Application of Membrane Technology to Waste Effluent of Textile

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Abstract— In this paper, membrane technology is used to treat effluent of textile waste after biologically treatment with activated sludge. The microfiltration, Ultrafiltration and Nan filtration are evaluated for permeate flux and separation of colour, turbidity, conductivity and total dissolve solids. Result Experiment result demonstrated that membrane treatment is a promising advanced treatment option for control pollution for textile effluents.

Key words: Membranes, Textile Effluents, Activated Sludge, Conductivity, TDS

I. INTRODUCTION

Textile companies often face a shortage of available water sources [1], not only because of water scarcity, but also as a result of permit systems, which limit the use of ground water to a pre–determined volume. A literature survey showed that much work has been focused on investigating the effectiveness and feasibility of new advanced technologies that are promising in terms of their performance and cost in the treatment and reuse of textile effluents. These technologies include membrane processes such as; microfiltration, ultra filtration, nanofiltration, they were also found to be more effective for the removal of colour and COD from textile wastewater when compared with conventional methods [2]

Most of the earlier studies have been related to the application of membrane technologies on the basis of laboratory, and/or pilot scale trials, and the quality of the treated water was evaluated with respect to the process water presently in use [3-9]. There have also been studies conducted into investigating the use of membranes in combination with physico-chemical processes for treatment and reuse of textile wastewater [21-22]. In addition, the use of an external membrane bioreactor for the treatment of waste has been researched and its operating conditions determined [23-24]. The treatment of wastewater for reuse in the textile industry by means of other advanced technologies including; ozonation, electro flocculation, and advanced oxidation was also studied in several works [10-11]

In the future, many of textile factories will face the requirement of reusing a significant part of all incoming freshwater because traomditionally used methods are insufficient for obtaining the required water quality. Textile wastewater is usually treated in an activated sludge plant to allow wastewater discharge within law requirements but not order to reduce a final effluent suitable for reuse in the textile processes. In fact, a considerable amount of recalcitrant contaminants still remain in biologically treated textile effluents. In environmental terms, these contaminants mean suspended solids, COD, BOD, as well as high pH and very strong colour. Membrane based separation processes have gradually become an attractive alternative to the conventional separation processes in the treatment of wastewater. The application of membrane filtration processes not only enables high removal efficiencies, but also allows reuse of water and some of the valuable waste constituents.

In this paper, membrane process was used to treat a textile effluent having high salinity, our aim to reduce polluting substances in reclaimed process water after membrane filtration. Textile effluent after biologically treatment is treated with microfiltration, ultration and permeates of microfiltration in utrafiltration and nanofiltration process.

II. MATERIALS AND METHOD

A. *Wastewater Origin*

The waste water from textile industry contains different dyes and chemical like detergents, salt and caustic soda. Their amount depends upon the process which generates the effluents. The effluents issued from the factory are then treated biologically in an activated sludge plant to allow waste water discharge, but it is not suitable for reused in textile process.

Only biologically treated water are used for treatments.

B. *Modules and Membranes*

The tubular microfiltration and ultra-filtration membranes composed of several layers of porous ceramic are purchased and nanofiltration flat sheet polyamide based thin film composite membrane was used in nanofiltration. The membranes were soaked in water for 24 hours in order to eliminate conservation products and then permeability was determined.

C. *Analytical Methods*

The conductivities were measured by conductivity meter. The turbidity of the samples was measured by turbidity meter. The color intensity of feed and permeate samples were analyzed by spectrophotometer. The color was measured using the integral of the absorbance curve in the whole visible range (400–800 nm). Total dissolved salts (TDS) of all the samples were measured by taking 10 ml of each sample in a watch glass and keeping in an oven till complete drying of the sample.

The COD is the measure of oxygen consumed during the oxidation of the organic matter by a strong oxidizing agent. The sample was refluxed with potassium dichromate and sulphuric acid in presence of mercuric sulphate and silver sulphate. The excess of potassium dichromate was titrated against ferrous ammonium sulphate using ferroin as an indicator. The amount of potassium dichromate used is proportional to the oxidizable organic matter present in the sample

Anions were determined by ion chromatography using conductivity detection.

Anion dual 2 column with a particle diameter of 6 mm.Ca^2+ and Mg $^{2+}$ amounts were determined by atomic

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absorption spectroscopy Na $^+$and K $^+$ were analyzed by atomic emission spectroscopy

For the evaluation of membrane rejection,

$$R=[Cf-Cp/Cf]\times100$$

Where R is the percent reduction of the target material, Cp and Cf are respectively the permeate and feed concentrations.

The Volume Reduction Factor (VRF) is equal to the initial feed volume divided by the retention volume

$$VRF= Vf / Vr$$

III. Result and Discussion

The membrane base separation process performances are controlled by operating pressure and permeability. Before the experimentation, membranes permeability are checked before and after cleaning,

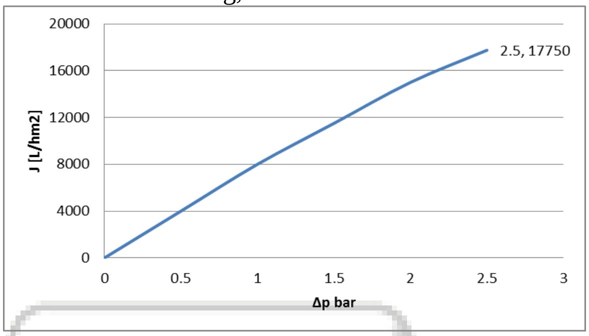

Fig. 1: MF

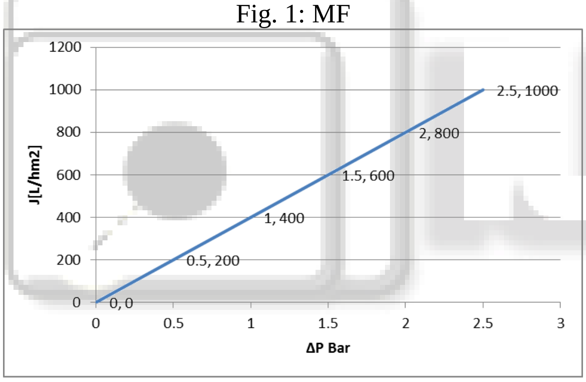

Fig. 2: uF

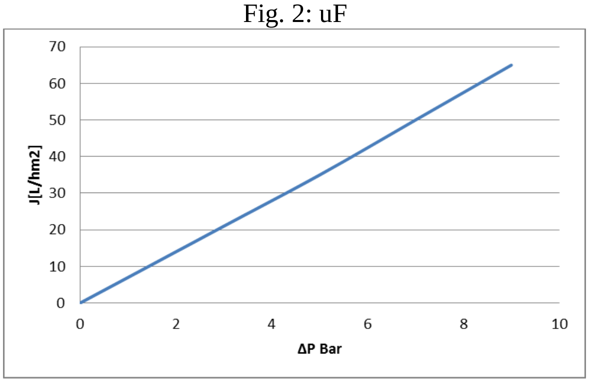

Fig. 3: NF

A. *Microfiltration*

Fouling of the membranes reduces the life of the membranes, so pretreatment to feed removed suspended solids contaminated in textile effluent. The results of the microfiltration experiments are presented in Table 1. Against VRF. The removal of respective parameters with MF is shown in Fig. 4. A middle removal of turbidity (40%) was obtained but Permeates still contain significant amounts of dissolved salts. On average, the COD value Was about 200 mg_1 which considered high for discharge As shown in Table 3, a significant removal of Ca2þ (about 60%) was observed nevertheless the important membrane's pore size. This result indicates a strong interaction between Ca2þ and other molecules contained in the wastewater forming complexes with high molecular sizes which minimize the incorporation of Ca2þ through the MF membrane. This phenomenon can be attributed to intermolecular bridging by Ca2þ which associates the COO_ functional groups on the textile wastewater [11].Although the microfiltration didn't lead to a good permeates quality, it can be used as a pre–treatment for nanofiltration or it is possible to improve the MF output using a multistage.

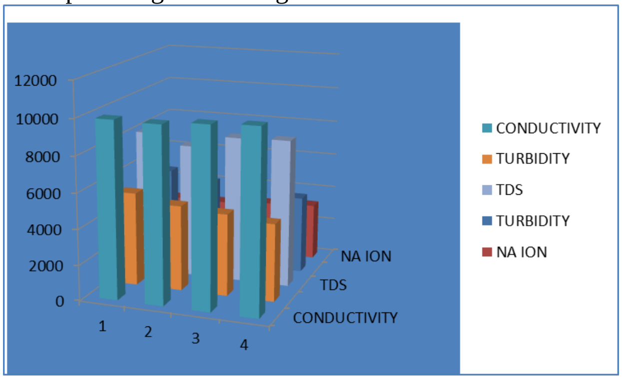

Fig. 4: A middle removal of turbidity (40%) was obtained

B. *Ultra Filtration*

1) *Ultra filtration of textile wastewater*

The Ultra filtration membranes are used for this study. Table 2 show respective parameters characterizing the ultra-filtration membranes and permeate at 300c and same operating pressure equal to 3 bar.

The fig 5 shows the evaluation of permeate flux with operating time for ultra-filtration membrane. It show that increased in operating time permeate flux decreased. As comparison between Ultra filtration and microfiltration membranes, it is cleared that permeate quality of ultra-filtration membranes is better.

VRF	1.11	1.25	1.43	1.67
Conductivity[um/cm]	8330	9030	9220	9260
Turbidity	1.087	1.1	1.07	1.6
TDS	6300	6620	7020	7010
Colour	3.23	3.8	4.2	3.6
Ca2+	100	95	67	100
K+	112	117	120	120
Mg2+	26	28	26	26
Na+	2425	2290	2340	2390
COD				

Tables 1: Results of the microfiltration experiments are presented

In fact, table 2 and 3 shows a high improvement of turbidity removal and little improvement of color removal. the COD value was about 80 mg/l which is acceptable value. A little improvement in turbidity and conductivity removal are obtained using the ultra-filtration membranes.

C. *Treatment of Microfiltration and Ultra-Filtration Membranes in Series*

The permeate of microfiltration membranes was ultra-filtrated in order to study the performance of both microfiltration and ultra-filtration membranes processes. it shows the important decrease was observed for major parameters. This observation is cleared in figure no.5. which shows an improvement in retention value of turbidity, conductivity and TDS. This result shows the better quality of permeate by application of multistage process in series like microfiltration and ultra filtration.

VRF	1.11	1.25	1.43	1.67
Conductivity	6220	6340	6350	6320
Turbidity	0.780	0.750	0.710	0.725
TDS	4240	4460	4790	4766
Color	0..87	2.22	1.76	2.02

Table 2: show a high improvement of turbidity removal

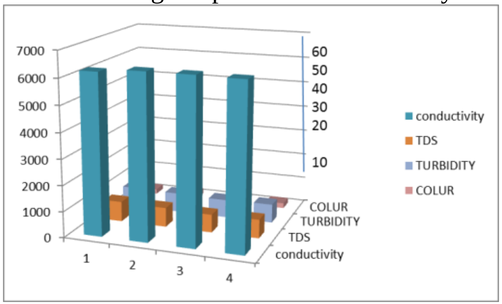

Fig. 5: shows the evaluation of permeate flux with operating time for ultra-filtration membrane

Nanofiltration the waste of textile is treated to nanofiltration process in two different operating conditions, the first condition is influence of different operating pressure on permeate flux in nanofiltration and the second considered on keeping a constant pressure 10 bar.

D. Influence of the operating pressure on permeates flux in NF process

Permeate flux is an important parameter in the design and economical feasibility of membrane separation processes**.** Fig. 6 shows the relationship between permeate flux and transmembrane pressure for clean water and textile wastewater. Permeate flux increases proportionally with the pressure drop within the pressure range studied,

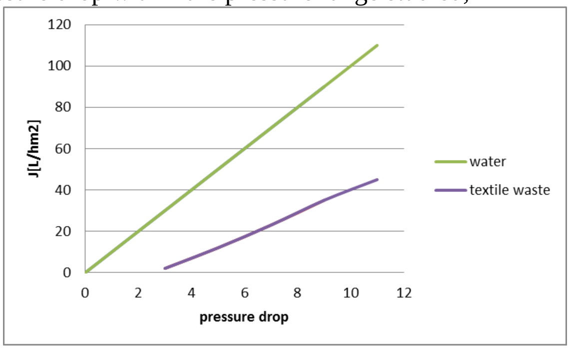

Fig. 6: Shows the relationship between permeate flux and transmembrane pressure for clean water and textile wastewater

E. Nanofiltration at Constant Pressure

Influence of time on permeate flux keeping operating pressure constant at 10 bar and with recycling retentate to feed tank at constant temp.30^0c.

Initial pure water flux was 93l/hm2.The immediate flux decline was 48% 45 L/hm2 indicating an important osmotic pressure effect due to the high salt concentration in the raw water. A stable process water flux of 10 L/hm2 was obtained after 5 h of the experiment, indicating an important flux decline (90%) due the polarization concentration, the adsorption and/or pore blocking caused by high COD value and high salt concentration.

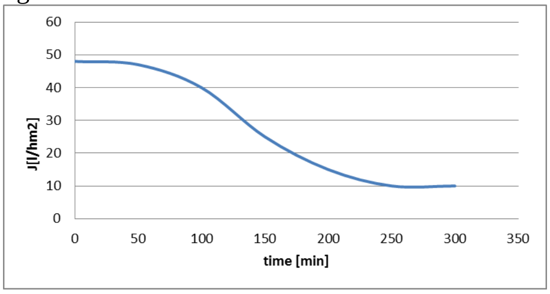

Fig. 7: Permeate flux with operating time at constant operating pressure 10bar and temp.30^0C

F. Characteristics of permeate against the Volume Reduction Factor (VRF).

VRF	1.11	1.18	1.25	1.33
Conductivity	3470	3460	3450	3450
Turbidity	0.497	0.447	0.367	0.386
TDS	2530	2300	2630	2635
Colour	0.36	0.46	0.70	0.35

Table 3: show a little improvement of color removal

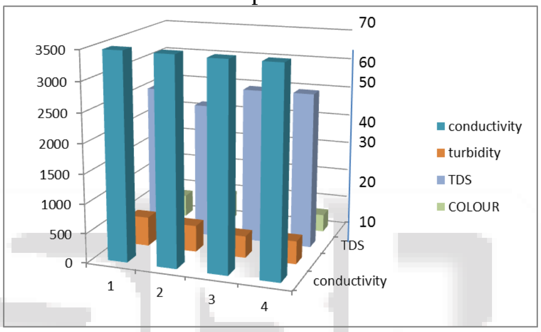

Fig. 8: shows that nanofiltration leads to a significant retention rate of all parameters

Fig.8. shows that nanofiltration leads to a significant retention rate of all parameters. The retention rates of TDS, turbidity and color increased The removal of conductivity is also increased. Therefore, the nanofiltration process is considered as the more interesting issue for the treatment of textile effluent and it can be an attractive alternative for reusing a significant part of all incoming freshwater.

IV. Conclusion

The comparison between microfiltration and ultrafiltration, after microfiltration permeate in ultra-filtration showed permeate quality better, for direct nanofiltration of biologically treated waste water with high salt concentration very good result obtainted. colur turbidity and conductivity and TDS removal increased, NF membranes are suitable for producing permeate of reusable quality.

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