Nitto
Innovation for Customers

HYDRANAUTICS

REDUCE THE TREATMENT COST IN RO BASED ZLD SYSTEM IN TEXTILE INDUSTRY BY INCORPORATING PRO-XS1 NF MEMBRANES

Case study

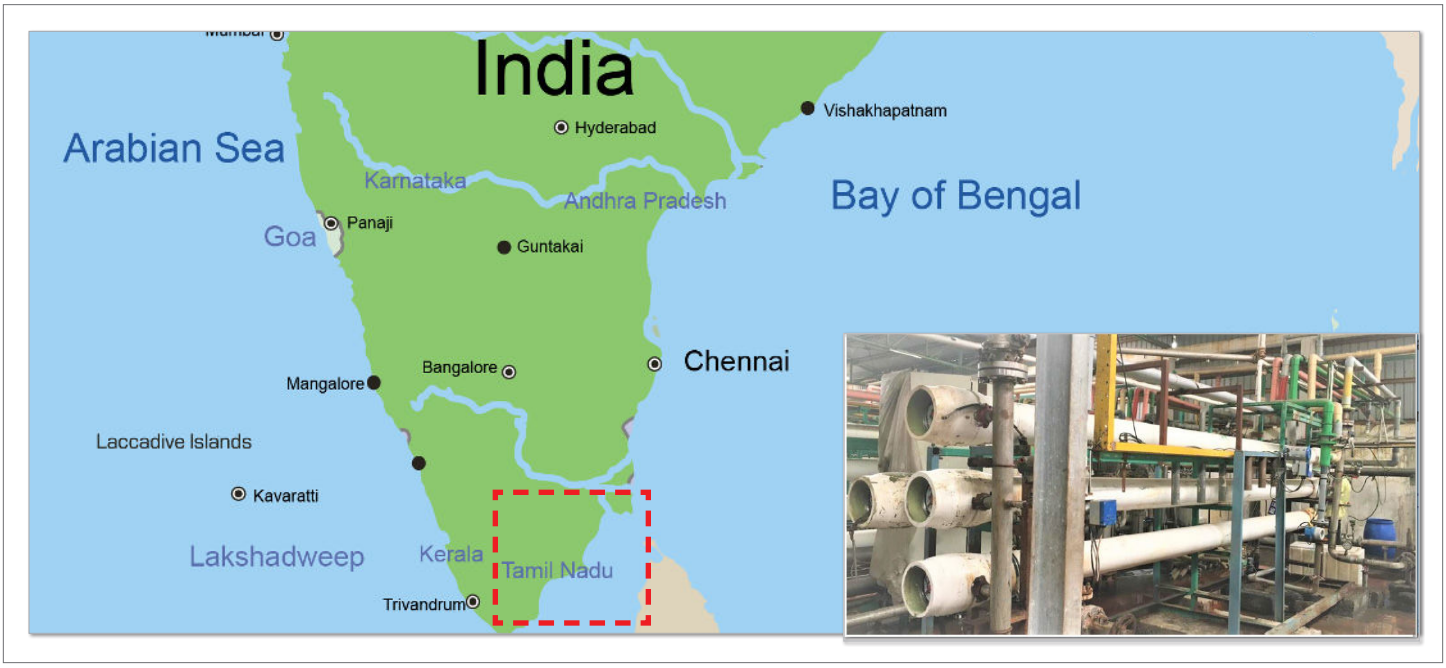
Reduce the operating cost of textile dyeing process by recycle and reuse the salt solution from waste water

The PROBLEM

Textile manufacturing involves the production or conversion of textile fiber through a defined process which includes sizing, desizing, scouring, bleaching, mercerization, dyeing, printing, chemical finishing, etc. The wastewater from the textile processes contains high TSS, fibers, TDS, BOD, COD, Color, starch, alkalis, and bleaching compounds. Because of their composition and variability, industrial wastewater is some of the most challenging water to treat for reuse.

But in regions experiencing extreme water stress, industries that had previously performed minimal treatment before discharging their wastewater are now being forced to use membranes to reclaim and reuse 100% through a ZLD process.

Depending on the type of textile being processed, effluent TDS can be in the range of 8,000ppm to 12,000ppm. COD levels can be in the range of 2,000 mg/l to 3,000 mg/l and BOD is in the range of 1000 to 2000 ppm and Sulphate is in the range of 3000 to 5000ppm



Depending on the textile processing capacity, the effluent treatment plant capacity is in the range of 500KLD to 4KLD and Multiple small textile unit in one region send their effluent to a Common Effluent Treatment Plant or CETP. Total CETPs in Tirupur textile belt are treating 100 MLD of wastewater and achieving ZLD.

The wastewater entering a wastewater treatment plant will undergo numerous pretreatment steps before going to the multistage RO to reduce the TSS, Color, Hardness, COD and BOD. At a minimum, the wastewater will undergo primary clarification, biological treatment, clarification, chlorination, dechlorination, softening and ultra-filtration for suspended solids removal.

After the multistage RO and other membrane-based processes recover 85% to 90% of the waste water, the remaining 15% to 10% will be treated through an evaporator and crystallizer to convert to solids. Earlier the recovered solids from evaporator is disposed in secured land filling because of high colour and mixed salts and also the challenges in the evaporator operation are more maintenance and frequent shutdown due to more number of rotating equipment and heavy scaling and higher power consumption, So evaporator operating cost is expensive and more than 6 to 8 times higher than RO membrane operational cost.

Evaporators consumes 20-25 kWh of power per m^3 of water treated and crystallizers consumes 52-66 kWh of power per m^3, but reverse osmosis system consumes at 1.5 to 6.0 kWh/m^3. Unfortunately, the current technology for treating the last portion of the RO brine before the evaporator is limited, costly, and requires high maintenance. A more efficient Nano filtration process was incorporated before thermal process to separate the sulphate stream and reduce the load on the thermal process.

The SOLUTION

Multi-stage RO systems is concentrated the reject based on the limitation of maximum feed pressure and Salt saturation limit and fouling tendency. The existing systems is five stage RO system and concentrating the TDS to about 65,000 mg/l. RO reject contains 30000 mg/l of sulphate , 2500 PtCo of colour,2000 mg/l of COD and 150 mg/l of total hardness. To separate the sulphate for reuse in dying process, Hydranautics developed a new, Nano filtration membrane, PRO-XS1, that can operate up to 82.7 bar (1200 psi) at 25 C. This allows to concentrate the TDS up to 150,000 mg/l or higher.

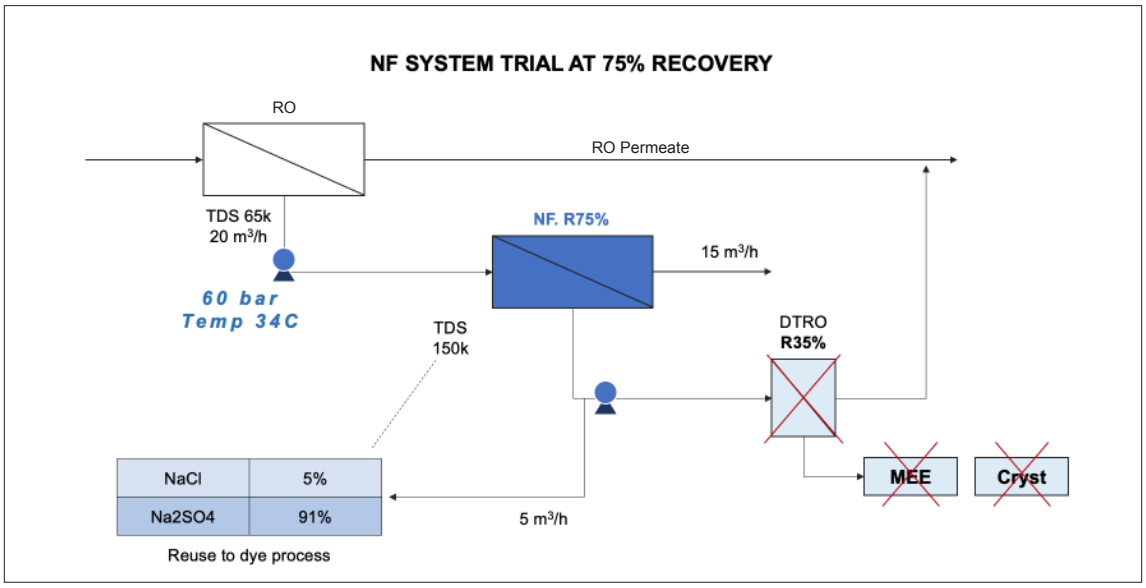
To demonstrate the feasibility of this new Nano filtration membrane PRO-XS1 for study the maximum possible separate the sulphate salt solution from existing RO reject in the textile processing unit, Hydranautics proposed to replace the RO membrane to NF membrane(PRO-XS1) in 5th stage RO for avoid the capital cost and conduct the study. 5th Stage RO plant is having five elements long 3 vessels with 20m3/h feed capacity of plunger pump system which was used to conduct the trial of PRO-XS1.

Study done using 15 Nos PRO-XS1 NF membranes installed in three pressure vessels in parallel.

This plant operated continuously at 50% recovery because of single stage system and achieved 95,000mg/l of TDS in the NF reject which is more that 95% of sulphate salt contribution. The Dying process is required 140,000mg/l solution for better colour absorption, so partially treated in MEE to increase the concentration as per the dying process requirement and reduced the treatment cost around 20% of earlier treatment cost.

Arranged the reject recirculation line to demonstrate to operate at 75% recovery. 65,000 mg/l of TDS of RO reject water concentrated to 1,57,000 mg/l of TDS at 75% recovery and recommended to install second stage of NF system for continuous operation to save 85% of exiting treatment cost by reduce the evaporator operational hours, reuse the salt solution and avoid the raw material cost of buying Globar salt.

The existing 5th stage RO system was converted to a nanofiltration system which operated at a feed flow of 20 m^3/h, a flux of 19 LMH and a recovery of 50%. An additional vessel was added to reduce the flux to 13 LMH to minimize the fouling from organics and TSS. The Customer is planning to further increase the capacity to 40 m^3/h using two more stages of PRO-XS1.



Parameter	Feed (ppm)	Perm. (ppm)	Conc. (ppm)
TDS	65,500	22,200	157,000
TH	140	8	560
Cl	8,933	9,926	4,963
SO_4	31,860	2,400	96 g/l
COD	2,620	400	9,600

The IMPACT

After existing multi-stage RO, incorporated the NF system, So we can further reduce the flow to the evaporator and crystallizer by 50% to 80% because only NF permeate can be treated in the thermal process, So the corresponding reduction in the size of the evaporator/crystallizer will reduce both capital cost and operating costs. Assuming the thermal, originally designed to treat 10 m^3/hr were reduced in capacity by 50% to treat only 5 m^3/hr. Assuming evaporator operational cost is INR 350/m^3; operating 300 days/year; 20 hours/day, the total operational cost would be INR 21,000,000/year for 10 m^3/h flow rate evaporator system. Assume that NF recovery is 50%, then saving will be maximum 50% from the total evaporator operational cost by using PRO-XS1 NF membrane which is INR 10,500,000/year. PRO-XS1 NF plant operational cost is INR 35~45/m^3, so additional cost for operating NF system would be INR 2,700,000/year, So total saving is INR 7,800,000/year which is less than one year of return of investment and apart from that solid disposal cost is saved and raw material cost also saved

Treating and reclaiming textile wastewater is both challenging and costly, especially when seeking to achieve zero liquid discharge (ZLD). The overall cost of textile processing was reduced at one plant by installing the innovative, PRO-XS1, membrane after a multistage RO to recover raw material from the textile waste water. By using PRO-XS1, the customer was able to separate the sulphate salt solution and further concentrate the solution to a level that meets the dying process requirements. Using PRO-XS1 also reduced the waste stream flow to the evaporator and crystallizer. At the same time, a colorless sodium chloride solution was recovered from the PRO-XS1 permeate and sold as a valuable byproduct. This study successfully achieved 157,000 mg/l of TDS in the PRO-XS1 reject while operating at a maximum feed pressure of 60 bar at 34C. Pretreatment before the NF was crucial for reducing fouling. The use of the PRO-XS1 in the ZLD process reduced the total water cost at the 2 MLD textile plant by $107,000 per year. The PRO-XS1, with its ability to run at pressures up to 83 bar, can be used on any high sulphate stream to increase the salt concentration and reduce treatment cost.

Authors

YASUHIRO TOMI
MANIKANDAN VASUDEVAN