

Development of Membrane Bioreactors for compact, high quality effluent treatment for decentralized woolen, carpet sector and common facility centres

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Abstract: A Membrane bioreactor (MBR) technology based 500 litres per day capacity Effluent treatment plant was designed and developed under the study and it was installed at Mahadev woollen mill, Sundarganar, where treatability analysis of effluent was carried out. The study covers the detailed components of Membrane bioreactor (MBR) technology based Effluent treatment plant and results of treated water samples.

Keywords: Membrane bioreactor, Effluent Treatment plant (ETP), COD, BOD, membrane

I. INTRODUCTION

The majority of the Indian woolen and carpet sector including common facility centres (CFCs) set up by Govt. of India for processing of Indian wool is decentralized in nature. A large number of these centres are located in the Himalayan region and other hilly terrains of India. As these woolen and carpet industries are decentralized located at far distances, often it is not possible to have a common effluent treatment plant (CETP) for entire region. Hence most of these industry and CFC have to deal with the effluent problems on their own. Because of cost factors and geographical factors such as hilly terrains, there is often very limited space available for construction of complete effluent treatment systems consisting of all primary, secondary and tertiary treatments. Also Indian woolen and carpet industry are major pollution source containing high levels of wool grease, high chemical and biological oxygen demand. Due to lack of space(or sometimes hilly terrain) and technical expertise, most of these centres are looking for new innovative effluent treatment plants which are compact requiring minimum space and efficient systems requiring shortest treatment time. One very promising technology involves the utilization of membrane bioreactor (MBRs). Bioreactor acts as a biological treatment processor and the membrane is used as a filter in the filtration process. Membrane bioreactor technology (MBR) a combination of the activated sludge process with micro- and ultrafiltration is widely regarded as an effective tool for industrial water treatment and water reuse due to its high product water quality and low footprint. MBRs combine a bioreactor and microfiltration as one unit process for wastewater treatment thereby eliminating secondary clarification and filtration stages. Membrane bioreactors provide the benefits of biological treatment with a physical barrier separation.

II. EXPERIMENTAL

2.1 Material:

Membrane: Membrane was used of KSP hydro make, made from Polypropylene (PP) hollow fibre type with filtrate flow of 0.025 M³/hr. A 500 Litres per day capacity plant was developed under the study. The fabrication partner was KSP hydroengineers Pvt Ltd, Jaipur. All the material used for fabricating the Membrane Bioreactor Plant was made of stainless steel.

2.2 Designed components for developed 500 litres per day capacity membrane bio reactor (MBR) system:

Components of the designed MBR system:

2.2.1 Collection/Equalization tank

The effluent is collected in the main collection tank and it is transferred to the collection tank close to the MBR plant via a pump. The pH of the effluent is maintained around 5.5 in this tank by adding acetic acid to the effluent. On an average, around 150 ml acetic acid is added for 20 litres of effluent. This pH correction is extremely vital and further settling using alum and polymer would only occur if inlet pH to the dosing tank is around 5.5 or less.

2.2.2 Oil and grease trap

Grease traps are designed to separate and capture waste grease and solids before they enter the waste water. They are used to reduce the amount of FOG that enters the main waste water system.

All grease traps consist of a large tank. Water from the drain flows into the tank and settles. Solids sink to the bottom, while lightweight grease floats to the top; leaving clear water in the middle. The water flows through to a second tank and discharges to the next process through a small pipe. They are required to be cleaned regularly to avoid accumulation of excessive oil and grease.



Fig.1 Designed Oil and grease trap

2.2.3 Dosing tank

In order to settle the pollutants, alum and poly electrolyte dosing is carried out through dosing pumps in the dosing tank. On an average, around 1000 ppm alum and 20 ppm poly is sufficient to completely settle the wool scouring effluent. For dyeing effluents, this quantity is much smaller.

2.2.4 Primary settler tank

After the separation of the pollutants from the effluent water, it is allowed enough time to settle the pollutants so it is not transferred to the next process and removed as solid sludge from the settling tank. For 500 litres per day effluent flow, the system is designed to provide 30 minutes settling time.

2.2.5 Buffer tank

After the settling takes place in the previous tank, effluent is transferred to the buffer tank where it is further allowed to settle and a pH correction is done to pH around 7.5-8 for anaerobic tank. There is a tank level sensor which starts the pump and transfers the effluent to the anaerobic digester once it is filled.

2.2.6 Anaerobic Digester

This is an optional tank added to the MBR system and its operation will depend on the effluent load of the industry. The pump transfers the effluent from the buffer tank to the anaerobic tank. in case the anaerobic operation is not required, it is directly bypassed to the aeration+MBR tank.



Fig.2 Anaerobic Digester

2.2.6 Aeration + MBR Tank

The Aeration+MBR tank is the main system where microbes are used to degrade pollutants that are then filtered by a series of submerged membranes (or membrane elements). The individual membranes are housed in units known as modules and a combined series of these modules are referred to as a working membrane unit. Air is introduced through integral diffusers to continually scour membrane surfaces during filtration, facilitate mixing and to contribute oxygen to the biological process. The final treated water is removed through hollow fibre membrane system, chlorinated and stored in the treated water tank. The MBR system also has a provision to clean the membrane through backwashing and use of chemicals.



Fig.3 Aeration + MBR Tank



Fig.4 MBR based ETP

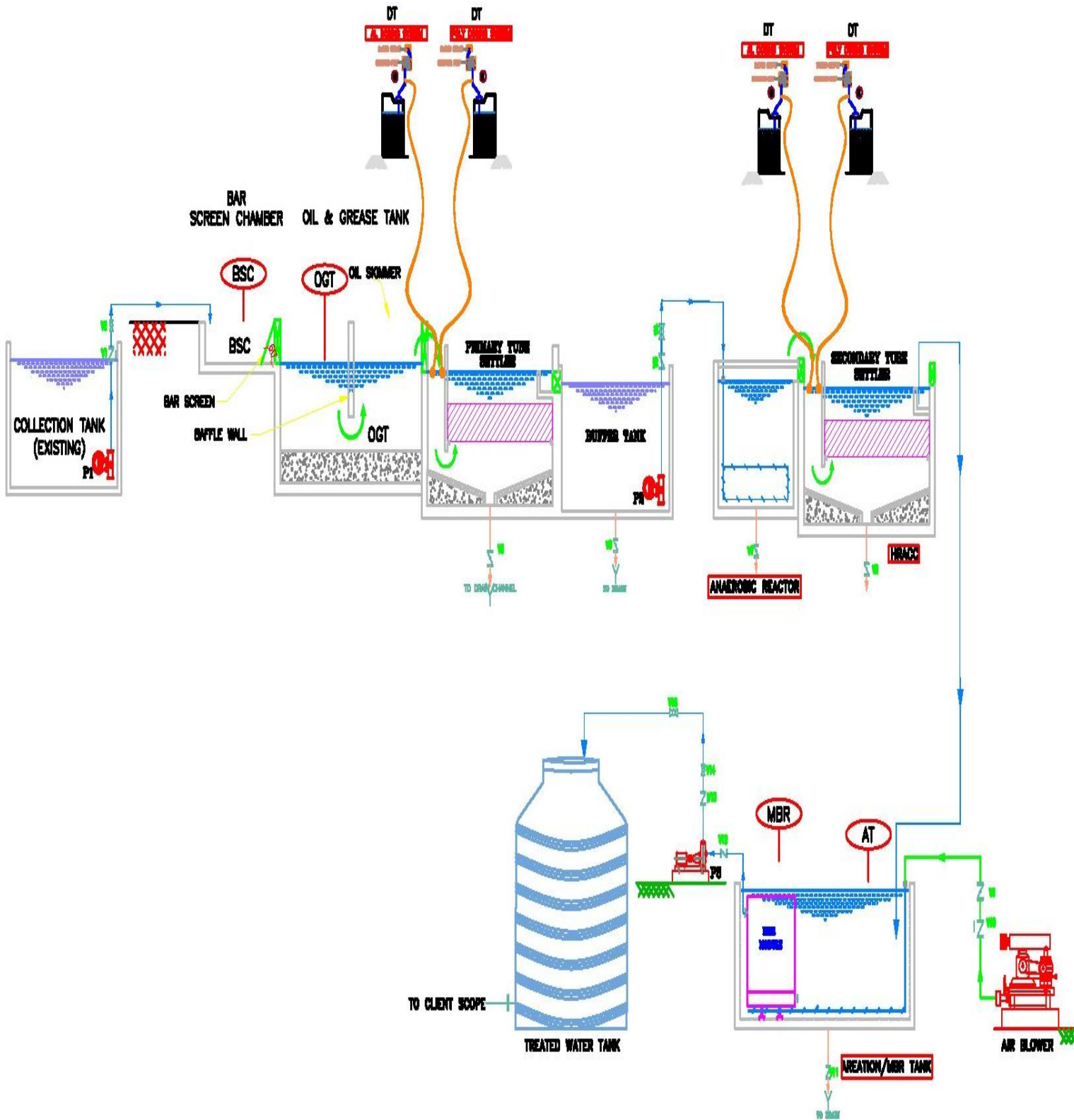


Fig.5 Schematic diagram of Membrane Bio reactor based ETP



Fig.6. 1st day water samples (before and after treatment)



(a) Before treatment



(b) after treatment

Fig.7 - 15th day water quality

III. RESULTS AND DISCUSSION

COD and BOD Values of MBR reactor installed at Mahadev woollen mill, Sundarganar

COD values, mg/lt		BOD vaules, mg/lt	
Input	Out put	Input	Out put
3940	240	230	26
2560	260	210	27
4006	234	234	38
2480	245	189	34
4310	216	260	32
2673	210	180	26
3760	223	250	37
2260	180	140	18
4460	179	320	40
2108	248	160	22
4060	173	260	32
1903	236	146	19
3401	179	220	27
2276	228	200	21
4616	163	310	18
2470	241	186	19
3471	179	229	36
2003	240	160	20
3643	186	249	21
3467	193	227	33
2610	243	150	23
3676	186	240	18
2746	219	176	25
3369	173	230	16
2193	239	200	21
3621	168	260	19
2013	243	160	18
4630	176	310	30
2160	263	140	29
4510	213	321	24
3106	247	210	27
4209	360	280	34
2960	253	160	28
4610	463	340	39

Standards for discharge of effluents Pollution Control Board norms: 250 mg/L COD & 30 mg/L BOD

IV. Conclusion

Membrane bioreactor is a waste water treatment system integrating biological degradation of waste water using products with membrane filtration. This system is effective in removing organic and inorganic contaminants as well as biological entities from wastewater. Under this project a MBR technology based Effluent treatment plant of 500 Litres per day capacity was designed and developed which was installed at Mahadev woollen mill, Sundarganar where effluent treatment trials were carried out. During trials, it was found that results of output treated water quality were in the set norms of Pollution control board.

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