

CASE STUDY: EFFLUENT RECYCLING IN DYES MANUFACTURING

Largest Reactive Black Dye manufacturer of the country joined hands with Advent Envirocare Technology Pvt. Ltd., an Ahmedabad-based environment services offering company and had set up an EFFLUENT MANAGEMENT SYSTEM of to treat 500 m³/day of difficult effluent.



The superior technology treats wastewater which is characterized by high COD level of 5000 mg/L with limited biodegradability and very dark colour. To achieve the disposal norms, conventional treatment alone would have been inadequate and had to be supplemented by membrane-based separation system.

While doing so, the wastewater gets purified enough to be reused in the manufacturing process.

The Effluent Treatment Plant is employed to remove / reduce TSS, Oil & Grease, and Biodegradable COD & BOD, and then Membrane-based Systems provide reusable grade water. The main units of the Effluent Treatment Plant are Transfer Sump, Oil Separator, Quality Equalization Tank, Flow Equalization Tank, Flash Mixer, Primary Clariflocculator, Integral Clarifier Activated Sludge System, Membrane Bioreactor, High Efficiency RO System and Multiple Effect Evaporator.



The Effluent Treatment Plant was designed incorporating three “state-of-the-art” technologies. The first stage biological treatment unit is the Advent Integral System, an activated sludge process based system with superior biomass clarification and recycling, without any moving parts (Refer Figure – 1). The second stage biotreatment system is a combination of extended aeration activated sludge process and membrane filtration, termed Membrane Bio Reactor. The MBR removes practically all of biodegradable organics present in the wastewater and provides contamination. Such a superior quality of outlet water provides an opportunity to use Hyperfiltration (Reverse Osmosis) as final treatment step to remove dissolved organics, inorganics (and colour) with lesser risk of fouling of membranes.

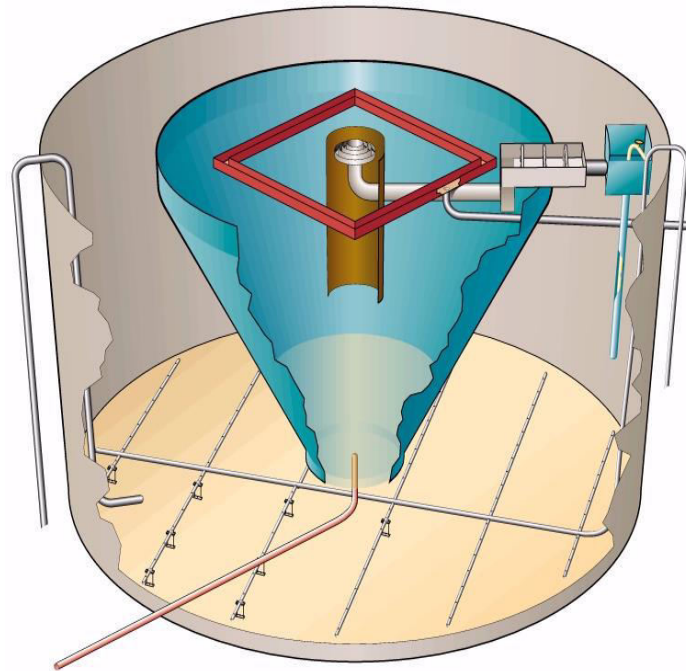


Figure – 1

The ETP was commissioned in September, 2009 and has been continuously in operations since November, 2009. The treatment results were exceptional as well as consistent over over the first year of operations and subsequently handed over to client (Refer Table-1). No

membranes were replaced in 3 years and still the outlet quality was good enough to permit recycling. Chemical cleaning of membranes had been recommended just once in a month based on experience of no deterioration in performance even after 8 – 10 weeks. Recoveries have been around 80% even though the feed TDS levels are more than double the design values. The reject from second stage RO is disposed by thermal treatment in Multiple Effect Evaporator.

Table – 1 : Plant Design & Performance

Parameter	Unit	Design Feed	Actual Feed	Actual Outlet
COD	mg/L	5000	2500 – 5500	< 50
TSS	mg/L	500	50 – 350	Nil
TDS	mg/L	3000	3000 - 8000	< 250
Colour	Co-Pt U	> 3000	> 5000	< 100



EFFLUENT RECYCLING FOR NON-SPRAY-DRIED DYES

While the above scheme of treatment augurs well for spray-dried products where mother liquor does not reach the ETP, it can not be adopted at all if the feed TDS is 50,000 mg/L or more. As a matter of fact, such a scheme is not viable if feed TDS is in excess of 25,000 mg/L.

Many dyes are separated out using membrane filtration systems (generally, nanofiltration membranes). Permeate from membrane unit is the effluent that goes to the ETP. It contains high concentration of salt and break-through organics and color. In cases where the overall feed TDS in the raw wastewater reaching the ETP, including washings and blow-downs, is less than 20 to 25,000 mg/L, the earlier treatment scheme can still be adopted to reduce the operating cost, although at high capital cost. Otherwise, as well as for higher TDS levels in wastewater, the wastewater can be effectively recycled using Multiple Effect Evaporator. MEE uses the steam “multiple” times to get higher evaporation per unit of steam applied. A two-effect evaporator, for example, can provide about 1.8 kg of evaporation per kg of steam while a five-effect evaporator can provide about 4.4 kg of evaporation per kg of steam applied. For feed rates up to 1500 – 2000 kg/h, two-effect evaporators are recommended and for feed of 8,000 kg/hr or more, five or six effects can be used. The condensate from evaporator, if the wastewater does not have a foaming tendency, can have COD and color limits well within the norms and can even be recycled as boiler feed or cooling tower make-up, apart from possibility of reuse in the process. The salt slurry is separated out using centrifuge and the salty sludge can either be sold or reused or disposed to landfill.

Effluent recycling is now a proven possibility for the wastewater generated during manufacture of synthetic organic dyes. Although the capital and operating costs seem high at the first glance, these are viable because of low quantity and high concentration of wastewater. In almost all instances, the capital expenditure towards such a system would be less than 10% of the total project cost and operating cost would be about 5% of the product cost. As a matter of fact, effluent recycling is the only way to achieve disposal norms for this industry since conventional treatment, advanced biological treatment or even chemical oxidation / electrochemical oxidation can not achieve the desired.