

Pulp And Paper Industrial Wastewater Treatment Using Modified External Membrane Bioreactor

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Abstract- The pulp and paper industrial wastewater is a Complex mixture of organic and inorganic compounds in higher concentrations which normally depends on the type of pulping process. Pulp and paper industrial wastewater treatment by conventional biological processes such as Activated Sludge struggle to treat Pulp and Paper wastewater.

The Membrane Bioreactor is result of research of clubbing two technologies into a single step treatment process. One is the Membrane Filtration and another one is Biological treatment. Dissolved Solids are removed by filtration unit and where as Biological degradation removes organic content. More number of MBR plants are established in various industries to treat wastewater. The present study is concentrating on study of conventional membrane bioreactor and fabricating a modified external membrane bioreactor. Various modification is done in design and fabrication of modified external membrane bioreactor. Modified external membrane bioreactor fabricate is employed to treat Pulp and Paper industrial wastewater (PPIW). Physicochemical parameter of raw Pulp and Paper industrial wastewater and treated Pulp and Paper industrial wastewater is compared. The present study focused on treating Pulp and Paper industrial wastewater by Modified External Membrane Bioreactor. The result obtained showed that highest removal efficiency of 94.42%, 95.921%, 94.423%, 94.56%, 85.90%, 98.286%, 96.63% of Color, Turbidity, EC, TDS, Sulphate, COD, BOD respectively is obtained. It is found that the Modified External Membrane Bioreactor is efficient in treating Pulp and Paper Industrial wastewater.

Keywords- Pulp and Paper Industrial wastewater, Modified External Membrane Bioreactor, Color, Turbidity, EC, TDS, Sulphate, COD, BOD.

polluted water and supplying that to the community may leads to overcome from the above impacts. Furthermore also by treating the polluted water and making that for drinking purpose and domestic use which is the major challenge for the world. Polluted water can be used for domestic purpose when it has been treated.

In the India the total paper production is 40% from hardwood and bamboo fiber, 30% is from agro waste and remaining 30% is other. paper publication and newsprint counts to 2 million tones in which 1.2 million tones of newsprint is manufactured and remaining is imported from producers it means that 40% of newsprint brought from other country. India imports 2 million tones of pulp wood (both soft and hard) and waste paper (sack waste for envelopes waste, unbleached grades, magazine waste and cup stock for white grades) for news prints.

In PPM (Pulp and Paper Mill) the amount of water consumption for the manufacturing of pulp and paper is about 250-300metre cube hence the amount of wastewater generated is equal to the amount of water consumed. the PPIW contains toxic and non biodegradable organic materials (sulphur components, pulping chemicals, organic acids, chlorinated lignin's, resin acids, phenolics, unsaturated fatty acids and terpense). Discharge of the pulp and paper mill effluent into the streams causes the depletion of oxygen and also toxicity makes the environment unstable hence to overcome from this impact we need to treat it efficiently. organic and in Organic matter, bacteria various suspended solids can be remove efficiently from Membrane process. Hence the filtration and biological treatment combined called as membrane bioreactor to treat the pulp and paper mill wastewater. The MBR which offers a more advantage against the conventional treatment..

I. INTRODUCTION

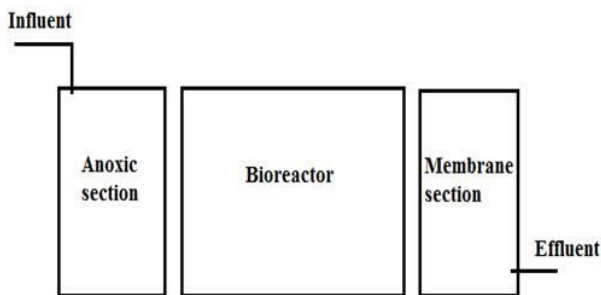
In the evaluation of life water is a unique component which has played a crucial role. the purpose of water for industrial, agriculture, domestic demand of growing population is more which increasing day by day which leads to depleting limited resources and also the quality and quantity of water. therefore sustainable supply of water and also treating

II. BACKGROUND

Filtration process is a tertiary treatment. The most effective filtration process is the sand filters from this study it has been observed that the membrane filter is more effective in the removal of total dissolved solids and giving a dischargeable quality of wastewater. At the end of any treatment the adoption of Membrane filtration was compulsory

from initial studies to give a extensive treatment for wastewater. The Membrane filtration with the existing treatment combined methodology. To get a dischargeable quality of wastewater that's nothing but the Membrane Bioreactor. It consists of Bio-reaction followed by Membrane filtration for effective treatment in single step. This MBR is more popular for industrial wastewater treatment as it observed from the study.

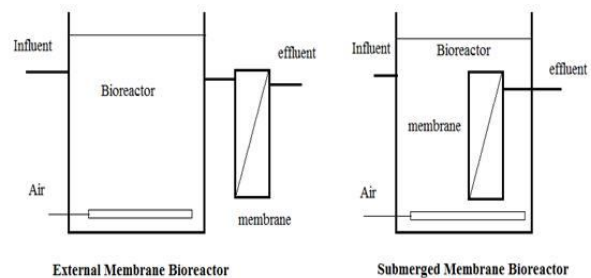
Membrane Bioreactor establishment is flexible with conditions because of aerobic process in it. The MBR consists of three sections that are Anoxic section, Bioreactor and Membrane section. In the anoxic section the nitrification and denitrification takes place by providing agitation and the removal of nitrogen is more essential because it is the nutrient for the algae growth. In the Bioreactor the removal of dissolved and suspended organic constituents takes place through biodegradation and the removal of suspended matter through physical separation. Bioreactor section removal efficiency of constituents mainly depends upon the biological treatment. In this dissolved oxygen of waste water is improved to change the oxygen required for degradation by providing aeration. Indirectly the degradation of organic matter is measured by Chemical oxygen demand and Biological oxygen demand it also indicate oxygen levels .The below figure shows the general view of Membrane Bioreactor.



Membrane Bioreactor Scheme

Effluent from the Bioreactor is pumped to the membrane section after completion of the reaction in Bioreactor and in the membrane Bioreactor the Membrane section is the final treatment. The Biomass separation from the treated water is takes place when it passed through the Micro or Ultra-filtration Membrane. The types of Membranes used in the MBR processes are plate and frame, Hollow fiber and Tubular. The most extensively used Membrane in MBR process is the Hollow Fiber Membranes. The two ways configuration of Membrane section takes place one is the Membranes are Submerged into the reactor another is it can be used as a separate section externally.

The bioreacted water is passed through the Membranes by using a suction pump. At the end of Membrane in Submerged type Bioreactor. With the application of pressure on membrane the bioreacted water passed through membrane by using pump in External membrane bioreactor. Depends upon the Design consideration such as pretreatment, substrate and solids removal, foot print area requires and nutrients removal the selection of the Membrane configuration is done. Depending upon the nature of the wastewater the two configurations have different application. In the MBR process the two configurations are shown in below figure..



Membrane configurations in Membrane Bioreactor

III. STUDIES AND FINDINGS

The Pulp and Paper Industrial Wastewater is collected from the dandeli. The temperature of the wastewater is 35°C. This wastewater is collected after bleaching process and it is collected in plastic cans of 20L capacity and it's sealed to prevent entry of moisture or any foreign matter to it. Pulp and paper mill industrial wastewater was kept in freezer at 4°C to avoid any microorganism activities. After maintaining the temperature of pulp and paper industrial wastewater to room temperature then only the analysis is done.

A. Design of Membrane Bioreactor

The External Membrane Bioreactor fabricated with two equal size tanks with a capacity of 4.5L each. The tanks are constructed using Acrylic sheet. Here the acrylic sheets are used instead of the glass to withstand the heat produced during reaction. To control the wastewater flow to the other tank the valves are provided. The valve is provided just above the bottom of tank to prevent the entry of settled solids to next tank and the water below valve is of 0.5L in each tank and the output of 3L. The volume of the Anoxic tank and the Bioreactor is 4.5L because in the bioreactor to give the sufficient amount of the space to the foam produced during reaction. The Effluent is passed through the plastic membrane encased with Hollow fiber membrane 0.1 micro metre. This hollow fiber membrane is same as the ultra filters used in

domestic RO plants. Next to diaphragm pump the sediment filter of 5 micro metres is used to prevent the clogging in HF membrane. The treated effluent is clear water which flows at the rate of 1L/min.

B. Working

The External Membrane Bioreactor consists of three sections and filtration unit consists of sediment and hollow fiber membrane.

The External Membrane Bioreactor consists of three sections

- Anoxic Tank
- Bioreactor
- Intermediate Tank

Anoxic Tank

In this tank the nitrification and denitrification takes place. The Pulp and Paper Industrial Wastewater is charged into the top of the tank and then it is closed. The agitation is provided by using magnetic stirrer to provide the uniform mixing which should takes place from the bottom of the tank. By observing the total nitrogen value the reaction time with regular interval can be optimized. It is observed that the optimized time in this tank is takes place at 3.5 hours where the reduction of nitrogen is more. Then the mixture is allowed to settle for the 5 minutes so that any settleable particles get settled and the valve is opened and effluent is discharged into the next tank i.e. Bioreactor for further treatment. In this treatment system the valves are fitted above the bottom of tank so that to prevent the entry of settleable particles into the next tanks.

Intermediate Tank

In this all the flocculated particles gets settles down by allowing the mixed solution to stand for half an hour. The floc formation takes place due to the addition of the alum. In bioreactor biomass is produced during reaction and suspended particles which forms the floc by addition of coagulant alum.

Filtration Unit

Using a diaphragm pump the supernatant is pumped to the sediment filter which removes the particle size greater than the 5 micron meter. To protect the hollow fiber membrane from damage sediment filter is used. The filtered water from the sediment filter is passed to the hollow fiber membrane which is the final stage of filtration. The filtrated effluent is collected in beaker which is the final effluent.

Bioreactor

In this tank the cow dung is used as a seeding agent for the initiation of reaction and its dosage is 1g/L. Two diffusers are connected to the two pumps by means of the pipes which provide a continuous aeration. In the Bioreactor the biological degradation of pulp and paper industrial wastewater takes place reducing BOD and COD. By knowing BOD and COD the reaction time is observed. It is observed that the more reduction of biological oxygen demand and the chemical oxygen takes place at 10th hour. Before discharge of effluent i.e. bioreacted wastewater to the next tank the bioreacted wastewater is neutralized by adding saturated NaOH by setting the pH at 7 using pH meter and pipette and in this the Alum Solution is Added at the dosage of 35mg/L then the mixing is done by using the air from sir diffusers. Effluent is stand 5 minutes and discharge to the Intermediate Tank.

IV. RESULTS AND DISCUSSION

The results obtained for treating Pulp and Paper Industrial Wastewater using Modified External Membrane Bioreactor are discussed below

Comparison of Raw and Treated Pulp and Paper Industrial Wastewater with Modified External Membrane Bioreactor.

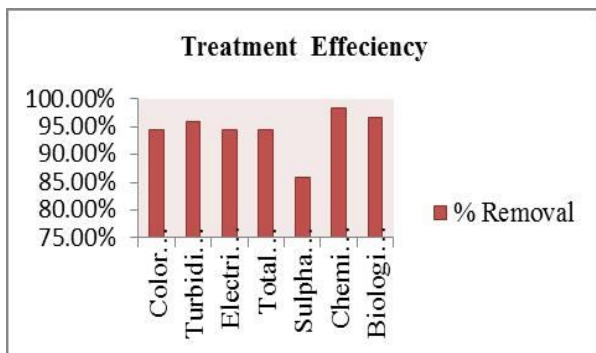
Treating Pulp and Paper Industrial Wastewater with Modified External Membrane Bioreactor yields low COD, BOD, Turbidity, Electrical Conductivity, Total Dissolved Solids and Total Nitrogen of effluent. In the Modified External Membrane Bioreactor the Sulphate reduction is also taking place that is in the moderate range. The effluent pulp and paper industrial wastewater from Modified External Membrane Bioreactor is in the range of discharge effluent quality into streams. In this Experiment the amount of Color removal is done in terms of PtCo. Which is also significantly removed from brown to Light Pale Yellow. Even odour of the effluent turned from Choking Smell to mild fruity smell.

The below figures and the tables represents the comparison of Raw pulp and paper industrial wastewater with the treated pulp and paper industrial wastewater and also there efficiency of removal explained below

Comparison of Raw Pulp and Paper Industrial Wastewater with Pulp and Paper Industrial Wastewater after treated with Modified EMBR



A Comparison of before and after treatment of Pulp and Paper Industrial Wastewater using MEMBR



Performance of MEMBR Treatment

V. SUMMARY AND CONCLUSIONS

a. Summary

The following summary is concluded based on the objective of proposed project i.e. PPIW treatment using Modified External Membrane Bioreactor. The initial characteristic of the pulp and paper industrial wastewater as; pH-3.33 , COD-2500 mg/L , BOD- 1050 mg/L, Turbidity- 228 NTU , EC- 3913µS , TDS-2298 mg/L ,Sulphate-1,66,400 mg/L , Color 2959 Pt Co are reduced effectively in Modified EMBR.

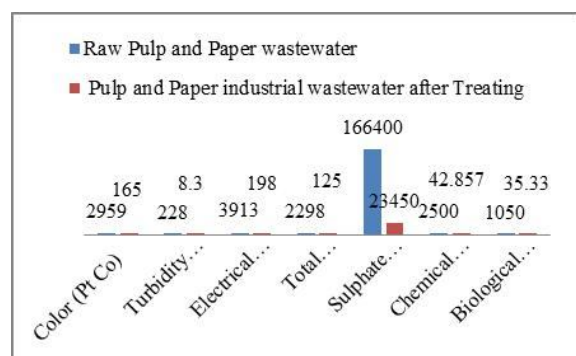
A brief study of Modified External Membrane Bioreactor technology is carried out to understand the methodology and to modify for enhancing performance. A lab scale Modified External Membrane Bioreactor is fabricated to PPIW. The fabricated Modified External Bioreactor treating pulp and paper industrial wastewater efficiently.

b. Conclusions

The work carried out on treating PPIW using ModifiedEMBR,which leads to the following conclusion.

Comparison of raw PPIW with Treated PPIW withMEMBR

Parameters	Raw Pulp and Paper wastewater	Pulp and Paper industrial wastewater after Treating	% Removal
Color (Pt Co)	2959	165	94.423%
Turbidity (NTU)	228	8.3	95.921%
Electrical Conductivity(µ S)	3913	198	94.423%
pH	3.33	3.34	—
Total Dissolve Solids(m g/L)	2298	125	94.56%
Sulphate (mg/L)	166400	23450	85.907%
Chemical Oxygen Demand(m g/L)	2500	42.857	98.286%
Biological Oxygen Demand(m g/L)	1050	35.33	96.63%



In the Modified External Membrane Bioreactor the percentage reduction in physicochemical parameters of PPIW is increased such as Color, Turbidity, EC, pH, TDS, Sulphates, COD, BOD is 94.42%, 95.921%, 94.423%, 94.56%, 85.09%, 98.28%, 96.63%

The MEMBR takes a lesser time to treat the any industrial wastewater here to treat the PPIW it took 14 hours and 17minutes. In the Modified External Membrane Bioreactor the removal efficiency of Sulphates is less it can be increased by increasing the retention time of the treatment.

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REFERENCES

- [1] Dilek.FB and Bese.S (2001),“Treatment of Pulping Effluent by using Alum and Clay-Colour removal and Sludge Characteristics”, Middle East Technical University Turkey,27(03):0378-4738
- [2] AnuragGarg ,Narayana V VV S S, ParmeshChaudhary and Shri Chand (2004), “Treatment of Pulp and Paper Effluent”, Journal of scientific and Industrial Research,Vol 63:667-671.
- [3] Priscilla ZuconiViana, Ronaldo Nobrega, Eduardo Pacheco Jordao and Jose Paulo Soares de Azevedo (2005), “Optimizing the Operational Conitions of a Membrane Bioreactor Used for Domestic WastewaterTreatment”, Brazilian Archives of Biology and Technology, 48:119-126
- [4] Stahi, Lerner and Galil (2006),“Comparative study of MBR and Activated sludge in the treatment of Paper mill wastewater”, Israel Institute of technology Haifa, 50(03):245-252.
- [5] Christian.MobiusH(2006),“Membrane Bioreactor for Wastewater Treatment”,Water use and Wastewater Treatment in Paper Mills Germany ,First edition.
- [6] Yuzhong Zhang ,Chunming Ma , Feng Ye ,Ying Kong ,Hong Li (2007),“The Treatment of Wastewater of Paper mill with Integrated Membrane Process”, International journal of Membrane Science and Technology, 236(2009):349-356.
- [7] Pratibha Singh.(2007),“Sequential Anaerobic and Aerobic Treatment of Pulp and Paper Mill Effluent in Pilot Scale Bioreactor”,Journal of Environmental Biology,28(1):77-78
- [8] Manyuchi M.M. and Ketwa E. (2013), “Distillery Effluent Treatment Using Membrane Bioreactor Technology Utilising Pseudomonas Fluorescens”, Published in Everything About Water, 2(12): 1252-1254.
- [9] Subtil E. L, Mierzwa J. C and Hespanhol I (2014), “Comparison between a Conventional Membrane Bioreactor (C-MBR) and a Biofilm Membrane Bioreactor (BF-MBR) for Domestic Wastewater Treatment”, Brazilian Journal of Chemical Engineering, 31(03):683-691.
- [10]JitendraGiri ,Anjanasrivastava , PachauriSrivastava SP (2014), “Effluent from Paper and Pulp industries and their impact on soil properties and chemical composition of plants in uttarkhand, India”, Journal of Environmental and waste management, 1(01):026-030.
- [11]MajidHosseinzadeh, GholaamrezaNabiBidhendi, Ali Torabian and NaserMehradadi (2014), “A study on Membrane Bioreactor for Water Reuse from the Effluent of Industrial Town Wastewater Treatment Plant”, Iranian Journal of Toxicology, 8(24):983-990.
- [12]Subtil, J. C. Mierzwa and Hespanhol.I (2014), “Comparison between a Conventional Membrane Bioreactor (C-MBR) and a Biofilm Membrane Bioreactor (BF-MBR) for Domestic Wastewater Treatment”, Brazilian Journal of Chemical Engineering, 31(03):683-691.
- [13]Dayalan J and Sharon Ann Mathew (2015), “An Experimental study on Sewage treatment using Membrnae Bioreactor”, International Journal of Engineering Research and Technology, 4(2):769-772.
- [14]SaimaFazal ,ZhenxingZhong, LanGao, Xuechuan Chen (2015),“Industrial Wastewater Treatment by using Membrane Bioreactor”, Journal of Environmental Protection,6:584-598
- [15]MohammadrezaKamali,ZahraKhodaparast (2015), “Review on recent Developmentson Pulp and Paper Mill Wastewater Treatment”,Journal of Ecotoxicology and Environmental Safety,114:326-342
- [16]Martin A Hubbe, Jeremy R.Metts ,Daphne Hermosilla (2015),Angeles Blanco, “Wastewater Treatment Reclamation: A Review of Pulp and Paper Industry Practices and Opportunities”, Journal of Bioresource,11(3):7953-8091
- [17]KhumGurung, Mohammed ChakerNcibi, Jean-MarleFontmorin , HeHeikiSarkka and Mikaa Sillanpaa (2016),“Incorporating Submerged MBR in Conventional Activated Sludge Process for Municipal Wastewater Treatment: A Feasibility and Performance Assesment”, Journal of Membrane Science and Technology,Volume 6,Issue 3
- [18]Vashi H, Iorhemen O.T and Tay J.H.(2017),“Aerobic Hanife granulation :A Recent Development on Biological Treatment of Pulp and Paper Wastewater”, Journal of Waster resources Malaysia,7:11-14