Study on Zero Discharge Plant for Waste Water Treatment of a Pharmaceutical Industry

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Abstract: - Pollutants must be removed from the water to protect the environment and public health. When water is used by the industry, the water becomes contaminated with pollutants. If left untreated, these pollutants would negatively affect the water and environment. Treatment of wastewater is an essential process that prevents contamination and the destruction of waterways, drinking water resources and natural water resources. Waterborne diseases are also eliminated through proper wastewater treatment. Wastewater is approximately ninety-nine percent water and only one percent solids. The removal of these solids and disinfection of the water before discharge is the basic concept of wastewater treatment. Zero discharge plant has many advantages in comparison with the older methods used for treatment. One of the pharmaceutical unit generates effluents, it can discharge effluents into the CETP (Common Effluent Treatment Plant) per day. So it has been decided to treat all the effluents in their plant itself and recycle maximum water by installing zero discharge units. Treatment of effluents is a must as per MPCB (Maharashtra State Pollution Control Board) norms. Effluent to comply the norms it has been incorporated of MPCB a zero discharge unit which recycles all the water from waste effluents and discards only solid wastes. In this paper the detailed study on zero discharge system of Pharmaceutical Plant has been done. It is observed that by implementing zero discharge concept pharmaceutical plant is able to utilize all recovered water in its utility unit.

Keywords: Zero Discharge, Waste Water Treatment, Plate Type Reverse Osmosis, Agitated Thin Film Dryer, Multiple Effect Evaporator, Water Recovery.

I.INTRODUCTION

In a typical pharmaceutical have invested heavily in their effluent treatment plant. Studied pharmaceutical plant is an API unit i.e. Active pharmaceutical (Drug) Ingredient unit. Production of all Drugs are made in plant and transported to other sites for packaging and distribution. Hence large amount of water is required for all the processes and thus large effluents are also being generated. Treatment of effluents is a must as per MPCB (Maharashtra State Pollution Control Board) norms. So the pharmaceutical plant incorporates a zero discharge unit which recycles all the water from waste effluents and discards only solid wastes. About 50% of water is recycled back to utility per day which is a very significant amount of water recovered. It was suggested to use the solid wastes in bug-gas boilers as a heating medium to generate steam but on analysis it was found that the solid wastes generated are inflammable. Thus the solids are sent to MWM (Municipal Waste Management) for disposal. It is observed that by implementing zero discharge concept pharmaceutical plant is able to utilize all recovered water in its utility unit. In this paper a detail study of a pharmaceutical industry is done

II.FLOW SCHEME OF EFFLUENTS IN ETP OF PHARMACEUTICAL PLANT IS AS FOLLOWS:

The effluent waste water from biological waste water is initially fed to the anaerobic bio-digester where effluents are digested to produce bio-gas. This bio-gas is used in boilers as heating medium to produce more steam. The over flow from anaerobic bio-digester goes to aerobic-1 unit. Synthetic waste effluents go to the aerobic-1 unit directly. After treatment from aerobic-1 the treated effluents move to aerobic-2 unit. Synthetic waste effluents go for treatment in aerobic-2 unit. All the effluents from aerobic-2 unit move to a treated tank which acts as a feed for the zero discharge plant. Zero Discharge plant consists of 3 units namely Reverse osmosis unit (RO), Multiple Effect Evaporator unit (MEE) and Agitated Thin Film Dryer unit (ATFD). From zero discharge plant pure water is recycled back to utility for reuse per day. The dry solids which we get at the end of zero discharge plant are sent to solid waste management for disposal.

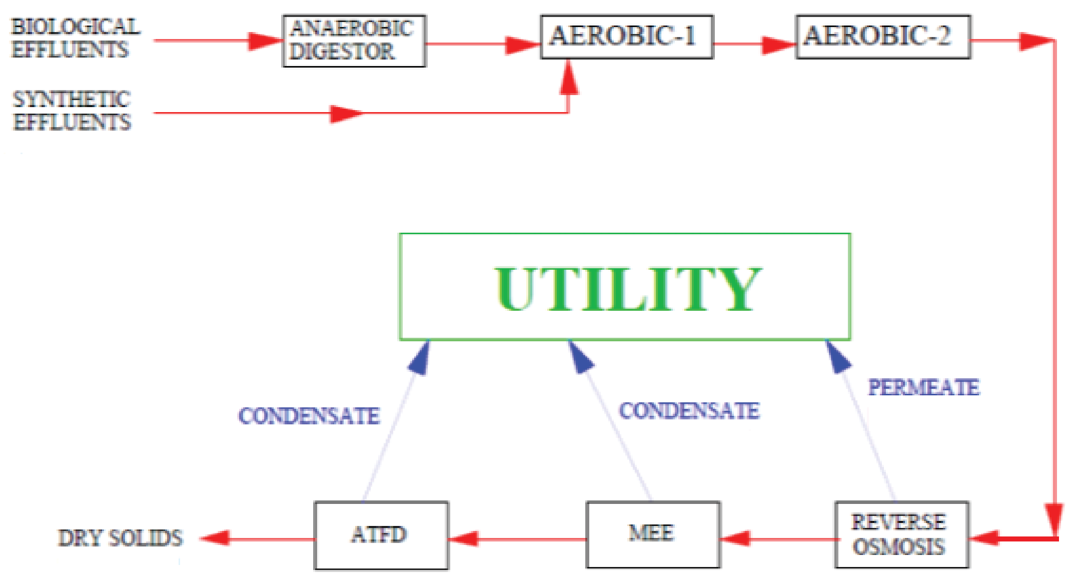

Figure 1. Flow Scheme of Effluents in ETP at Pharmaceutical Plant

The major aspects of ZERO DISCHARGE PLANT areas follow

1 Reverse osmosis

2 Multiply effect evaporator

3 Agitated Thin Film Dryer

III.REVERSE OSMOSIS PLANT

This plant completely works on the principal of reverse osmosis:

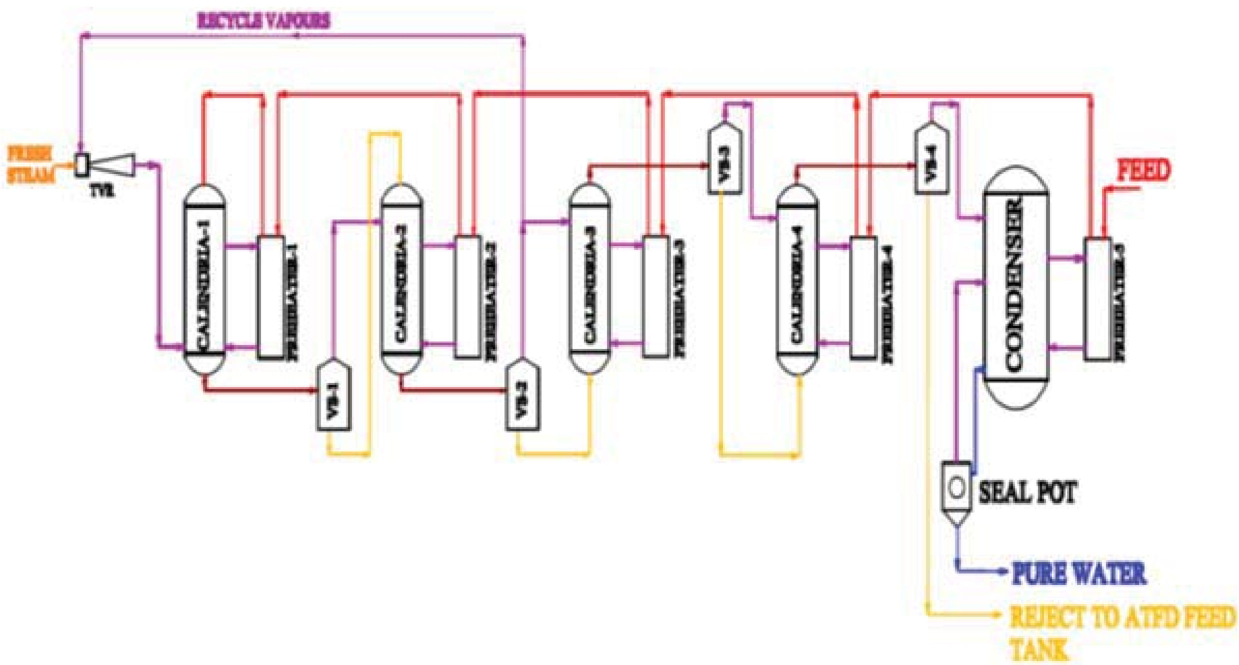

Figure2. Flow Scheme of Reverse Osmosis at Pharmaceutical Plant

Reverse osmosis (RO) is the workhorse of water purification. RO membranes reject a high percentage of ions, organics, colloids, pyrogens and microorganisms from feed water. Water is forced from the comparatively concentrated solution to a dilute solution by being pumped through a semi-permeable membrane, under pressures that exceed the normal osmotic pressure. RO membrane configurations are either spiral-wound or hollow-fiber. The membrane material include cellulose-acetate, polyamides, or TFCs. TFC membrane offer the highest flux and contaminant rejection, operate in a broad spectrum of pH(2 to 12) are relatively easy to clean, and are fabricated with adhesives that tolerate relative high operating temperature(45 to 85^0 C). Most RO units operate at 70 to 75% recovery. A common arrangement for enhancing rejection and minimizing waste is referred to as double-pass product-stage. The product from first stage becomes the feed of second stage. Membrane cleaning frequency is once in a month. The phenomenon of reverse osmosis has been extensively developed as an industrial process for the

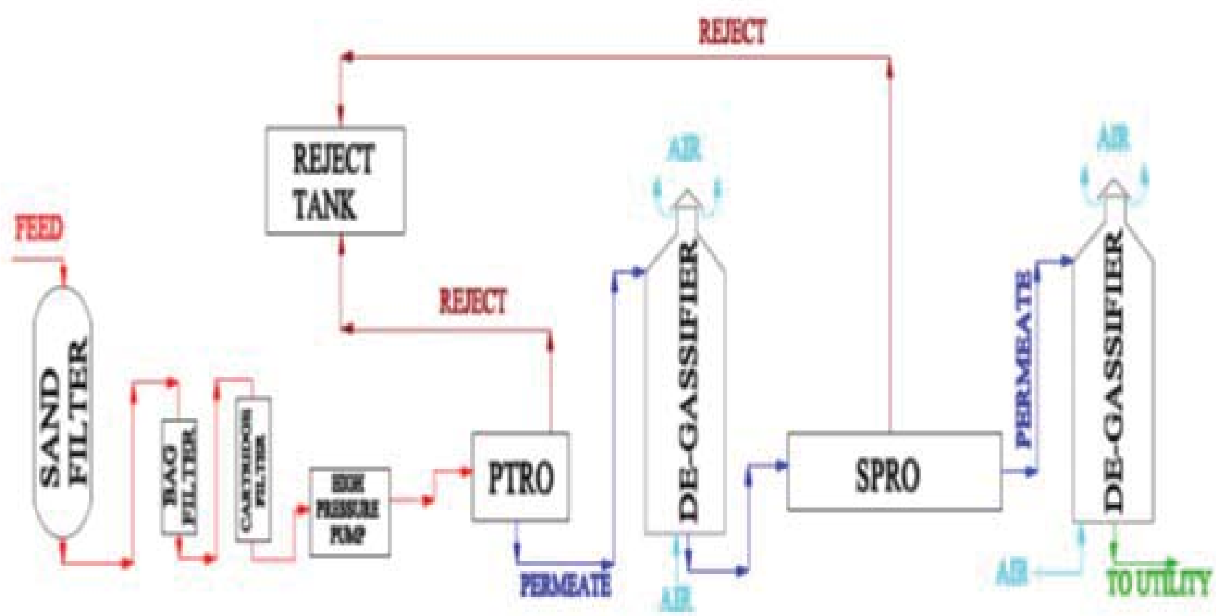

Figure 3. Flow Scheme of Multiple Effect Evaporator at Pharmaceutical Plant

concentration of low molecular weight solutes and especially for the desalination, or more generally demineralization, of water. Membrane equipment for industrial scale operation of microfiltration, ultra-filtration and reverse osmosis is supplied in the form of modules. The area of membrane contained in these basic modules is in the range 1–20 m^2. The modules may be connected together in series or in parallel to form a plant of the required performance.

The treated tank of aerobic-2 plant acts as the feed tank for the RO unit. The effluent waste water collected in treated tank is highly basic. The feed must be neutralized before entering the RO unit since it might affect the membranes in the unit. For neutralizing the feed, we require hydrochloric acid is added. After neutralizing the effluent water, it is fed to the sand filter. Sand filter has different size gravels inside it. Maximum 50-micron size particle can pass through the sand filter. After passing through the sand filter, the effluent water is fed to the bag filters. Maximum 30-micron size particles can pass through the bag filter. After passing through the bag filters the effluent water is made to pass through cartridge filter. Maximum 5-micron size particles can pass through the cartridge filter. After removing most of the suspended solids from the effluent water it is passed through high pressure pumps which push the water with great force into the Plate Type Reverse Osmosis unit (PTRO). Reverse osmosis process takes place in the PTRO and pure water as permeate and impure water as reject is separated. Impure water is sent to reject tank. The permeate water from PTRO is sent to De-gasifier in which water is fed from top and air is blown from bottom. Any entrapped gases in the permeate are removed. The permeate water is then sent to Spiral Type Reverse Osmosis unit (SPRO) for more purification by reverse osmosis process. Here the permeate water obtained is again sent to another de-gasifier and then to utility for reuse. The impure water from SPRO is directly sent to reject tank.

IV.MULTIPLE EFFECT EVAPORATOR PLANT (MEE)

MEE plant works on the basis of evaporation:

The plant is specially designed for handling the Effluent and to increase their concentration. The evaporator is a 4-effect evaporator with Thermo Vapour Recompressor (TVR). The feed is introduced into Calendria-1 after sequential preheating from the preheaters 5, 4, 3, 2, 1. The feed is then fed to Calendria-1 top on the tube side. The concentrate from Calendria 1 is fed to Calendria 2 for further concentration and so on up to calendria 4. The final product of evaporator is taken out from Calendria 4. Live steam is used on motive side of TVR which sucks vapours from vapour separator-2 and mixed vapour are introduced on shell side of Calendria-1 as heating medium. Balance evaporated vapours from calendria-1 are used as heating medium in calendria-2. Evaporated vapours from Calendria-2 are used as a heating medium for calendria-3. Evaporated vapours from Calendria-3 are used as a heating medium for calendria-4 and evaporated vapours from calendria-4 are finally condensed in condenser where cooling water is used as cooling medium. The condensate from Calendria-1, 2, 3, 4 is sent to seal-pot for collection of condensate. A common pump is provided to take condensate out. The non-condensable from each calendria are parallel drawn and sent to condenser. The uncondensed non-condensable are sent out by vacuum pump hooked up to the condenser. Calendria-1 and 2 work on Falling Film principle, which are the most efficient of all types thermally. Feed is sprayed at the top and gets distributed uniformly to all the tubes due to presence of an efficient liquid distributor as shown in fig-3 below. The feed travels as a falling film on the periphery inside tube and gains heat due to condensing vapours outside the tubes. As a result, evaporation starts on the tubes and both liquid concentrate and vapours travel down. The concentrate is collected and pumped out further. The vapours separated at the bottom, enter a vapour separator where droplets are separated and the vapours are taken further through a duct from the vapour separator to next calendria as a heating medium on shell side. To maintain adequate wetting of tubes, recirculation of part of the product is provided. Calendria-3 and 4 work on forced circulation principle where concentrate is fed from bottom on the tube side of calendria to maintain the required velocities in the tubes and also to avoid chocking. The liquid only gains sensible heat in the calendrias and are flashed in the vapour separators.

V.AGITATED THIN FILM DRYER

An Agitated Thin Film Dryers has a vertical jacketed cylinder with a closely fitting rotor. During operation the rotor revolves at a high speed. A distributor spreads the incoming feed uniformly over the cylinder top periphery. The rotors blades pick up the material spread it over the heated surface in a thin film and agitate the film intensely as it travels down the heated cylinder. The vapours generated rise counter-currently through the inbuilt entrainment separator. Here the entrained droplets are separated from the vapour stream. The clean vapours leave the dryer through a nozzle at top. The concentrated product leaves the dryer through the bottom.

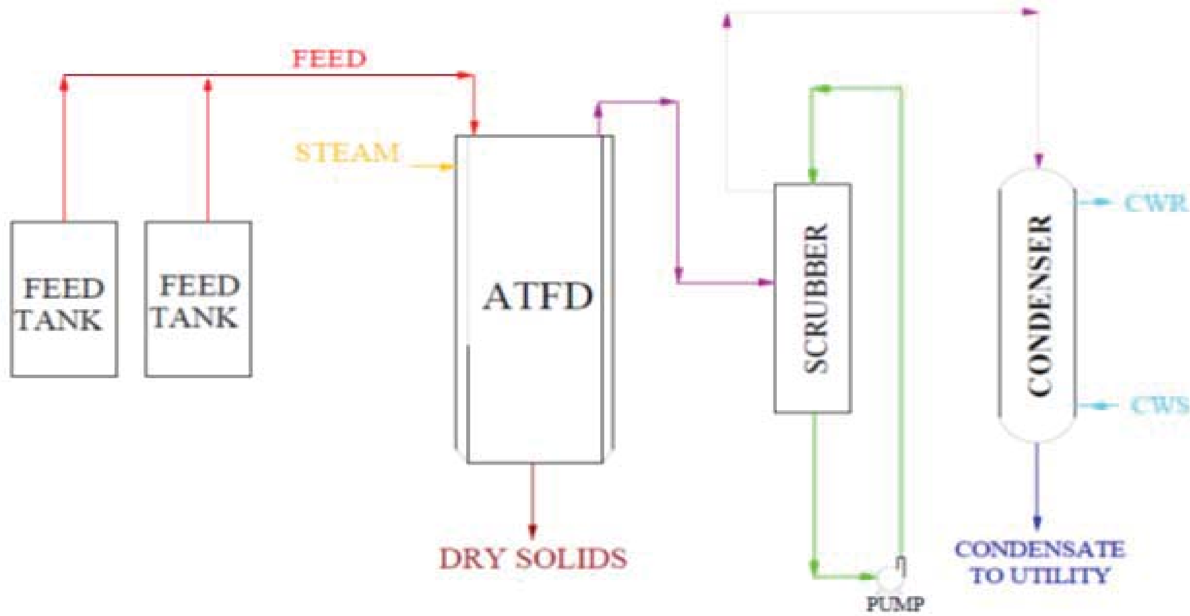

Figure 4. Flow Scheme of Agitated Thin Film Dryer at Pharmaceutical Plant

The concentrate enters the ATFD unit along the walls. The unit is completely jacketed with steam provided for heating purpose. ATFD unit has a rotor to which 98 plates are attached. These 98 plated are hinged so that they are free to move and evenly spread the concentrate on the walls of the ATFD. The steam provided, heats the concentrate and evaporates all the water content. The solid left when completely dried is scraped off by the same plates and is collected at the bottom. The vapours carry along with them few solids so it is necessary to scrub the vapours with water. After scrubbing the pure vapours are sent to condenser from where the condensate is sent to utility for reuse. Dry solids waste collected and disposed off..

VI.CONCLUSION

By considering environmental issues due to pharmaceutical industries, installing ZERO DISCHARGE PLANT pharmaceutical plan saves 50% of water per day which is in very large amount. the recycle water utilized in utility plant.

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