Using RO and single Stage evaporation, treatment of secondary effluent of textile industry - Approach to ZLD

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Abstract: Textile industry is the major source of water consumption and wastewater pollution. Textile printing and dyeing processes include pretreatment, printing/dyeing, finishing and other technologies. Pretreatment includes desizing, scouring, washing, and other processes. Major pollution problems in textile industry are colour, COD, dissolved solids, toxic metals, residual chlorine, which are such properties that directly affect the human health and aquatic life. Treatment systems are consisting of physico-chemical treatment and biological treatment. Wastewater generated from dyeing process may contain residuals of dyes, leveling agents, salts, caustic soda and heavy colour load, which makes biological degradation, becomes difficult and treatment is not feasible. It is necessary to find the most suitable treatment method for textile wastewater that will minimize the production and investment costs of wastewater treatment plants. So the advance treatment RO and evaporation technique is to be used. For reusing and recycling purpose of water, this two techniques is best, which produce high quality water, reduce volume of waste and achieves zero liquid discharge. Permeate from RO is reused for processes. Reject from RO is sent for evaporation.

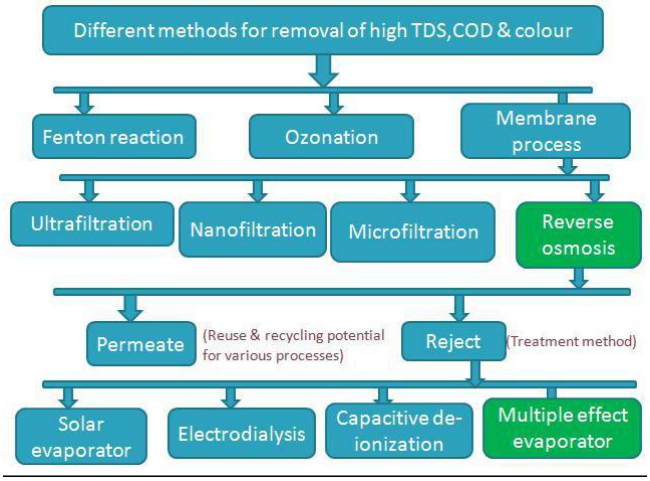
Keywords: Reverse osmosis, textile effluent, evaporation, recycling of wastewater.

Introduction

India is the one of the world's largest producers of textiles and garments. 'cloth' which are supplied by processing of natural and man-made fibers in the textile industries is the basic need of human. Textiles account for 14% of India's industrial production and around 27% of its export earnings. Textile processing comprises pretreatment , dyeing, printing and finishing operations. Dyeing is a combined process of bleaching and coloring, which generates voluminous quantities of wastewaters and in turn causes environmental degradation .These production processes produce substantial wastewater. The textile dyeing industry demands large quantities of water and produces wastewater having high load of contaminants. Textile processing employs a variety of chemicals depending on the nature of the raw material and product. Hosiery fabrics processes requires salt ,salt used is either sodium chloride (NaCl) or sodium sulphate(Na_2SO_4). This generates large quantity of effluent is in the range of 5000-7000 mg/L with chloride in the range of 2000-3500 mg/L as compared to the tolerance limits of 2100 mg/L for TDS and 1000 mg/L for chlorides. More than 80% of the salt and 90% of the colour is discharged. The salt is largely unaffected by biological treatment methods. Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, colour, acidity, and other soluble substances. Wastewater discharged in to the main water decreases the light permeability in the water

environment and effects the photosynthetic activities negatively. Accumulation of dyeing substance cause great damages to the human body, functions of kidneys, reproductive system, liver, brain and nervous system by making toxic and carcinogenic products. The wastewater of cotton based textile units is usually alkaline, whereas synthetic and woolen fabric processing generates acidic effluent.

[1] EFFLUENT TREATMENT: There are different methods for treatment of secondary treated textile effluent but some methods have disadvantage.



[2] Limitations:

Fenton reaction: It requires additional chemical cost, removing mud cost, the potential of polymerization reactions, potential corrosion problem, continuing of normal chemical reactions.

Electrodialysis: Problems associated with electrodialysis process is chemical precipitation of salts with low solubility on the membrane surface, clogging of the membrane by the residual organic matter.

Ozone process: There are organic materials that it gives very slow reactions or do not enter in reaction.

Ultrafiltration: It enables elimination of macromolecules and particles but the elimination of polluting substances, such as dyes, is never complete.

Nanofiltration: Treatment of dyeing wastewater by nanofiltration give dissolved solids which makes discharging the treated effluent into the water streams impossible.

Solar evaporator: Solar evaporator has disadvantage like it uses lot of space, solar energy storage is expensive and weather dependent.

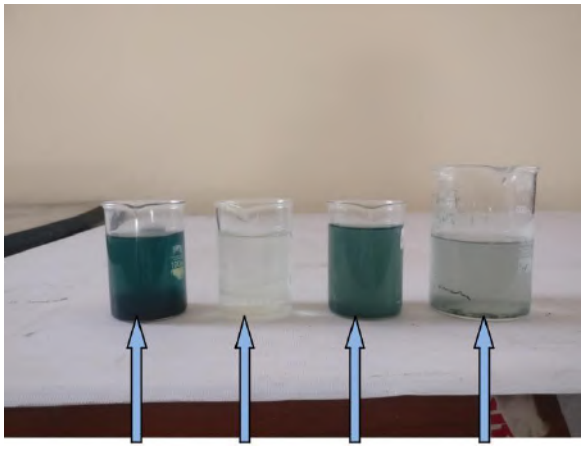
Textile wastewater include various combination of biological, physical and chemical methods, but these methods require high capital and operating costs. Technologies based on membrane

systems are among the best alternative methods that are adopted for large-scale ecologically friendly treatment processes.

[3] Principle of Reverse Osmosis: It is a pressure driven membrane desalination process. The process is also known as hyper filtration. It is heartening to note that this process has undergone the most rapid development of any desalination technique. The fluids of different concentrations in a tank are separated by a membrane; the dilute solution will flow through the membrane into the concentrated solution. It is called osmosis.

[4] Lab scale setup of RO: I had taken the different results at different dates from the two membranes. Permeate from the RO is used for another process.

Image of Lab scale set up of RO



INLET PERMEATE REJECT CONDENSATE

SPECIFICATION OF RO:

- Flow rate –1.6 LPM
- Temperature- Ambient
- pH- 4 to 11

Pump Capacity

- Maximum Pump Output-140 PSI
- Maximum Pump Inlet Pressure-40 PSI
- AMP-1.2 A
- Volt-24 VDC

Membrane used for treatment of secondary treated effluent is given below:
1-Dow
2-CSM
Volume of effluent: 2 L,

MEMBRANE OPERATION LIMITS:

- Maximum operating temperature-45°C (113°F)
- Maximum operating Pressure-150 PSI (10 bar)
- Maximum Feed Flow Rate-7.6 lpm (2.0 gpm)
- Free Chlorine- <0.1 ppm
- pH- 4 to 11

Membrane which are used in the RO

Image of DOW membrane

Image of CSM membrane

Side view of membrane

[5] Results:

(1) Result of Dow membrane,

[1]Results of TDS in (mg/L)

Sr. No.	Date	INLET	PERMEATE	REJECT
1	29-12-2017	4270	142	4536
2	1-1-2018	4289	357	4496
3	2-1-2018	4260	305	4412
4	4-1-2018	3980	238	4235

[2]Results of COD in (mg/L)

Sr. No.	Date	INLET	PERMEATE	REJECT
1	29-12-2017	589.06	120.3	640.2
2	1-1-2018	591	90.2	673.6
3	2-1-2018	580.3	75.2	610
4	4-1-2018	341	192	440

[3]Results of Color in (cu)

Sr. No.	Date	INLET	PERMEATE	REJECT
1	29-12-2017	780	21.6	284
2	1-1-2018	760	14.6	189
3	2-1-2018	766	16	162
4	4-1-2018	1231	24.9	380

[4]Results of Turbidity (NTU)

Sr. No.	Date	INLET	PERMEATE	REJECT
1	29-12-2017	27.1	7.69	59.6
2	1-1-2018	26.9	6.14	45.6
3	2-1-2018	25.4	5.98	42.3
4	4-1-2018	10.9	2.86	26.7

(2)Results of CSM membrane:

[1]Results of TDS in (mg/L)

Sr. No.	Date	INLET	PERMEATE	REJECT
1	10-1-2018	3980	873	4310
2	17-1-2018	3987	468	4423
3	19-1-2018	3889	504	4337
4	22-1-2018	1080	123	4265
5	24-1-2018	868	110	2364

[2] Results of COD in (mg/L)

Sr. No.	Date	INLET	PERMEATE	REJECT
1	10-1-2018	341	11.73	422.4
2	17-1-2018	320	14.4	631.38
3	19-1-2018	355	28.8	890.3
4	22-1-2018	342	70	938.46
5	24-1-2018	496	41.6	990

[3]Results of Color in (cu)

Sr. No.	Date	INLET	PERMEATE	REJECT
1	10-1-2018	1260	0	178
2	17-1-2018	1226	19.3	558
3	19-1-2018	1150	14.9	1221
4	22-1-2018	1230	25.7	2111
5	24-1-2018	1290	14.8	2130

[4]Results of Turbidity (NTU)

Sr. No.	Date	INLET	PERMEATE	REJECT
1	10-1-2018	12.9	0.24	39.3
2	17-1-2018	16.9	0.52	28.6
3	19-1-2018	12.6	1.92	35.6
4	22-1-2018	11	0.09	20.3
5	24-1-2018	52.6	0	90.9

[6] Distillation unit: Before starting of simple distillation pH was maintain below 6.

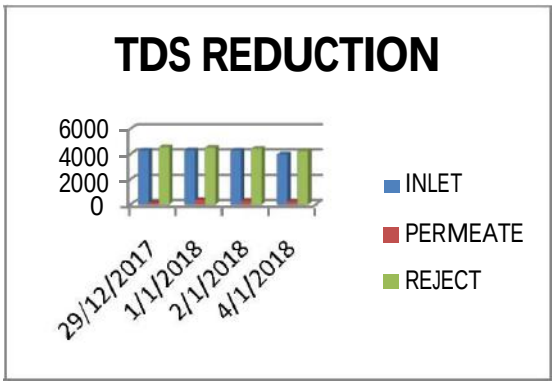
Image of maintaining pH

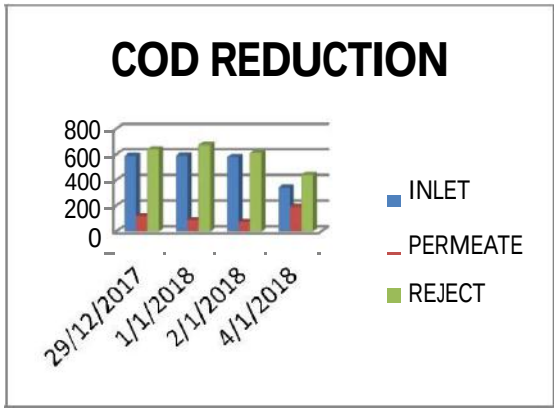
Image of Distillation unit

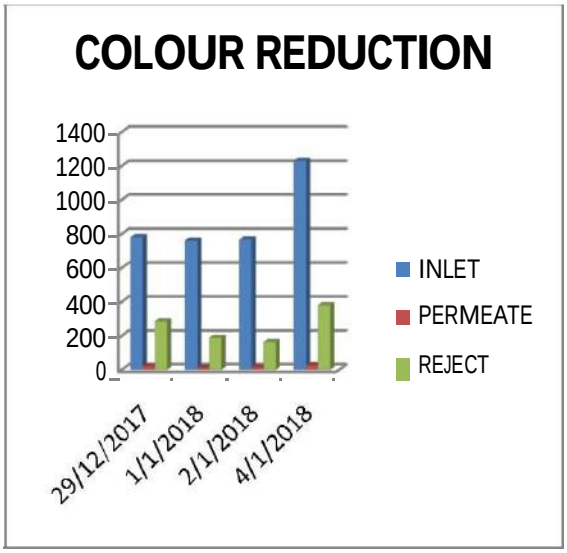
- Reject from the RO is treated by simple distillation.
- pH of the reject is maintained below 6 before distillation.(pH-5.58)
- Volume of reject is 100 ml, time taken for complete the process is 47:04. Condensate is 99 ml.
- Initial weight of flask-115g.
- After distillation weight of flask-115.5g. Remaining solids-0.5 g.

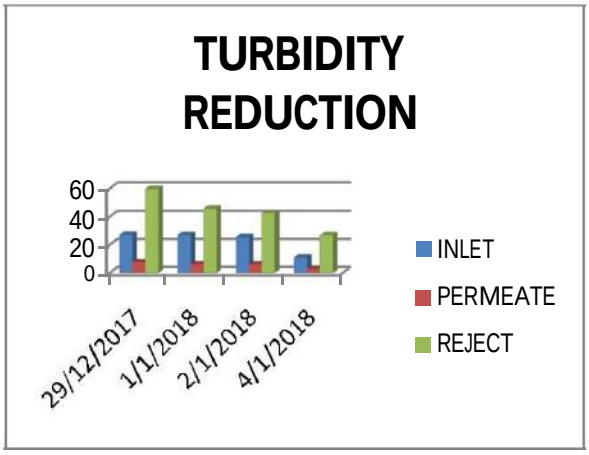
[7] Data Representation:

Results of DOW membrane:

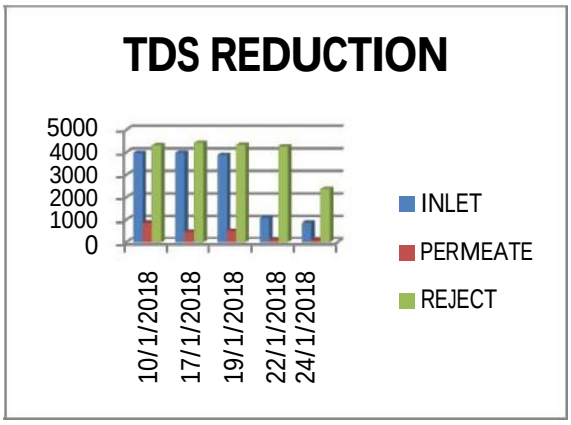


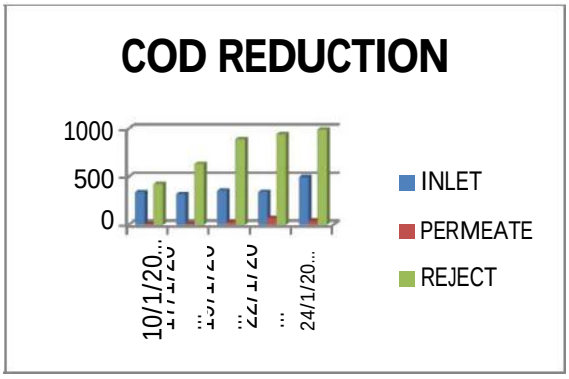


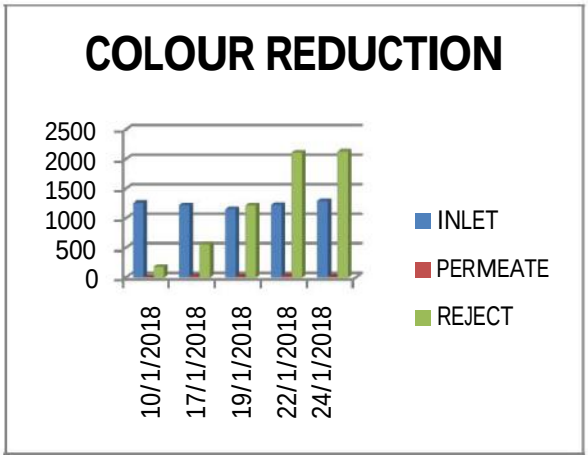


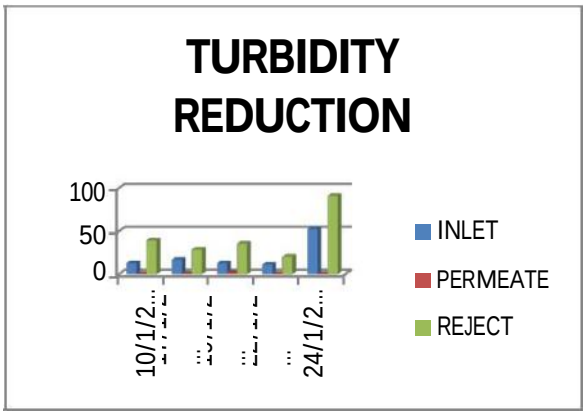


(2)Results of CSM membrane:









[8] Conclusion: The Chemical Oxygen Demand test is widely used as a means of measuring the organic strength of domestic and industrial wastes. This test allows measurement of a waste in terms of the total quantity of oxygen required for oxidation to carbon dioxide and water. It is based on the fact that all organic compounds, with a few exceptions, can be oxidized by the action of strong oxidizing agents under acidic conditions. The COD of the reject increase significantly, while the COD of the permeate is considerably low.

COD of condensate is below 70 mg/L, TDS is below 500 mg/L.

- From run 1 and 2, it was observed that permeate from the process is clean and it can be reused in the another process of industry. Reject from the process contain high COD and TDS so it can not directly used in the further process. Treatment is required so distillation was carried out for treatment of reject before distillation, pH was maintained below 6 for more reduction of TDS, COD, Turbidity, and Colour.
- From the graph-5 & 6, condensate is clean and reduce the TDS, COD, Turbidity, and Colour. It can also reused in the process.
- From the graph-1, CSM reduces more TDS than DOW.
- From the graph-2, DOW reduces more COD than CSM.

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