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Water Management in Fertilizer Industry

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Water is the most important and critical natural resource for sustaining life and human activities. It is also an important resource for various industrial activities. Though, 71% of the Earth surface is covered with water but only 0.3 per cent of it is usable and other 99.7 per cent is in oceans, soils, icecaps and atmosphere. Globally, more than 20% of water is used by industrial sector. In fertilizer plants, water is used for process, heating and cooling, steam generation, firefighting, drinking, cleaning, deashing and sanitation. The source of water in the fertilizer plants is both ground or surface water. A few plants are sourcing sewage from nearby city municipalities and treating it and using treated water as raw water. In some fertilizer plants, rain water is stored in large storage ponds and used after treatment. Surface water is treated before use as raw water to remove suspended solids and other undesirable impurities. The characteristic of raw water varies from source to source and location to location and also plays an important role in water management and designing raw water & effluent treatment plants. The quantity of water consumed in the fertilizer manufacturing process depends upon the process technology, characteristics of water and raw materials used.

Fertilizer manufacturing is water intensive. Therefore, water conservation has been a focus area in fertilizer industry. Fertilizer plants have adopted the principle of reduce, reuse and recycle while implementing various water conservation schemes. A number of schemes have been implemented to reuse/recycle waste water generated from the process after treatment. Plants have also implemented measures to reduce consumption of water by improved/ modified processes and turbines which consumes less steam. With the concerted efforts of the industry, water consumption in ammonia-urea integrated plants have reduced from 12.0 $M^3 MT^{-1}$ urea in 1990-91 to 6.2 $M^3 MT^{-1}$ urea in 2020-21 and in case of complex (NP/NPK) plants it reduced from 11.4 $M^3 MT^{-1}P_2O_5$ to 4.5 $M^3 MT^{-1}P_2O_5$ over the same period. This translates to reduction of about 50% in ammonia-urea plants and 60% in case of complex fertilizer plants.

Ammonia is the major intermediate for production of urea and all other nitrogen bearing fertilizers derived from it. Its production is highly water intensive as steam is also required for process apart from other industrial use. The ammonia and urea production are highly exothermic in nature and water is used as medium for absorbing the exothermic heat of reactions. Cooling of process gas containing steam results in condensation of steam in condensers. The process condensate so generated contains constituents of the reactions and are separated in condensers. The process condensate from ammonia plants carry some dissolved impurities in form of ammonia, methanol and carbon dioxide. In urea production, process condensates generated from different sections of the urea plant contains various impurities like ammonia, carbon dioxide and urea. As a part of reuse of waste water, each plant has its own treatment system. The ammonia plant condensates are treated in process condensate stripper while urea plants have employed hydrolyser and stripper to treat its condensate.

Steam is used as motive force to drive the large compressors and pumps. The steam used for driving the turbines in the process plants are condensed after use. It normally does not get contaminated with any process materials. Hence, steam condensate from turbines require minor treatment like activated carbon filters and basket strainer to remove foreign particles in the demineralized (DM) plant. The treated water after polishing is reused as boiler feed water. Thus, recovery and reuse of condensate save considerable amount of raw water.

Water consumption level in complex fertilizer plants varies for plants with or without captive acid production. In captive acid plants, water is consumed in sulphuric acid production as process water where water is used to absorb sulphur trioxide to produce sulphuric acid and to generate steam from waste heat of the exothermic reactions. Water is consumed for preparing slurry of rock phosphate which reacts with sulphuric acid in reactor in phosphoric acid plants. Water is also used for scrubbing of gases and dust from processes in the complex and SSP fertilizer plants. In addition, water is consumed in utilities for generating steam which in turn used for power generation and drying of products.

In case of complex fertilizer plants, various methods

Being highly water intensive industry, fertilizer industry has always focused on water conservation. As a result of concerted efforts, water consumption of ammonia-urea plants had reduced by 50% and NP/NPK complex fertilizer plants by 60% over a period of 30 years.

of recycle and reuse of effluents from plant discharge through the balance pond into the plant through surge pond are in practice. This has not only reduced the water consumption per tonne of product but also improved P_2O_5 recovery efficiency. Use of cooling tower blow down, scrubber bleed off in the process areas and treated trade effluents are used for cake wash in phosphoric acid plant itself. The washings / wash water in the phosphoric acid plant is neutralized with lime if required and the neutralized wash water is reused in the phosphoric acid plant. Switching from wet gypsum stacking to dry gypsum stacking also helped in conserving water.

The rejection of heat to atmosphere is carried out in cooling towers which are the major consumer of water. Evaporation loss takes place from cooling tower which is the major reason for high water consumption. Continuous blowdown is carried out from cooling tower to maintain the TDS in the circulating water. Make-up water is required to compensate for the evaporation losses and blowdowns. To reduce the consumption of raw water, effluents are treated and water is being used as the cooling tower make up. Blowdowns take place during boiler operations to maintain the quality of DM water. The quality of boiler blowdowns is found suitable to be as cooling tower make-up water. During regeneration of DM plant, effluent generated is of quality that can be used for cooling tower makeup.

Fertilizer plants are upgrading the effluent treatment system by installation of lamella clarifier, ultra-filtration and reverse osmosis (RO) technologies for the treatment of trade effluent. RO reject water is directly used in venturi scrubber of reaction section in complex fertilizer plants. In urea plants, the RO permeates are used as cooling tower makeup. The RO rejects are further treated in multi-effect evaporators (MEE) where water vapours are condensed and used as cooling tower makeup water. The sewage treatment plant (STP) has been installed for treating sewages in the township. A plant has been sourcing the sewages from the city, treating it in STP and returning treated water back to municipality. Many plants have upgraded to technologies like membrane bio reactor (MBR) which makes the treated water from STP suitable to be reused as cooling tower make-up water.

There has been continuous development in water treatment chemistry. Better and environment friendly chemicals helped in reduction in use of chemicals as well as improving the quality of waste water and circulating water. This resulted in increase in reuse of treated water in process and improved cycle of concentration in cooling water circuit.

Raw water is sourced in large quantity and stored in ponds. Evaporation loss from these ponds is quite substantial. Efforts are being made by the plant management to reduce the evaporation losses from the storage pond. In a recent scheme, a plant implemented floating solar panels on its reservoirs, thus reducing evaporation losses as well as generating renewable power. Rain water harvesting has been adopted by many plants for recharging ground water. The rain water is collected and treated and being used as cooling tower make-up water.

Monitoring of water consumption is a prerequisite for efficient water management. The digital flow meters with totalizers in place of analog meters provide more accuracy. For efficient water management, it is also important to understand the water distribution network, identify points of water consumption, leakages and wastages. Water audit is an important tool which helps to identify the areas where wastage of water is taking place and measures can be undertaken to plug the leakages. A number of fertilizer plants have undertaken water audit. The Central Ground Water Authority (CGWA) Guidelines on ground water restricts withdrawal of ground water and use for commercial and industrial activities falling under over-exploited assessment areas. The plants which are located in such areas and relying only on ground water have to put lot of efforts to reduce fresh water consumption. One such fertilizer plant is exploring innovative method of collecting moisture present in atmosphere by condensation on air chilling coils. These have great potential of recovery during the humid seasons or in plants located at coastal areas.

All ammonia and urea plants which were commissioned recently have been given the condition of zero liquid discharge. The existing plants are also working to fully recycle and reuse the treated waste water and achieve zero liquid discharge. Reduction in water consumption for production of fertilizers is an ongoing process. The focus of this Special Issue is on the various recent efforts made by the fertilizer plants to reduce water consumption. We hope that the Special Issue will be quite useful to all engaged in management of water in process plants. ■