Distillery Spent wash treatment with the use of Nanofiltration followed by Reverse osmosis process

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Abstract: *Thin-film composite nano-filtration (NF) and reverse osmosis (RO) membranes based NF followed by RO pilot plant at a feed pressure of 20 atm. and flow rate of 10 L/min. was used to remove colour, total dissolved solid (TDS) and chemical oxygen demand (COD) of distillery spent wash. NF was found to be effective for high rejection of TDS, colour and COD by 85%, 99% and 95%, respectively. Furthermore, significant reduction of TDS (97%), colour (99.8%) and COD (99.90%) was achieved from RO runs.*

1. Introduction

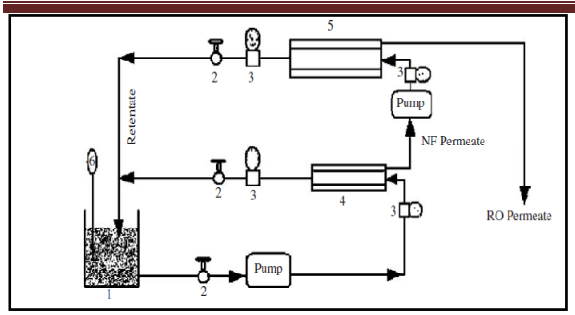
Distilleries are to be scheduled as one of the most polluting industries by the Central Pollution Control Board (CPCB) due to generation of huge quantities of high toxic effluents, e.g. spent wash.[1] The spent wash is characterized by extremely high chemical oxygen demand (COD) (85,000–1,20,000 mg/l) and biochemical oxygen demand (BOD) (35,000–60,000 mg/l), apart from low pH, strong odor and dark brown color.[2] Most of the treated spent wash with the best available process technology (conventional effluent treatment plant (ETP), screening and equalisation followed by biomethanation) yields very high levels of COD and total dissolved solids (TDS), with black-colored effluent with odors. Moreover, ferti-irrigation and biocomposting with sugarcane press mud are highly energy intensive and hence quite expensive.[3] These disadvantages limit the use of existing technology and needed further research in the field of novel separation methods. Pertaining to this, membrane-based separation techniques such as RO and NF would yield excellent results when applied. [4-6] The effectiveness of NF membrane processes in water and wastewater treatment is generally acknowledged and has now become the most reliable standard technique. Hybrid techniques are also quite popular.

The main objective of this study was to purify the spent wash by removing colour, TDS and COD by the combined use of NF and RO hybrid process.

2. Materials and methods:

The spent wash was obtained from Sayan Vibhag Sahkari Kand Udyog Mandali Ltd., Surat, Gujarat, India. Tetra sodium EDTA, hydrochloric acid and sodium bisulfate for membrane cleaning and storage were purchased from S.D. Fine Chemicals, Mumbai, India. KCl, NaCl and deionized water for the atomic absorption spectrometer (AAS) standard preparation were obtained from Merck Specialities, Mumbai, India, and all were of analytical grade.

As shown in **Fig. 1** experiments were carried out on a Perma-pilot scale membrane system (Permionics, Vadodara, India) consisting of a spiral-wound thin-film composite (TFC) NF and RO membrane modules. These modules were built by incorporating a commercial TFC polyamide RO membrane with an inlet operating pressure of 20 atm. and TFC NF with an inlet pressure of 15 atm. inside an FRP cylindrical pressure vessel; 2.5 inches diameter X 21 inches length was the size of each module. Damper is provided to regulate the flow fluctuation due to the reciprocating action of the pump. A feed tank (30 L capacity), made of stainless steel-316 is provided for storage and supply of effluent to the system as well as collection of the recycled concentrate. A cooling coil is installed inside the feed tank for circulating cold water to maintain constant feed temperature within the range of 28-30^{o}C.



1. Feed 2. ; Control valve; 3. Press guage; 4. NF module; 5. RO module; 6. Thermocouple

Fig. 1. Schematic of NF and RO pilot plant

Thirty liters of the pretreated feed (neutralised and free of suspended solids) was poured in the feed tank after thoroughly cleaning the membrane systems and wetting with deionized water. The high-pressure pump was employed to transport the feed to the spiral wound membrane module and the system pressure was adjusted at a value greater than the osmotic pressure, by means of a restricting needle valve. With a control valve, the permeate flow rate was maintained constant (10 L/min) throughout the experiments, to ensure the steady hydrodynamic conditions inside the membrane module. The feed pressure was maintained 20 atm. and composite permeate samples were collected at an interval of 10 min. for a period of 30 min. The experiment was repeated twice with every feed sample for reproducibility of the permeate characteristics.

The feed and permeate of the experimental samples were analyzed for colour, TDS and COD by the different methods. Colour and TDS values were measured by the multi parameter probe (Hech, USA) and COD was determined by open-reflux method.

3. Results and analysis:

Typical characteristics of the distillery spent wash used for this study are given in Table 1. Earlier laboratory studies have shown that higher feed pressure (above 15 atm.) found to be effective for the removal of TDS, colour and COD from spent wash of distillery.[7] Due to that all the experiments were carried out at a feed pressure of 20 atm.

Table 1. Characteristics of distillery spent wash and permeate

Parameter	Unit	Spent wash	NF Permeate	RO Permeate
pH	-	3.2	6.5	6.4
TDS	mg/Lt	36780	5517	1103
Colour	Pt.Co. scale	760	7	1
COD	mg/Lt	132000	6600	125

Feed with a TDS concentration of 36780 ppm was run mainly to remove the color and COD. As shown in **Table 1** TDS, colour and COD removal efficiency of NF membrane module were observed to be in the tune of 85%, 99% and 95%, respectively. It signifies the high efficiency of NF permeate membrane module for the rejection of the possible bivalent and trivalent ions that include calcium, magnesium, and iron-like trace metals. Retention of some color was observed due to the penetration of suspensions as a result of high applied pressures (20 atm.). Remaining ions and larger species from the NF permeate significantly removed by passage through RO module. Quality of RO permeate shows that TDS, colour and COD removal efficiency of spent wash through hybrid processes (NF followed by RO) were found to be 97%, 99.8% and 99.9%, respectively.

Conclusions:

NF followed by RO hybrid process could be successfully used for the removal of TDS, colour and COD of spent wash. At a feed pressure of 20 atm. and flow rate of 10 L/min. conferred the rejection efficiency of TDS, colour and COD of spent wash by 97%, 99.8% and 99.9%, respectively.

References:

1. Central Pollution Control Board (CPCB). Annual Report. New Delhi, India **(2003).**
2. Central Pollution Control Board (CPCB),./http://www.cpcb.nic.in/ dec942.htmS **(1994)** (accessed on 12.12.2011).
3. Y. Satyawali, M. Balakrishnan, Wastewater treatment in molasses-based alcohol distilleries for COD, and color removal: A review, J. of Environ. Manag., 86, 481 **(2008).**
4. R.D. Noble, S.A. Stern, Membrane Separation Technology: Principles and Applications. Elsevier, Amsterdam **(1995).**
5. R. Rautenbach, T. Linn, L. Eilers, Treatment of severely contaminated waste water by a combination of RO, high pressure reverse osmosis and nanofiltration potential and limits of the process. J. Memb. Sci., 174, 231 **(2000).**
6 D. Sekar, D.V.S. Murthy, Colour removal of distillery spent wash by adsorption technique. Ind. Chem. Eng. A, 40, 367 **(1998).**
7. S. K. Nataraj, K.M. Hosamani and T. M. Aminabhavi, Distillery wastewater treatment by the membrane-based nanofiltration and reverse osmosis processes, Water Research, 40, 2349 **(2006).**