

Toray's Membrane Technologies Achieve Zero Liquid Discharge in India's Special Economic Zone

BACKGROUND

Zydus Infrastructure operates the Pharmez Special Economic Zone (SEZ) near Ahmedabad, where a 'common effluent treatment plant' (CETP) collects industrial wastewater from 12 pharmaceutical sites, treating it via clarification, followed by a 750 KLD membrane bioreactor (MBR) process.

Due to ongoing operational issues, the MBR modules required replacement. However, a Zero Liquid Discharge (ZLD) process would be integrated to meet the increasing demand for clean water within the SEZ and compliance with environmental policies. The engineering firm, Haskak Water Pvt. Ltd. was selected to design and build the ZLD process system using Toray's reverse osmosis (RO), nanofiltration (NF), and MBR membrane technologies.

MEMBRANE BIOREACTOR

In 2017, Haskak commissioned a new MBR system with 1.5 MLD capacity using Toray's MEMBRAY™ MBR flat-sheet membrane modules. A year later, the existing 750 KLD MBR system expanded to 3.0 MLD to meet production capacity and ensure the continuous production of filtered water should one of the MBR systems require downtime for maintenance. Illustrated in Figure 2 is the complete ZLD system.

MEMBRAY™ MBR modules use durable PVDF microfiltration flat-sheets with uniformly sized pores (0.08 μm) densely distributed along the membrane surface. MEMBRAY™ provided the following benefits to Pharmez SEZ:

- Enhanced fouling and chemical resistance;
- Elimination of a backwash process, simplifying maintenance and energy-savings;



Figure 1: MBR tank

- Conversion from a suction pump to a gravity flow process further minimizing energy costs;
- Approximately 70% reduction in sludge.

Before the MBR process, PVA (polyvinyl alcohol) gels are added to the aeration tank to reduce the volume of sludge, improve MBR outlet parameters, and minimize system footprint (Figure 3).

HIGH-RECOVERY RO/NF DESIGN

The filtrate from the MBR is chlorinated, treated by activated carbon, and de-chlorinated before entering the RO system. Due to elevated levels of Chemical Oxygen Demand (COD) in the RO feed, the 1st-stage RO system uses ROMEMBRA™ "Durable" D-Family low-fouling RO membrane elements to combat membrane degradation, and maintain performance for day-to-day operations and cleanings.

Designed to operate reliably under high salinity feedwater conditions, ROMEMBRA™ seawater membranes reduce the TDS content from 13,000 to 200 ppm in the 2nd-stage.

CSM™ NF membranes maximize water recovery by concentrating the brine from 75,000 ppm (4th-stage RO concentrate) to 92,000 ppm. Lastly, multi-effect evaporation crystallizes the salts completing the ZLD process for a total water recovery of 97.1%.

Within the high-recovery RO/NF system, the exponential increase of salt concentrations heightens the risk of membrane scaling. The RO system is dosed with Toray's ROPUR RPI® antiscalants to prevent irreversible scaling, minimize system downtime, and optimize the recovery performance of the membranes. Compared to the previously used antiscalant, only half the dosage of ROPUR RPI is required, further contributing to cost-savings.

Table 1 — Toray water treatment technologies

Technology	Toray Brand	Model	Quantity
MBR	MEMBRAY™	TMR140-200D	14
		TMR140-100S	36
Low-fouling RO	ROMEMBRA™	TML20D-400	96
Low-energy SWRO		TM820V-400	36
NF	CSM™	NE8040-70	8
Antiscalant	ROPUR RPI®	RPI 3000A	

Table 2 – Water Quality

Parameter	A: Feed influent	B. MBR influent	C. MBR filtrate	D. 1st stage RO feed	E. NF feed	F. Final RO permeate
Flow rate (KLD)	4,500	4,500	4,500	1,500	45	1,455
TSS (ppm)	280	100	<1	BDL		
Turbidity (NTU)		<50	<1			
BOD (ppm)	450	450	<3			
COD (ppm)	1,200	1,200	<25			
TDS (ppm)	2,000	2,000	2,000	2,000	75,000	<250

Figure 3 : Aeration and MBR tanks

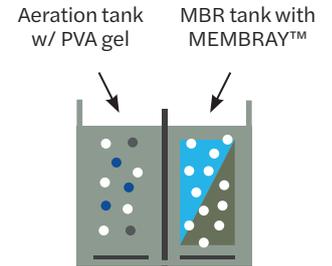
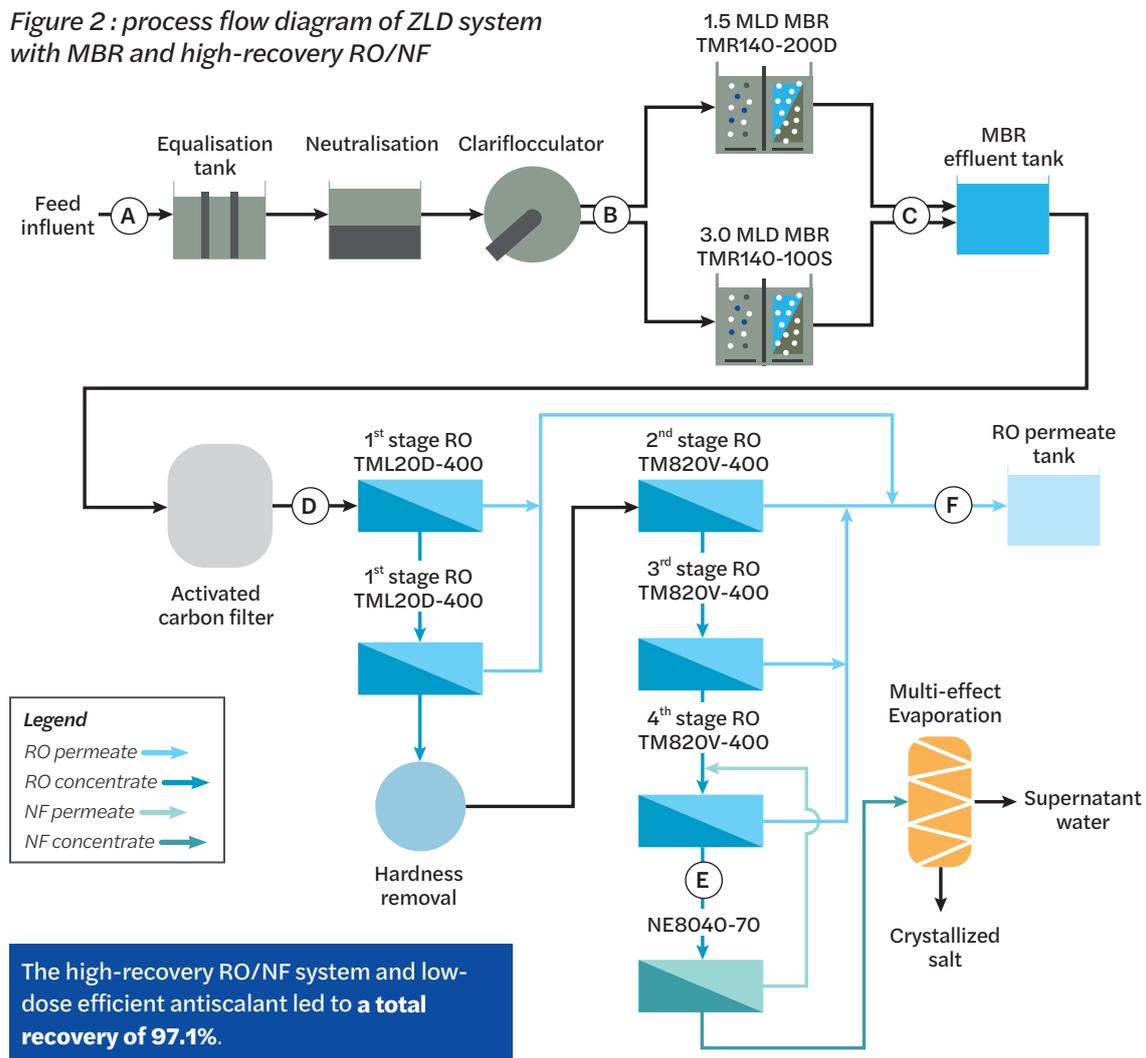


Figure 2 : process flow diagram of ZLD system with MBR and high-recovery RO/NF



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