Jr. of Industrial Pollution Control 27(2)(2011) pp 1-5

INTEGRATED EFFLUENT TREATMENT IN TANNERY INDUSTRIES - FEASIBILITY STUDY

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Key words: Tannery effluent, RO, Activated sludge process, Waste water treatment, Ultra filtration, Nano filtration

(Received 25 July 2011; accepted 1 September 2011)

ABSTRACT

Waste water treatment with Reverse Osmosis technology is the best option for treating high conductivity of global waste water from tannery industry. Feasibility of reusing tannery waste water by combinations of existing conventional activated sludge process, with Ultra filtration, Nano filtration and Reverse Osmosis treatment technologies were studied. The characteristics of untreated effluent in two tannery industries were collected. From the result, it can be seen that conventional treatment system marginally removes the organic pollutant where as it failed to remove total dissolved solids. On the other hand membrane technology removed salts and organic pollutants. From the analytical result of the treated water it can be understand that the treated water can be reused for the process. The rejects obtained in the process is subjected to solar evaporation system or multiple evaporation system for further recovery of salt.

INTRODUCTION

Manufacturing of leather, leather goods, leather boards and fur produces numerous by products, solid wastes and high amount of waste water containing different loads of pollutants and emission in to the air. The transformation of the raw hide into leather requires various mechanical and chemical treatments and is generally carried out using different acids, alkali and salts of sodium and chromium (Dutta, 1999). The leather industry is one of the highly polluting industries. The uncontrolled release of tannery pollutants into natural water bodies increases the health risk for human beings and environmental pollution. Effluent from raw hide processing tanneries which produces wet blue, crust leather or finished leather. Organic and other ingredients are responsible for high BOD and COD values and result in an immense pollution load causing technical problems. In India the annual amount of hides and skins processed is about 80,000 tones resulting in 85,000m^3 of liquid effluent per day from 3500 tanneries (Naidu *et al*. 2000). Erode district of Tamilnadu in India has clusters of tanning units at Chithode, Bhavani and Perundurai. Sodium chloride, sodium sulfide lime, chromium proteins, fats are the major constituents used (More *et al.* 2001).The effluent discharged from these industries have high BOD and COD. Conventional Activated Sludge Process was adopted in the treatment of tannery industry effluent which was found to be

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inadequate for the removal of total dissolved solids. Membrane based process offer cleaner technology in the treatment of various industrial processes for separation, purification, concentration and fractionation of solutes (Marcucci *et al.* 2002; Afonso *et al*. 1991; Brans *et al*. 2004; Jonsson, 1990 and Cassano *et al.* 2001) presented a detailed application of membrane based process like microfiltration, nanofiltration (NF) and reverse osmosis (RO).

The conventional treatment technology like chemical flocculation and biological process like up-flow anaerobic sludge blanket and activated sludge process are found to be effective in removal of organic pollutants. Tare *et al.* (2003) reported that the ASP is superior to UASB. However, those processes are not competent in reduction of total dissolved in organics. Membrane technologies are advanced methods to solve problems of dissolved solids in the effluents. Pilot studies have been carried out for removal of chromium from tannery waste water using RO system and found high concentration of NaCl affected chromium separation as well as percent recovery of permeate (Hafez *et al*. 2002 & 2004). In the present work tanneries located in Erode district which have installed Reverse osmosis membrane process are studied to evaluate their performance.

MATERIALS AND METHODS

Two tanneries operating reverse osmosis membrane technology namely EKHM tannery and Leads leather, located in Erode district of Tamilnadu was considered for feasibility study. The information such as production capacity, raw materials, water balance and existing treatment technologies were collected. In general, hides and skins after stripping in the slaughterhouse are immediately preserved by applying NaCl (1:3 salt and skin weight ratios) and are brought to tanneries for making leather. Salts are removed initially by manual or mechanical desalting and hides are soaked in tank filled with water overnight and also one hour soaking is carried out at least in fresh water. Soaking removes the salt generation about 11-15L/kg of waste water with high TDS in the range of 20000 mg/L to 53000 mg/L. Finally, these effluents are subjected to multiple/solar evaporation (MSE).

Table 1. Characteristics of effluent from EKHM tanneries, Erode

Parameter	Effluent	After coagulation	After Biological treatment	RO permeate	RO reject
pH	4.4	7.4	8.5	7.1	7.2
TDS, mg/L	8100	6120	5900	250	12200
BOD ,mg/L	2460	520	66	BDL	98
COD, mg/L	5460	1300	280	15	680
Total hardness, mg/L	1210	890	930	BDL	2680
Sodium, mg/L	1900	1800	1620	48	3100
Chloride, mg/L	1480	1620	1500	91	2960
Sulphide, mg/L	2.4	-	0.2	-	-
Sulphate, mg/L	3600	2400	2220	55	4620
Electrical conductivity, mS/cm	9.4	7.9	7.3	0.48	12.88

Table 2. Characteristics of effluent from Leads leather, Erode

Parameter	Effluent	After coagulation	After Biological treatment	RO permeate	RO reject
pH	4.2	7.3	7.8	7.4	7.7
TDS, mg/L	7100	6820	5200	230	11700
BOD, mg/L	2860	580	58	BDL	88
COD, mg/L	6760	1420	320	20	720
Total hardness, mg/L	1330	845	890	BDL	2950
Sodium, mg/L	1830	1780	1520	56	2900
Chloride, mg/L	1215	1320	1470	86	2780
Sulphide, mg/L	1	-	0.3	-	-
Sulphate, mg/L	3600	2400	2220	55	4620
Electrical conductivity, mS/cm	10.8	10.1	9.4	0.35	27.2

The next part is to remove hair, fleshy and unwanted organics, the hide is soaked in the suspension of lime (7.5%) sodium sulfide (2.5%) and subject to de-haring and de-fleshing. The quantity of effluent generated is 4 L/kg with high calcium, sodium sulfide and organic pollutants. The lime processing is followed by ammonium salt pickling overnight for the removal of impregnated lime in the process of hides. Sulphuric acid is used as acid pickling to bring down the pH to 2-4 to avoid biological effect and good tanning. Chromic acid about 8% is used for tanning for about 9 hours. 20-30% of used chromium salts are let into the waste water.

Waste water sampling for analysis

Composite sampling has been carried in the interval period of 1 hr before and after treatments of both conventional and RO technology. The sampling and analysis were carried out as per prescribed standard methods (APHA 1998) and (CPCB 2001).

RESULTS AND DISCUSSION

The characteristics of effluent in EKHM and Leads leather industries are shown in Table 1 & 2. The schematic diagram of effluent treatment followed in the above industries is shown in Figure 1. Characteristics of waste water of both tanneries are following bar chamber for particle separation, clariflocculation with conventional sludge process as convention treatment process and it was embedded with UF, NF and RO system of advanced treatment. The initial values of pH for the tannery waste water are acidic due to the use of the mineral acids in the process. Lime and chemical coagulations have been added to raise the alkalinity of the water. This will remove 92-96% of BOD followed by biological oxidation which subsequently reduces 92-96% BOD. There is significant removal of suspended solids and chemical oxygen demand. Also it is noted that there is significant change in removal of inorganic substances in the range of 0-35%.Anerobic treatment and polishing with lime and polyelectrolyte's has further reduced BOD. The main purpose of the conventional method is to increase the life of the membranes of RO system which will result reduction in cost for effluent treatment. The conventional methods also pay way to remove toxic pollutants like chromium and sulphides by oxidation and precipitation. However, the removal of TDS is a hectic problem with respect to conventional technology. Therefore, in addition to conventional technology the RO treatment system is embedded for the remove of dissolved solids. To enhance the efficiency of recovery permeate and to increase the life cycle of the membrane a physical-chemical combination of UF and NF are used.

The permeate of these RO treatment system are more than 75-85% recovery and rejects 15-25%.The BOD level in the permeate was found to be below detection level.TDS is one of the important parameters to analyze the performance of RO system was found to be in the range of 3000-9000 mg/L in feed water and in the case of permeate it was in the range of 230-250mg/L which are well within the drinking water standard. On the other hand rejects are generally in the range of 12000 mg/L. The quality of RO permeate may be enhanced by installing further RO system before it is subjected to solar evaporation system or multiple evaporation system. The results are shown in Figures 2 and 3.

CONCLUSION

The effluents of tanneries are segregated as high TDS soaking waste water chromium toxic waste water and other waste water streams. From experimental study, it can be concluded that conventional treatment system marginally removes the organic pollutant where as it failed to remove total dissolved solids. On the other hand membrane technology removed salts and organic pollutants. The rejects are subjected to solar/multiple evaporation to recover the salt which can be used in the process. Hence, the combination of conventional activated sludge process coupled with UF, NF and RO technology seems to be very efficient method for treating tannery effluent.

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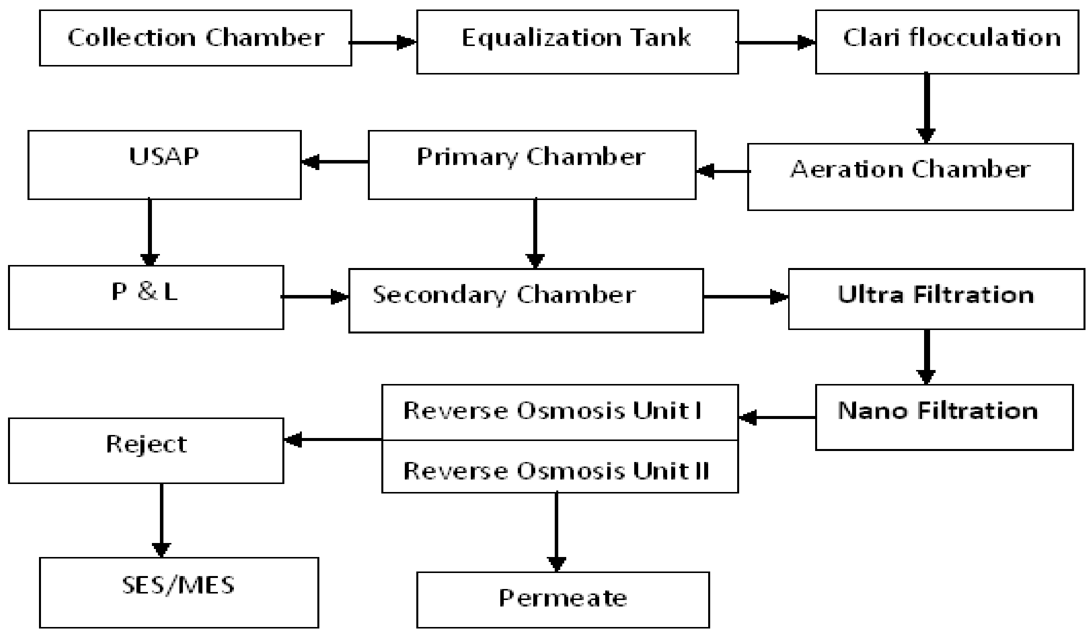

Fig. 1 Process Flowsheet

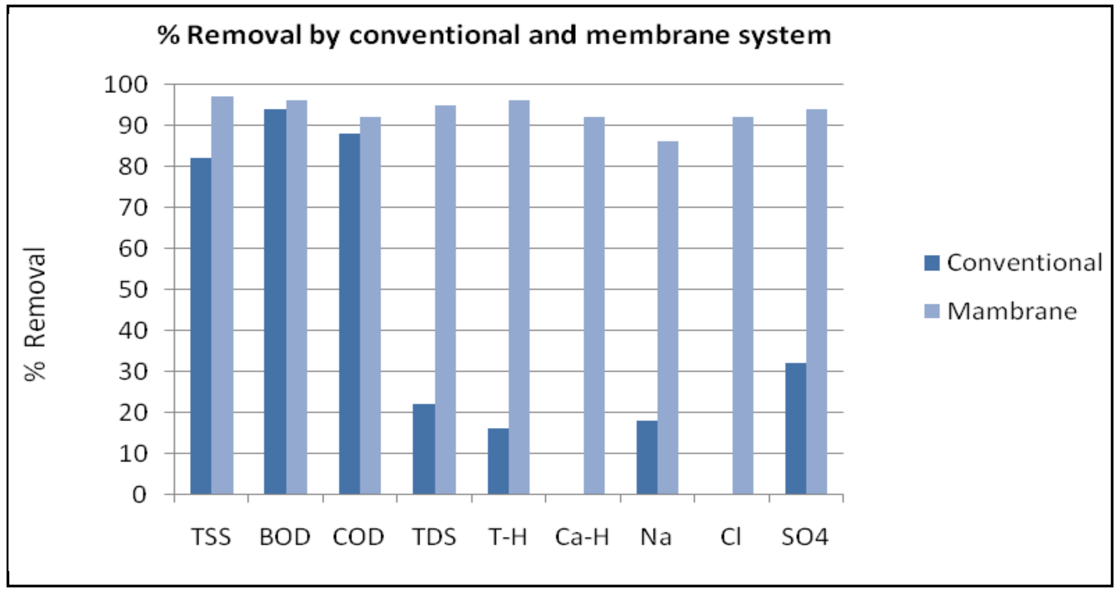

Fig. 2 % Removal by conventional and membrane techniques

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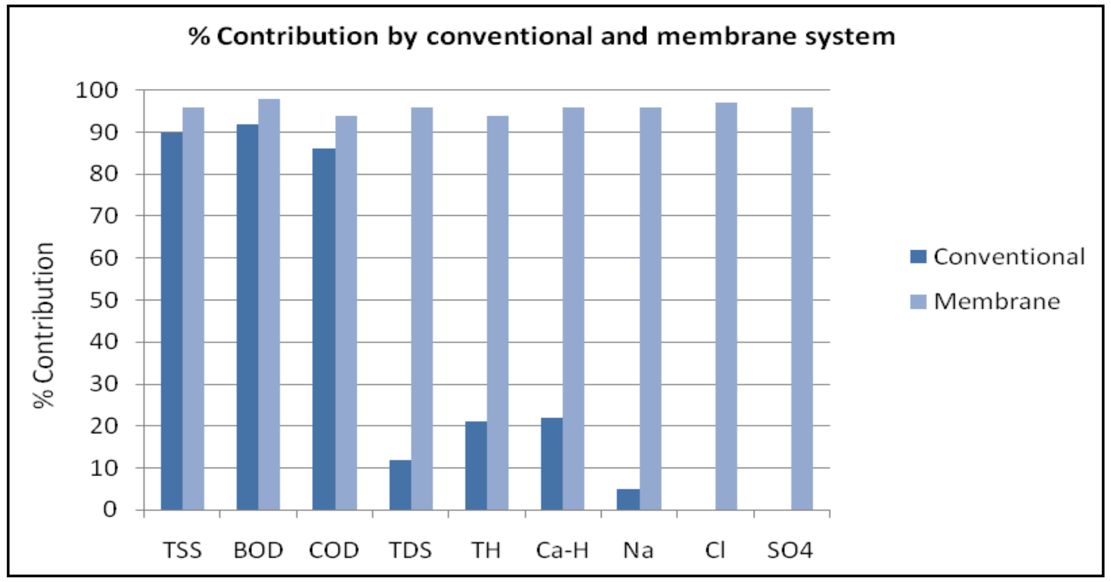

Fig: 3 % Contribution by conventional and membrane techniques

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