Distillery Spentwash Treatment Using Modified External Membrane Bioreactor

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Abstract- *Distillery industries are considered to be an important segment for development of country, because of revenue they generate from product manufactured. Spirit production from molasses yields wastewater stream from distillation process. Wastewater produced from distilleries are Dark brown in colour and high organic content known as spentwash. Conventionally spentwash treated with anaerobic treatment methods. But due to stringent norms towards pollution control it is essential for distilleries to further refine their treatment methodology to meet stream or discharge standards.*

Membrane Bioreactor are result of research of clubbing two different technology into a single treatment process. Membrane Bioreactor is combination of Membrane Filtration and Biological treatment of wastewater. Biological degradation removes organic contents whereas filtration removes dissolved solids present. More number of MBR plants are established in varies industries to treat wastewater. Present study is concentrating on study of conventional membrane bioreactor and fabricating a modified external membrane bioreactor. Varies modification is done and a lab scale Membrane Bioreactor is fabricated, aimed to reduce power consumption and improve efficiency. Membrane Bioreactor fabricate is employed to treat Distillery spentwash. Physicochemical parameter of raw spentwash and spentwash treated with Modified External Membrane Bioreactor are compared. The present study focused on treating Distillery spentwash by modified External Membrane Bioreactor. The result obtained showed that highest removal efficiency of 98.48%, 99.88%, 99.97%, 97.61% and 97.12% of COD, BOD, Turbidity, EC and TDS respectively is obtained. It is found that Modified External Membrane Bioreactor is efficient in treating Distillery Spentwash.

Keywords- Distillery Spentwash, Modified External Membrane Bioreactor, COD, BOD, Turbidity, EC, TDS.

I. INTRODUCTION

Water is basic need of life for both animals and plants, has become the most mercantile product of the century. Human beings are putting an increasing pressure on the planet's water resources. In the earlier days when earth's population was less, it was imagined that oceans were too big to pollute. In the recent century with increasing population the ocean seems to be too smaller for getting polluted. Water pollution has become major problem in the recent years due to manmade activities. Scarcity of fresh water raised all over the world. Hence strict regulation on usage of fresh water and discharge of wastewater are imposed for survival and sustainable development.

There are about 285 distilleries in India, producing about 2.75 billion litre of alcohol annually. India is the fourth larger producer of ethanol in the world and the second largest in Asia. Though, the alcohol production from starchy material is also practiced on a very limited scale, most of Indian distilleries use sugarcane molasses as raw material. About 4-9 kg of molasses is required for production of one litre of alcohol. Apart from its uses for beverages, medicinal, pharmaceutical and flavouring alcohol constitutes the feedstock for large number of organic chemicals, which are used in manufacturing a wide variety of intermediates, drugs, rubber, pesticides, solvents etc. distillery ranks as top most industry among list of 17 heavily polluting industries identified by Ministry of Environment and Forest, Government of India, and are covered under Central Action Plans. Distillery spentwash is not only high on organic and inorganic loading, but also has dark brown colour even after industry standard treatment by anaerobic digestion/ bio-methanisation. The anaerobically treated spentwash does not meet Central Pollution Control Board (CPCB) standards of discharge into streams or land application. Spentwash behaves hazardously when disposed into water bodies, since it may result in the complete depletion of dissolved oxygen and aquatic life will be destroyed.

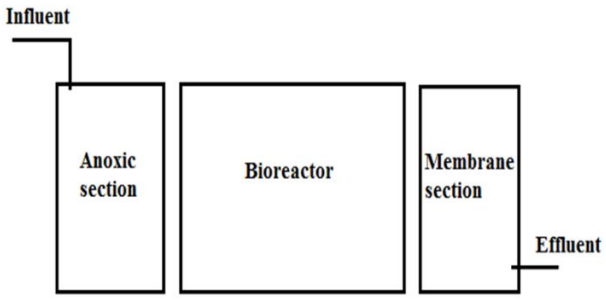
Membrane process could efficiently remove several contaminant from wastewater i.e. organic, inorganic matter, bacteria and various suspended solids. The Membrane Bioreactor is a combined system of biological treatment and membrane filtration that offers several advantages against conventional treatment. Membrane bioreactor involves biological treatment hence best treatment for wastewater with high organic matter such as spentwash from distilleries.

Membrane Bioreactor offers high quality effluent, low sludge production, lower needs of chemical agent and lower footprint area for treatment plant.

II. BACKGROUND

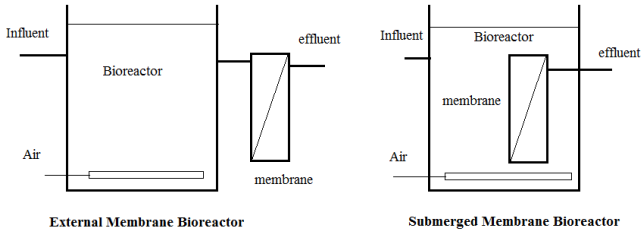
Traditionally filtration process considered to be a tertiary or polishing treatment. Sand filters are assumed to be effective filtration method, but advancement in technology leads to discovery of membrane process. On study it is observed that membrane filtration is much more effective in removal of dissolved solids thereby giving wastewater a dischargeable quality. Initially studies were done to adopt membrane filtration at the end of any treatment process. Later on membrane filtration coupled with existing treatment methodology to give extensive treatment for wastewater. One such combination of treatment method is Membrane Bioreactor. The treatment scheme consists of bio-reaction followed by membrane filtration to effectively treat wastewater in single step. Despite of cost, MBR process is popular among industries for wastewater treatment. As a result increased number of MBR treatment plant is observed.

Membrane bioreactor are aerobic process hence can be employed in existing aeration process of wastewater treatment or further new treatment plant can be established using equipment from earlier aerobic treatment process. Thus establishing MBR is flexible with the conditions. Generally Membrane Bioreactor consists of three sections. Namely Anoxic section, Bioreactor and Membrane section. In anoxic section agitation is provided for nitrification and denitrification process. In this section reduction of nitrogen takes place which is most essential nutrient for algae growth. Reducing nitrogen reduces chances of algae growth. In Bioreactor biological treatment is provided which removes dissolved and suspended organic chemical constituents through biodegradation and suspended matter through physical separation. The Bioreactor is provided with aeration to enhance the amount of oxygen required for degradation thereby improving dissolved oxygen of wastewater. Biotreatment requires appropriate reactor conditions in order to maintain sufficient amount of viable microorganism which aids the degradation process. The degradation of organic matter is measured indirectly with Chemical oxygen demand and Biochemical oxygen demand, even though they indicate oxygen levels. General Membrane bioreactor is shown in the figure below



Membrane Bioreactor scheme

After completion of reaction effluent from bioreactor is pumped to membrane section. Membrane section is final treatment part is any Membrane Bioreactor. Here influent is passed through a Micro or Ultra-filtration membrane which allows biomass separation from treated water. Variety of membranes used in MBR processes. Plate and frame, Hollow fibre and Tubular are some of variety of membranes used. Hollow fibre membranes are extensively used in MBR process. Membrane section can be conFig.d in two ways. The membranes are either submerged into the reactor or used as separate section externally. In submerged type the bioreacted water is passed through membranes by applying suction at the end of membrane. In external membrane bioreactor the bioreacted water is pumped through membrane with application of pressure on membrane.



Selection of membrane configuration depends upon number of design consideration such as pretreatment, substrate and solids removal, footprint area required and nutrients removal. The two configuration have different application depending on nature of wastewater to be treated the two configuration of membranes in MBR process is as shown in figure.

III. WRITE DOWN YOUR STUDIES AND FINDINGS

Raw spentwash collected from Samsons Distilleries Pvt. Ltd., manufacture rectified spirit, neutral spirit. The presently named as Indian Cane Power Ltd Unit: Samsons Distilleries which is 30 KM from Davangere near Duggavati village of Harihar. Spentwash wash after fermentation

processes is very high temperature liquid cooled down to 40ºC which is then collected in Plastic canes of 20L capacity and sealed to avoid entry of moisture or foreign particle into it. Raw spentwash was stored in freezer below 4ºC to avoid any microorganism activities. Before analysis or experimentation the temperature of spentwash is allowed to set for room temperature, then experimentation will be conducted. A scum at top of raw spentwash developed is removed from sample.

A. Design of Membrane Bioreactor

MBR fabricated with two equal size tank of 4.5L capacity each. The tanks are constructed using Acrylic sheet instead of glass to withstand heat produced during reaction. Valve is provided to all section to control wastewater flow to next tank. Valve is located just above bottom of tank to settle down solids which could pass to next tank. The water remained below valve in each tank is 0.5L. To obtain output of 3L, Initial Anoxic tank volume is fixed to 4.5L followed by Bioreactor of same volume to provide room for foam produced during aeration. The intermediate tank volume is limited to 4L as flow to the tank will be only 3.5L. The settled effluent is then passed through Hollow fibre membrane 0.1µm encased in a plastic cylinder same as Ultra filters used in domestic RO plants. To reduce HF membrane clogging a Sediment filter of 5µm is used next to diaphragm pump. A clear water is obtained at end of HF membrane which flows at rate of 1 L/min.

B. Working

The Membrane Bioreactor consists of three section and a filtration unit consists of Sediment and Hollow fibre membrane and the working is explained as below.

Anoxic section

In this section Nitrification and de-nitrification takes place with aid of agitation provided. Spentwash charged to the top most tank in sequence with dilution of 1:100 with distilled water. Agitation of mix is done using magnetic stirrer. Reason to use magnetic stirrer is that mixing takes place from bottom of tank so that uniform mixing place unlike external blade type agitator. Reaction timing is fixed by observing total nitrogen value at regular interval of time. It is found that nitrogen value decreases considerably at 2nd hour of reaction. Then the mix is allowed to stand for 5 minutes so that any settable particle get settled then valve is operated to discharge effluent into next tank i.e. Bioreactor. Valve is fitted just above from bottom of tank so that settled particle should not move to next tank.

Bioreactor

In bioreactor the influent is mixed with cow dong as seeding agent for initiation of reaction. Dosage of cow dong is 1g/L. Continues aeration is provide using air pumps by means of diffusers into tank. Two diffusers connected to two air pumps by means of pipes, provide saturation amount of air required for reaction. In bioreactor biological degradation of spentwash takes place reducing Chemical oxygen demand and biochemical oxygen demand. The reaction timing is fixed using these two parameters. It is observed that at 10th hour maximum reduction in COD and BOD obtained. Before discharging effluent to next tank effluent is neutralised using saturated NaOH and set pH to 7 using pH meter and a pipette. Then Alum solution is added with dosage of 30mL/L and mixed well using air from diffuser. Effluent is allowed for 5 minutes and discharged into next tank.

Intermediate tank

In this tank well mixed solution is allowed for half an hour so that all flocculated particle get settled to bottom. Most of biomass produced during reaction in bioreactor and suspended particle form floc due to addition of alum to the effluent. The supernatant solution is withdrawn from valve is passed to filtration unit.

Filtration unit

The supernatant is pumped using diaphragm pump to sediment filter. Any particle larger than 5µm is filtrated in this filter. Reason to use sediment filter is that protect Hollow fibre membrane filter from damage. Then the effluent passed to HF membrane filter for final stage filtration. Filtrated effluent is collected in beaker as final effluent.

IV. RESULTS AND DISCUSSION

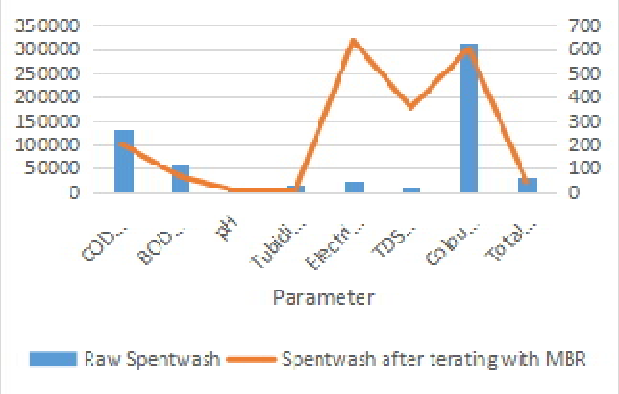
The results obtained for treating distillery spentwash using Membrane Bioreactor are discussed below

Comparison of Raw and Treated Spentwash With MBR

Treating spentwash with Membrane Bioreactor yields low COD, BOD, Turbidity and total nitrogen effluent. The effluent spentwash from MBR is in range of discharge effluent quality into streams. Colour also significantly reduced from Dark brown to pale yellow. Even odour of effluent turned from strong alcoholic liquor to mild fruity smell. Results are tabulated

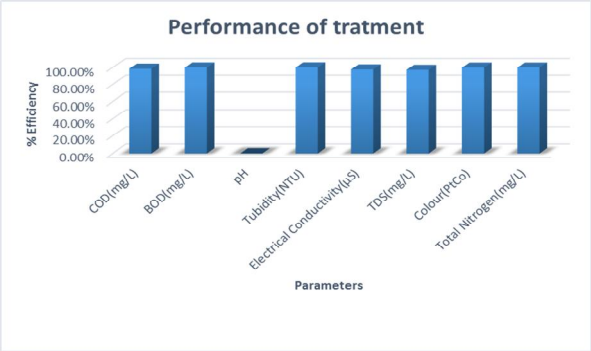
Comparison of raw spentwash parameter with spentwash parameter treated with MBR

Sl no	Parameter	Raw Spentwash	After treatment	% Removal
1	COD(mg/L)	132000	200	98.48%
2	BOD(mg/L)	59072	65	99.88%
3	pH	4.15	4	***
4	Tubidity(NTU)	15880	4.29	99.97%
5	Electrical Conductivity(µS)	22470	637.1	97.61%
6	TDS(mg/L)	12300	353.8	97.12%
7	Colour(PtCo)	316000	604	99.80%
8	Total Nitrogen(mg/L)	2930	43	98.83%



Comparison of raw spentwash parameter with spentwash parameter treated with MBR

A comparison of before and after treatment of Spentwash using MBR



Performance of MBR treatment

The MBR effectively treat spentwash from distilleries as it contains very high amount of organics as technology comprises of both biological treatment and filtration methods. MBR yields low volume of sludge and better treatment in less time compared to traditional anaerobic treatment plants

V. SUMMARY AND CONCLUSIONS

a. Summary

Based on objective of proposed the proposed work the following summary is concluded from the on Distillery spentwash treatment using modified membrane bioreactor: Distillery spentwash has initial characteristics as; pH-4.15, COD-132000 mg/L, BOD-59072 mg/L, Turbidity-15880NTU, EC-22470 µS and TDS-12300 mg/L and all parameter are above discharge limit.

A detail study of Membrane Bioreactor Technology is carried out to understand methodology and to modify for enhancing performance. A lab scale External Membrane Bioreactor is fabricated to Distillery spentwash. Fabricated MBR treating distillery spentwash efficiently.

b. Conclusions

The work carried out on treating Distillery Spentwash using Modified External Membrane Bioreactor leads to following conclusions

On study of Conventional Membrane Bioreactor systems observed that power consumption was more for pumping wastewater from one section to other. Designing of Membrane Bioreactor is done considering power consumption of system and cost economy. Locally available material are used for maximum extent to achieve cost economy.
Three different chambers are constructed to give complete treatment before final filtration. First section of system is to remove Total Nitrogen content of the spentwash. In next

chamber aeration and seeding is provided for biological treatment of spentwash in bioreactor. In intermediate section settling of biomass produced in the bioreactor is carried out so that efficient filtration of supernatant solution is possible, reducing load on filtration unit.

Membrane Bioreactor is treated with Distillery Spentwash. Initial physicochemical parameter viz. Chemical Oxygen Demand, Biological Oxygen Demand, Total Dissolved Solids, Turbidity, Total Nitrogen, pH, Electrical conductivity, Colour are analysed.

Distillery spentwash is passed through Membrane Bioreactor system. It is observed that maximum removal efficiency is achieved in Modified External Membrane Bioreactor. A transparent pale yellow colour effluent is collected from filtration unit. Hence designed Membrane Bioreactor is efficient in Distillery Spentwash. The system is capable of treating similar wastewater with organic loading. This research work gives insight of Membrane technology.

VI. ACKNOWLEDGMENT

It is with deep sense of gratitude, I acknowledge the help and encouragement of all those who have helped me directly or indirectly throughout this work.

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