport and utilization of phosphogypsum.

Another important area gaining attention recently is the utilization of green hydrogen/ammonia. Fertilizer industry has been identified as one of prospective users for utilization of green hydrogen/ammonia. Utilization of green hydrogen, no doubt will help in decarbonization of the fertilizer production. However, there are certain concerns of the industry. Ammonia-urea integrated plants have technological limitations in utilization of green hydrogen. However, it can be utilized for production of complex fertilizers. But fertilizers are sold to farmers at heavily subsidized prices. Therefore, any increase in cost of ammonia will translate into higher subsidy. There should be a mechanism in place to neutralize the higher cost of green ammonia before any mandate is given to the industry.

The fertilizer industry has adopted the principle of sustainable production. In spite of various constraints, industry has gone much beyond its regulatory obligations. Maintaining high environmental standards also makes good business sense. ■