



MEMBRANE TECHNOLOGY AN INNOVATIVE METHOD FOR DISTILLERY WASTEWATER TREATMENT

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ABSTRACT

Distilleries produce vast amounts of contaminated effluents which if disposed to the water bodies will pose environmental problems hence need to treat this effluent. Worldwide environment regulatory authorities are becoming more and more stringent in setting norms for discharge of wastewaters from industries. Distillery wastewaters are highly polluted and their pollution potential is one of the most critical environmental issues of today. For these reasons, distillery industries are forced to look for more effective technologies for wastewater treatment. In recent years, membrane processes have been widely used for various applications, especially for wastewater treatment. The usage of membrane technologies is reflected in high removal efficiency, optimal costs and simple handling with devices. The present study deals with the treatment of distillery spent wash by an ultrafiltration (UF) membrane. This review presents these membrane processes in the sense of their application on distillery wastewater purification.

Keywords : Bioreactor, Distillery Membrane, Wastewater, Ultrafiltration.

I INTRODUCTION

1.1 Background

Today membranes are used on a large scale to produce potable water from the sea by reverse osmosis, to clean industrial effluents (distillery wastewater) and to recover valuable constituents by electrodialysis. In recent years, membranes and membrane separation techniques have grown from a simple laboratory tool to an industrial process with considerable technical and commercial impact. In many cases, membrane processes are faster, more efficient and more economical than conventional separation techniques. With membrane, the separation is usually at ambient temperature, thus allowing temperature-sensitive solutions to be treated without the constituents being damaged or chemically altered. There are two major types of waste inorganic waste and organic waste. Organic wastewaters are potent sources of water pollution.

1.2 Objective and Scope

Now a day's wastewater treatment is not an easy task. For distribution of water to the public it is necessary. The distillery wastewater has high amount of organic matter so without treatment pull down in water stream is not



ethical. Objective of my study is treatment of distillery wastewater using membrane technologies. The scope is to first characterize the distillery wastewater and membrane technology, then by these studies membrane techniques use for treatment of distillery wastewater.

Firstly a full description of distillery wastewater which consist of composition of distillery wastewater, source, effect, zero discharge system of distillery then about membrane technologies which describe about membrane types, membrane modules, type of membrane techniques, and also about how the membrane bioreactors are helpful for treatment of distillery wastewater. Finally there are three case studies on microorganism which are helpful for distillery wastewater and also about biofiltration how help in these treatment processes.

II LITERATURE REVIEW

2.1 Distillery Wastewater

Among the raw material sources for distillery, two very important raw materials are cane sugar molasses and beet sugar molasses. Distillery wastewater (stillage) is the main byproduct originating in distilleries, and its volume is approximately 10 times that of ethanol produced. It is not surprising that the utilization of the stillage raises serious problems, and that many attempts have been made all over the world to solve them. Distillery wastewater is usually comprised of a high volume of greatly acidic matter which presents many disposal and treatment problems. Waste streams generally contain high levels of both dissolved organic and inorganic materials. There has been increasing interest in the use of ethanol from biomass as a liquid fuel alternative. Ethanol fermentation is examined in relation to distillery wastes. Reducing the volume of wastewater may be accomplished by fermenting higher strengths of molasses. To characterize distillery wastewater in detail so that proper insight may be gained in an attempt to treat the waste to reduce the pollution hazards. Oxygen consumption values can use to quantify the amount of organic matter present in wastewater. However, considerable work has been reported in this field and should be taken into account with the characteristics of distillery wastewater. Some of the work done on distillery waste characterization by various parameters like: - pH, COD, BOD, phosphate, total solids, total dissolved solids, total suspended solid, ammonia, sulfate, color and iron etc as in the Table 2.1

Table 2.1 Typical characteristics of distillery spentwash

Parameter	Range
pH	3.8-4.4
Total solids (mg/L)	60000-90000
Total suspended solids (mg/L)	2000-14000
Total dissolved solids (mg/L)	58000-76000
Total volatile solids (mg/L)	45000-65000
COD (mg/L)	70000-98000
BOD (for 5 days at 20 ⁰ C) (mg/L)	45000-60000
Total nitrogen as N (mg/L)	1000-1200
Potash as K ₂ O (mg/L)	5000-12000
Phosphate as PO ₄ (mg/L)	500-1500
Acidity as CaCO ₃ (mg/L)	8000-16000
Temperature (after heat exchanger) (⁰ C)	70-80

2.1.1 Effect of Distillery Wastewater on Environment

To characterize distillery wastewater in detail, so that proper attempt to treat the waste to reduce the pollution hazards. In a distillery, sources of wastewater are stillage, fermenter and condenser cooling water and fermenter wastewater. The liquid residues during the industrial phase of the production of alcohol are liquor, sugar cane washing water, and from the cleaning of the equipment, apart from other residual water. This extract is extremely polluting as it contains approximately 5% organic material and fertilizers such as potassium, phosphorus and nitrogen. The amount of water used in this process is large, generating a high level of liquid residues as in the Figure 2.1

The effluents from molasses based distilleries contain large amounts of dark brown colored molasses spent wash (MSW). The molasses spent wash (MSW) is a potential water pollutant in two ways. First, the highly colored nature of MSW can block out sunlight from rivers and streams, thus reducing oxygenation of the water by photosynthesis and hence becomes problem to aquatic life. Secondly, it has a high pollution load which would result in eutrophication of contaminated water sources. Due to the presence of putriciable organics like skatole, indole and other sulfur compounds, the MSW that is disposed in canals.

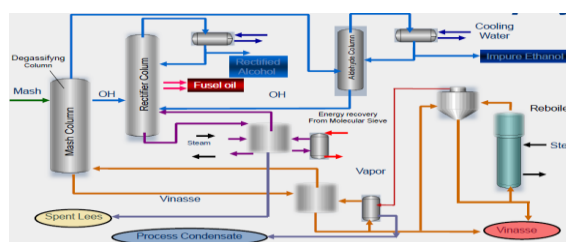


Fig. 2.1 Schematic production of distillery wastewater

In India, there is a number of large scale distilleries integrated with sugar mills. The waste products from sugar mill comprise bagasse (residue from the sugarcane crushing), pressmud (mud and dirt residue from juice clarification) and molasses (final residue from sugar crystallization section). Bagasse is used in paper manufacturing and as fuel in boilers, molasses as raw material in distillery for alcohol production while pressmud has no direct industrial application.

2.1.2 Treatment and Disposal of Distillery Wastewater

During the 1970s, land disposal was practiced one of the main treatment options, since it was found to enhance yield of certain crops. In Brazil waste generated from sugarcane juice fermentation is mainly used as a fertilizer due to its high nitrogen, phosphorus and organic content. It is use to increase sugarcane productivity and also under controlled conditions the effluent is capable of replacing application of inorganic fertilizers. However, for the high strength molasses-based spentwash, the odor, putrefaction and unpleasant landscape due to unsystematic disposal are concerns in land application.

2.2 Membrane Technologies

Physical, chemical and biological treatment approaches have been employed for the treatment of distillery wastewater. The physical methods are Sedimentation, Screening, Aeration, Filtration (Membrane Technologies), and Flotation. The chemical methods are Chlorination, Coagulation, Adsorption, and Ion Exchange. The



biological methods are grouped into two types. Aerobic methods are activated sludge treatment, lagoons, trickling filtration, and oxidation ponds, and anaerobic methods are anaerobic digestion, septic tanks.

The fact behind the membrane technology, works without the addition of chemicals, with a relatively low energy use and easy and well-arranged process conductions. Membrane technology is a generic term for a number of different, very characteristic separation processes. These processes are of the same kind, because in each of them a membrane is used. Membranes are now competitive for conventional techniques. Membrane filtration can be used as an alternative for flocculation, sediment purification techniques, adsorption (active carbon and sand filter), extraction and distillation.

2.2.1 The Growth of Membrane Technology

Membrane systems have been used in specialized applications for more than 30 years, largely for water treatment (distillery wastewater), including desalination of seawater and brackish water. With technical advances and corresponding cost reductions, membrane systems are now capable of decontaminating waters (including treated wastewaters) in single step processes at competitive costs. About two-thirds of the market will be for water, and one-third for wastewater. Membrane technologies are receiving special recognition as alternatives to conventional water treatment and as a means of polishing treated wastewater effluent for reuse applications. Membrane technologies are energy intensive. New membrane technologies feature the use of low pressure systems that significantly reduce energy use and operation and maintenance costs.

2.2.2 Components of a Membrane System

Typical membrane systems consist of various steps which are describe below:

1. Pre-treatment
2. Pumping
3. Cartridge filtration
4. Membranes and
5. Post-treatment.

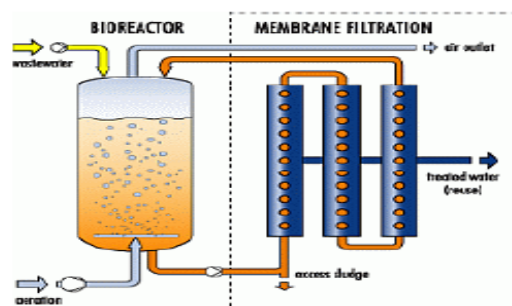
The effluent collected from the distillery industry is highly acidic with a pH range of around 3. Hence, it is neutralized using sodium hydroxide. The neutralized solution has a lot of suspended solids, so the filtration is carried out to remove the suspended particles with a fine-pore thin cloth. This pre-filtrate is used as feed. Pretreatment of alcohol-distillery wastes with ceramic membranes is performed prior to anaerobic digestion. Ceramic membranes of different pore size are chosen based on the particle size distribution in raw wastes. In some pretreatment, chemical oxygen demand (COD) is reduced from 36000 to 18000 mg/L and suspended solids are almost completely removed. Mixed stillage exhibited higher fouling tendency than pure naked barley stillage. Several cleaning methods are attempted to recover water flux. Although lumen flushing is effective, hydrogen peroxide proved to be the most effective cleaning agent. The negative flux recovery after nitric acid cleaning could be explained by the ligand exchange theory. The performance of digester is greatly improved with membrane pretreatment, especially in the case of naked barley based stillage. Pretreatment may include the addition of chemicals to prevent organic materials or soluble salts from fouling the membrane.

2.3 Treatment of Distillery Using Wastewater Membrane Bioreactor

Membrane bioreactors (MBRs) are being increasingly recognized as an effective method for the treatment of industrial (distillery) wastewaters. MBRs offer the advantages of total solids retention at all biomass concentration, low sludge yield and better treated effluent quality. In addition, the high mixed liquor suspended solids (MLSS) concentration encourages the treatment of high strength wastewater. The widespread application of MBRs is however, limited by two reason high initial membrane cost and progressive membrane fouling, which leads to frequent membrane cleaning and eventual replacement, thus contributing to the high operating costs. There are very few investigations on distillery wastewater treatment in an MBR. The COD removal efficiency was 94.7%. Membrane coupled anaerobic bioreactor (MCAB) using 0.2 μ m polypropylene and 0.14 μ m zirconia skinned inorganic tubular membranes has also been investigated for the treatment of 40000 mg/L COD distillery wastewater at 55°C. High COD removal (90%) was observed in both the anaerobic.

Anaerobically treated spentwash from sugarcane molasses based distilleries has a high COD and requires further aerobic treatment. So the objective to investigate the optimum start up method and continuous operation of aerobic MBR using anaerobically treated spentwash as feed. The main objective behind using MBR was to provide long.

SRT (sludge retention time) so that the degradation of high molecular weight compounds could be achieved in the reactor. Nylon mesh was used instead of commercial microporous membranes to decrease the cost. During MBRs study, the initial sludge acclimatization phase where the focus was on biomass growth and sludge properties, followed by continuous operation that mainly deals with reactor operation and filtration performance.



MBR concept

Fig 2.6 MBR Concept

III CASE STUDY

3.1 Case Study on Treatment Of Distillery Wastewater Using Microorganisms

The microorganisms used for distillery wastewater treatment are given below which may directly immobilized on the membrane or their enzyme is immobilized on the membrane as in the Table 3.1. Major finding of this work is the microorganism used for decolonization is identified, which includes both bacterial and fungal microorganisms.

Table 3.1 Microorganism employed for the decolorization of distillery effluent

Name	Color Removal (%)
BACTERIA	
<i>Xanthomonas fragariae</i>	76
<i>Bacillus cereus</i>	82
<i>Acetobacter acetii</i>	76.4
<i>Pseudomonas pudita</i>	60
<i>Pseudomonas fluorescens</i>	94
<i>Pseudomonas aeruginosa</i>	67
FUNGI	
<i>Trametes versicolor</i>	82
<i>Geotrichum candidum</i>	80
<i>Aspergillus niger</i>	80
<i>Mycelia sterilia</i>	93
<i>Rhizopus sp.</i>	90
<i>Aspergillus oryzae</i>	75

IV. SUMMARY

Drinking water quality is essential to public health. Although water treatment is a common practice for supplying good quality of water from a source, maintaining an adequate water quality throughout a distribution system is never an easy task. Municipal, agricultural and industrial liquid or solid wastes differ very much in their chemical, physical and biological characteristics. There are two type of waste like inorganic waste and organic waste are potent source of water pollution. Organic wastewater that is known to cause serious problems may be contributed by distillery effluent, pulp and paper effluent and textile effluent etc. Among the raw material sources for distillery, two very important raw materials are cane sugar molasses and beet sugar molasses. Distillery wastewater is usually composed of a high volume of acidic matter which presents many disposal and treatment problems.

Waste streams of distillery wastewater generally contain high levels of both dissolved organic and inorganic materials. There has been increasing interest in the use of ethanol from biomass as a liquid fuel alternative. Ethanol fermentation is examined in relation to distillery wastes. Reducing the volume of wastes may be accomplished by fermenting higher strengths of molasses. There are various methods used in the treatment of distillery wastewater. Physical-chemical treatment of distillery wastewater has little success. Anaerobic digestion, anaerobic filters, lagoons, activated sludge and trickling filters have all been successfully applied to the treatment of distillery wastewater. This diverse spectrum of wastes requiring efficient treatment has focused the attention of researchers on membrane, ion-exchange and biological technologies. Membrane and membrane separation techniques with immobilized microorganism or enzyme have very significant role in treatment of distillery wastewater.

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