Performance Evaluation of Moving Bed Bio-Film Reactor Technology for Treatment of Industrial Waste Water for Common Effluent Treatment Plant (CETP)

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ABSTRACT

An industrial unit installed at Jetpur Rajkot region developed by the Government of Gujarat is discharging Industrial waste water generated by the workers and treated in the 20MLD capacity Common Effluent Treatment Plant. We use MBBR technologies in aeration tank for wastewater treatment. In this study, the performance of MBBR technology in removal of Biological Oxygen Demand and suspended Solids have been evaluated by testing the raw sewage and treated effluent at various situations like normal weather condition, heavy organic shock loading, dilution with storm water, when artificial aeration is disturbed due to power failure. The test results showed that the removal efficiency of BOD5 and SS from the domestic waste water in normal weather condition in more than 98%, the efficiency of MBBR has not been affected due to heavy Organic shock loading and the efficiency is about 90% in the disturbance of artificial aeration. The efficiency has been brought to this level by improving the surface area per unit volume of the carrier element. It is suggested that the Moving Bed Bio-film Reactor technology could be used an ideal and efficient option for the treatment of domestic waste water, when the available area is minimum.

Key words: *Environment, MBBR, Common Effluent Treatment Plant (CETP), pH, BOD, COD, TSS, TDS, chemical and biological treatment, wastewater treatment, Textile industry.*

1. INTRODUCTION [2]

In recent years, the treatment of waste water is considered to be very essential before its discharge to the environment, as it needs Public Health Protection from water borne deceases, Environmental Protection of our land and water, Aesthetics look such as free from smell, odor and flies etc., The domestic sewage contains liquid waste about 99.7 to 99.9%, solid waste about 0.1 to 0.3% and millions of micro-organisms. The solid components comprise the Organic solids about 70% such as Proteins, Carbohydrates, Fats derived from the living things and Inorganic solids about 30% such as Grit, Salts, and Metals. The Organic Solids which can undergo decomposition by the microorganisms will fix the characteristics of the Sewage and measured in terms of BOD (Biological Oxygen Demand) and COD (Chemical Oxygen Demand) in mg/lit. Hence the Organic Solids and Inorganic Solids are to be removed by suitable Treatment Technologies to preserve the water bodies, since they will cause several problems, such as eutrophication, oxygen consumption and toxicity, when discharged into the environment. The characteristics of typical domestic waste water are as follows

BOD5 (Biological Oxygen Demand)	: 100 – 300 mg/L
COD (Chemical Oxygen Demand	: 250 – 1000 mg/L
TDS (Total Dissolved Solids	: 250 – 1000 mg/L
TSS (Total Suspended Solids)	: 100 – 400 mg/L
TKN (Total Kjeldal Nitrogen)	: 20 – 80 mg/L
TP (Total Phosphate)	: 5 – 20 mg/L

The Gujarat Pollution Control Board has fixed norms to discharge the sewage effluents into water bodies with following characteristics so as to avoid the adverse effects.

BOD5 (Biological Oxygen Demand)	: 20 mg/L
COD (Chemical Oxygen Demand)	: 250 mg/L
TSS (Total Suspended Solids)	: 30 mg/L

It is necessary to reduce these parameters into allowable limits using the effective technologies. Biological processes are a cost-effective and environmentally sound alternative to the chemical treatment of wastewater. The Biological processes are mainly based upon suspended growth system and attached growth system. The suspended biomass growth system (i.e., activated sludge process) is effective for organic carbon and nutrient removal in domestic waste water treatment plants. But there will be some problems of sludge settle ability and the need of large size of reactor and settling tanks and biomass recycling. But whereas attached growth biofilm processes have proved to be reliable for organic carbon and nutrients removal without some of problems encountered in activated sludge process such as area requirement for the treatment units, recycling of biomass etc.,

There are many different types of biofilm treatment processes in use, such as Trickling Filter (TF), Rotating Biological Contactors (RBC), Fixed Media Submerged Bio filters (FMSB), Granular Media Bio filters (GMB), Fluidized Bed Reactor (FBR), etc., and Each and every method has merits and demerits. To overcome the demerits of the above biofilm processes, a new technology as Moving Bed Biofilm Reactor (MBBR) process has been developed in Norway in the late 1980s and early 1990s.

The Moving Bed Bio-film Reactor is a highly effective Biological treatment process and it was developed on the concept of conventional activated sludge process and bio film process. It is a completely mixed and continuously operated system. The micro-organisms present in the sewage will be attached in carrier element and the biomass is grown on the carrier element. The carrier element will be in moving position within the reactor where the biological treatment process is taking place. The movement of the element is caused by artificial aeration. The material of the element will preferably be plastic/UPVC with density lesser than water, so as to enable the micro-organisms to take the atmospheric oxygen for its respiration, when there will be a power problem. The diffused aeration will be given from the bottom of the reactor and the inflow of sewage is coming from the top of the reactor. Due to the counter current motion of the air and influent and the carrier media is in continuous random moving condition, the rate of oxygen transfer is enhanced to maximum. It has been proved by the researchers that MBBR technology has excellent characters such as relatively smaller size of reactor, strong tolerance to organic loading impact, high biomass, high BOD/COD loading, no sludge bulking problem. During the past decade this technology is successfully used in the treatment of municipal domestic wastes and wastes from various industries such as pulp & paper industry, poultry processing industry, cheese factory, dairy industry, refinery & slaughter house.

The main objective of this study is to evaluate the performance of Moving Bed Bio-film Reactor and to analyse the design parameters involved in MBBR Technology for the treatment of Industrial wastewater in the Textile industrial area of Jetpur, Rajkot region Gujarat.

2. Materials and Methods

2.1 About the Study Area:

Currently I will be work on the Industrial waste water treatment plant situated in Gujarat at Jetpur (Rajkot region) to solve the problems on wastewater.

CETP in Gujarat at Jetpur(Rajkot region) which have a capacity of 20 mld municipal sewage generated in the CETP, Jetpur (Rajkot region) heavily contaminated with various streams of industrial waste and result in to waste water Jetpur has a good base for Textile industries.

In order to become water self-sufficient and to meet increasing process water requirements, the CETP plant realizes the importance of reuse of wastewater for agricultural and industrial uses.

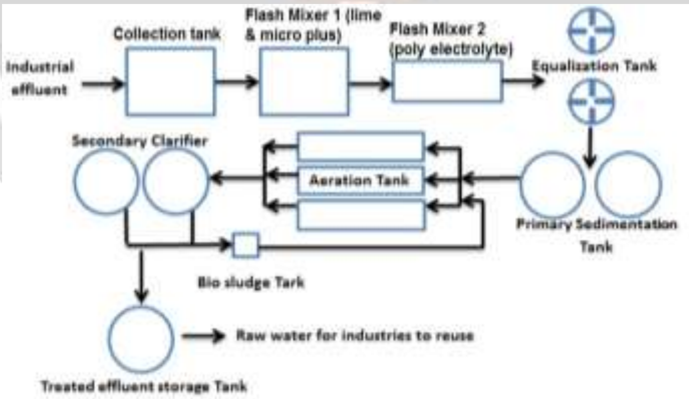


Fig 1 Typical CETP Block Diagram

3. MBBR Process description

Waste water from various sections of the industrial unit shall be passed via a Screen Chamber. This ensures the removal of coarse particles and other floating debris present in the stream. After the pre-treatment process the waste water to be treated shall be routed to a common Collection Tank. The collection Tank shall be sized in such a manner to have adequate volume to counter the peak flow.

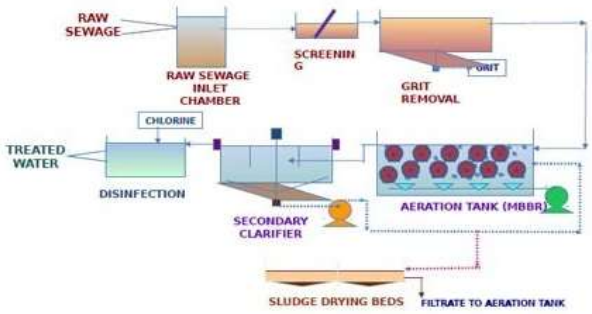


Fig 2 Process Flow Diagram

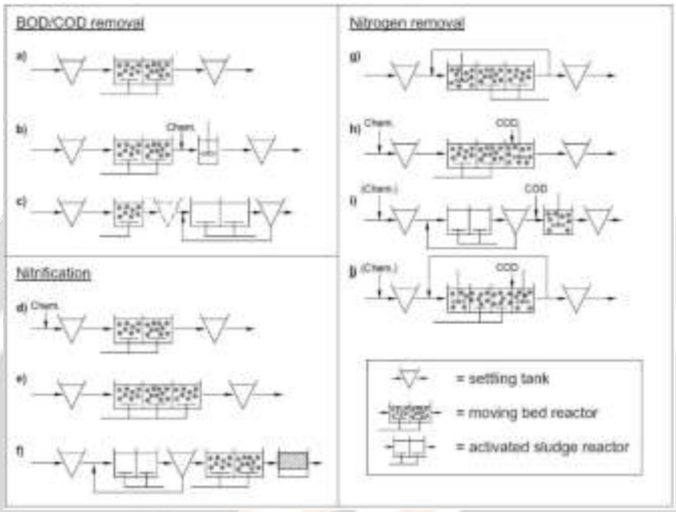


Fig 3 process of removal parameter

From the collection tank, waste water shall be pumped in a uniform rate to the aeration tank after grit removal. One pump will be on working and other will be on standby. The concept underlining the Moving Bed Bio Reactor is to provide continuously operating bio-film reactor, which is non-cloggable, does not require backwashing and has a very low pressure drop. This is achieved by growing the bio-film on smaller carrier elements that move along with the waste water in the reactor.

The MBBR aeration tanks are two in number and are located next to each other. Each of the tanks shall be provided with aeration pipe lines at the bottom, which shall be in anticorrosive materials and are Mani folded to cover the total periphery of the tank. Aeration tank is filled with a specific quantity of the bio-media, which is made up of plastic material with a specific gravity just below that of water, to enable it to remain in suspension. The inlet of the Aeration Tank is on the top with the waste water falling freely into the MBBR tank. The outlet is located on the opposite side, which has a perforated Screen mounted on it, which prevents the bio-media from flowing out of the MBBR Tank. Both compartments are connected to each other by openings, which has perforated sheets on each side. The outlet of the second MBBR is connected to the Clarifier (Clari-settler).

In the clarifier the separation of solid from waste water is achieved by laminar flow developed inside. Due to this, heavier solids settle down, whereas the clear water rises up and flows out. The sludge settling at the bottom of the tanks shall be transferred from time to time to the sludge drying beds.

The supernatant from the Clari-settler shall be collected in the Chlorine contact Tank to which Sodium Hypo Chloride is dosed and allowed to remain in the tank for a predetermined time of half an hour so that there is enough contact time for the oxidant to totally disinfect the water. The disinfected water is shall be pumped through a Pressure Sand Filter followed by an Activated Carbon Filter so as to remove any remaining suspended solids and bad odor. The Treated water is then collected in the treated Water Tank.

4. DESIGN PARAMETERS ANALYSIS

The following parameters are to be considered while designing the MBBR.

1. Organic Loading Rate: It is the amount of organics measured in terms of BOD5 that can be handled per unit volume of the reactor in a day.
2. Fill Media Loading Rate: It is the amount of micro-organisms that can be attached in the media per unit area in one hour.
3. Surface area of fill media: It is the surface area to be provided per unit volume of the media for giving site to the microorganism to attach on it. Initially the fill media provided in the MBBR was as in the figure. But the treatment efficiency was not up to the mark.

Fig 4 plastic media

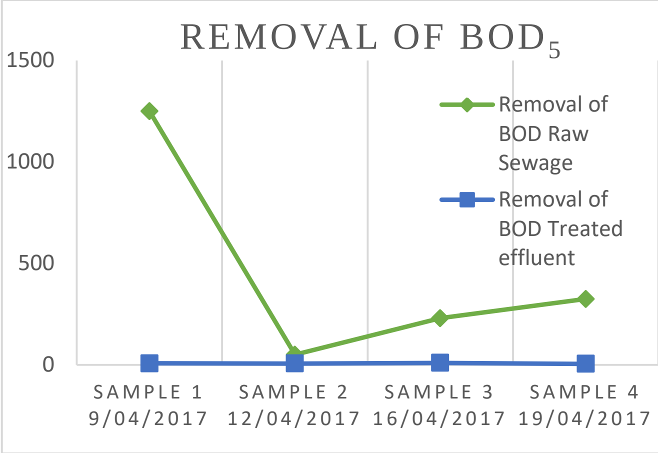
After analyzing the reason for the shortfall of efficiency, it was found that the surface area provided by the unit volume of media was not sufficient. Hence the type of media have been replaced with the new type of media having higher surface area having corrugation as prescribed by M/s Anox Kaldnes, the Norway company, as in the figure. Now the efficiency has been improved up to the mark. It is ascertained that the microorganisms attached with carrier media are taking oxygen from the atmosphere during the artificial aeration is failed, as the carrier elements floats on the surface, since density of carrier element is less than that of sewage.

During power failure, microbes take Oxygen from atmosphere

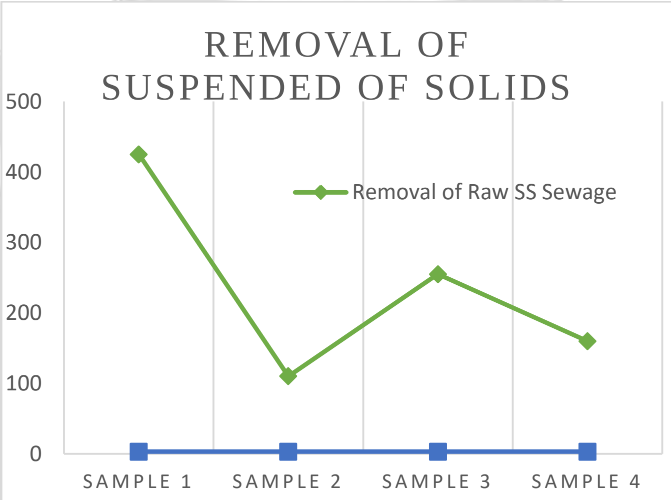
5. RESULTS AND DISCUSSION

As a part of the study, samples of raw sewage and treated effluent have been tested in Jetpur dying and printing association industry laboratory. The samples have been taken in a normal weather condition of industrial waste

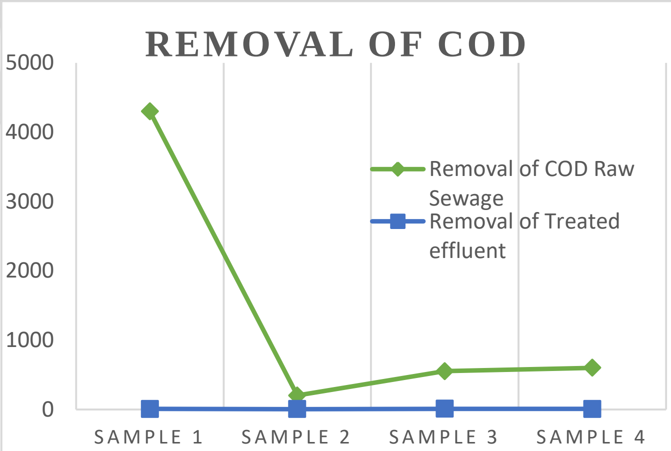
The removal of BOD5 is tabulated below. On 09.04.17 the sample was taken when the industrial discharge is mixed with domestic waste whereas. On 12.04.17 the sample was taken during storm water was mixed the concentration was diluted. On 16.04.17 the sample was taken during there was continuous power shut down and the microorganism took the oxygen from the atmosphere. On 19.04.11, the sample was taken in normal weather and working condition.

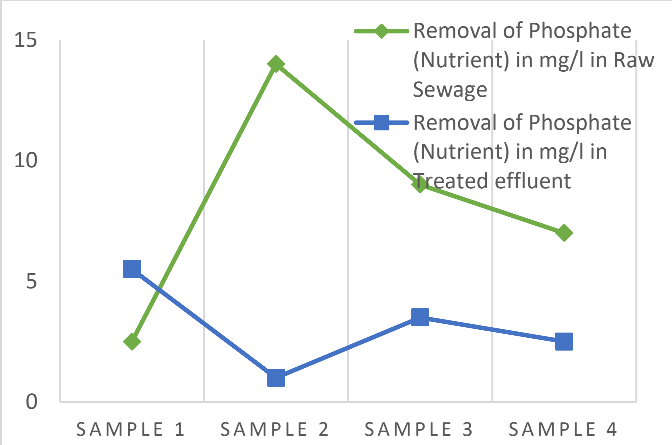


The removal of suspended solids was also analyzed on the above same dates.



The analysis of removal of COD (Chemical Oxygen Demand) on the same samples is given below.





6. Conclusion

From the study to evaluate the performance of MBBR system for the removal of organic BOD (Biological Oxygen Demand) and the SS (Suspended Solids) from the domestic waste water for various conditions have been analyzed and the following conclusion can be made based on the test results of the samples.

The removal of BOD5, COD and Suspended solids in normal condition (when the domestic waste only is coming as influent) are more efficient, more than 98%.

The MBBR technology can withstand the heavy Organic shock loading.

The system with MBBR technology will give the required standards of effluents, even when the artificial aeration could not be given due to power failure.

The efficiency level can be improved by providing required surface area per unit volume of the carrier element to give sufficient active site for the attachment of micro-organisms.

Small foot print area is required to accommodate the Sewage Treatment Plant with MBBR technology

According to the test results, we suggest that the Moving Bed Bio-film Reactor technology could be used an ideal and efficient option for the treatment of domestic waste water, when the available area is minimum.

7. Acknowledgement

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