



HELPING COAL-TO-CHEMICAL MLD PLANT TO ACHIEVE STABLE PERMEATE QUALITY

Case study

Using PRO-LF1 and PRO-XP1 membranes to reduce high TDS and high COD brine effluent volume in a CTX MLD project in China

PROBLEM

A Coal-to-Chemical (CTX) company in China produces methanol from coal. The annual production capacity of the plant is 500,000 million. Initially, the plant only constructed a reclamation system to reuse process and circulating wastewater. Brine water was discharged into an evaporation pond. But due to the limited volume of the evaporation pond, a MLD system was installed in August 2018 to treat 100 m³/h high TDS, high COD brine water. With two stages RO concentration systems, the brine water was reduced to 25 m³/h and then discharged to evaporation pond. RO permeate water is reused as

circulating water. The process is shown in Fig.1; system configuration is shown in Table1.

Initially the plant was using the high-pressure RO and ultra-high-pressure RO membranes of Brand A. After a year of operation, RO systems rejection rate reduced to 90-93%, CIP was required in every 3-5 days unlike initially once per month. Hence the customer decided to replace the elements and looked for the elements which have stable rejection rate, improved anti-fouling technology, longer life and can reduce the number of CIPs.

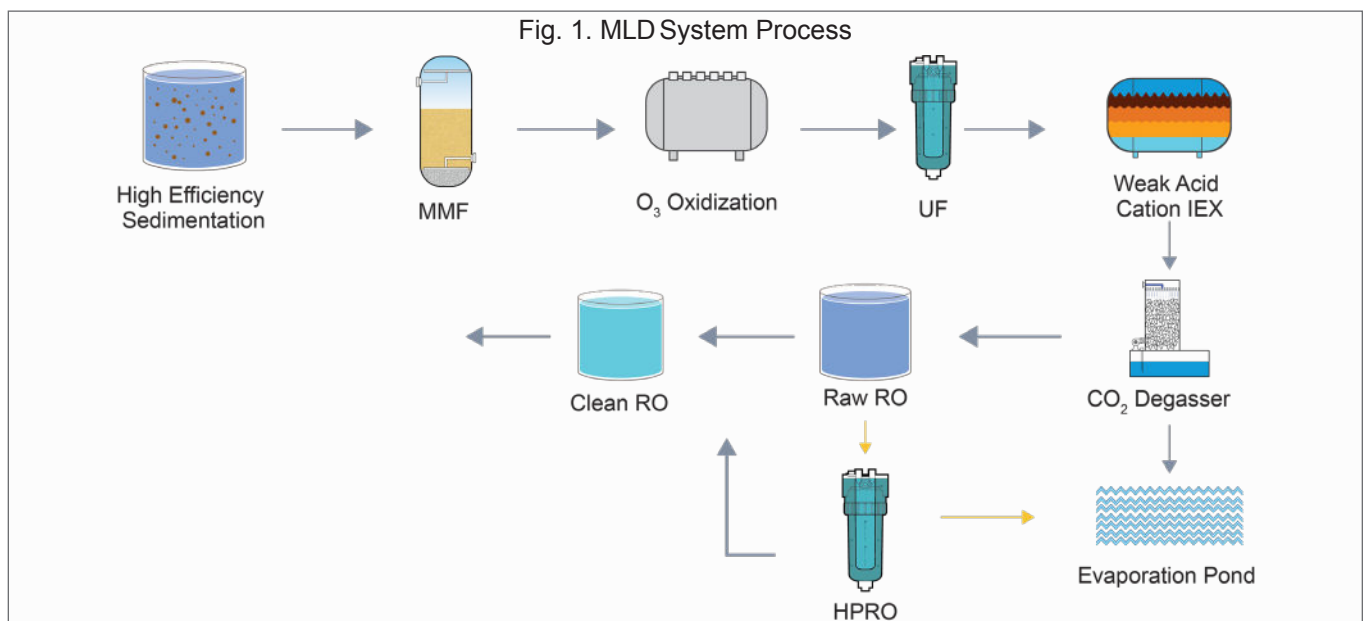


Fig. 1. MLD System Process

Table 1. Two concentration RO systems configuration

	Raw RO system	HP RO system
Design flowrate (m ³ /h)	30 x 2 trains	7.5 x 2 trains
Design recovery (%)	56	31.9
Array	(6:3) PV x 6M	(2:2) PV x 6M

The SOLUTION

Based on original RO models, Hydranautics recommended equivalent models PRO-LF1 for raw RO and PRO-XP1 for HPRO. PRO series elements are high-performance specialty membranes tailored to meet the challenges and issues faced by wastewater treatment plants. PRO-LF1 is neutrally charge and hydrophilic, which minimizes organic fouling absorption, enhances anti-fouling performance. Through strict selection and enhanced element

configuration, robust PRO-XP1 can operate pressure up to 12.4 MPa. It exceeds normal high-pressure RO kept decades' pressure limit of 8.27 MPa. PRO-XP1 can concentrate the NaCl to 12%, and can reduce brine water volume by 50% than the normal RO. It can significantly reduce CAPEX and OPEX by downsizing 50% evaporation system treatment volume.

The IMPACT

PRO-XP1 train started up in January 2020. The typical feed and permeate quality is shown in table 2. With feed COD_{Cr} 300-1000 mg/L, PRO-XP1 conducted the first CIP after two months of operation. pH11.5 caustic and pH1.5 acid solutions were used in the CIP. System Differential Pressure (DP) restored from 4.8 bar to 3.7 bar after cleaning. The first stage DP decreased from 2.8 bar to 2.2 bar and the second stage DP decreased from 2 bar to 1.5 bar.

During April to May, ozone oxidization system encountered some problems, resulted in HPRO feed COD_{Cr} > 2,000 mg/L. System DP sharply increased to 7.3 bar. End-user tried cleaning the system through harsher cleaning solutions and took longer contact time to reduce DP (Fig. 2). Although in the six months of early operations feed quality fluctuated, but PRO-XP1 system normalized the salt passage which mostly remained < 1% and also normalized the rejection rate which remained higher than 99% (refer to Fig. 3).

Table 2. Typical feed and permeate quality of HPRO system

Items	Unit	PRO-XP1 Membrane		Items	Unit	PRO-XP1 Membrane	
		Feed	Permeate			Feed	Permeate
TDS	mg/L	42,300	436	Cl ⁻	mg/L	2,020	203
NH ₃ -N	mg/L	2.19	0.142	SO ₄ ²⁻	mg/L	4,710	22.5
Ca ²⁺	mg/L	12.6	<0.02	NO ₃ -N as N	mg/L	250	9.35
Mg ²⁺	mg/L	17.8	0.1	F ⁻	mg/L	7.8	0.186
Na ⁺	mg/L	13,800	160	SiO ₂	mg/L	48.7	0.28
K ⁺	mg/L	140	2.69	pH	-	8.1	6.58
HCO ₃ ⁻ as CaCO ₃	mg/L	1,677.5	13.66				

Fig. 2 PRO-XP1

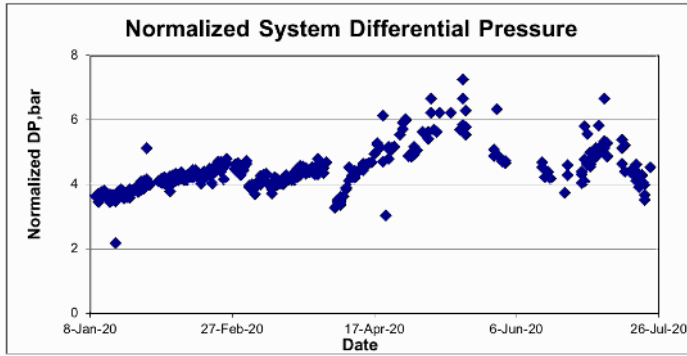
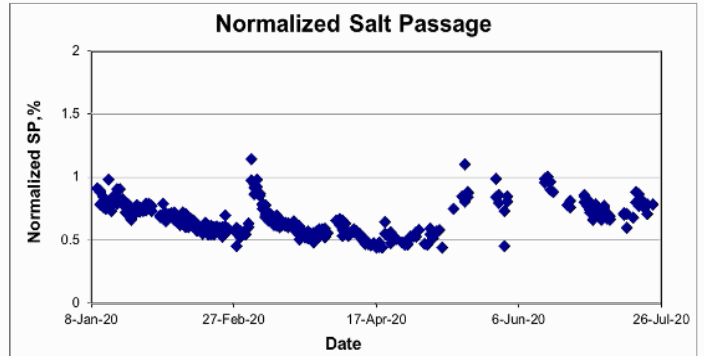


Fig. 3 PRO-XP1



PRO-LF1 train started in May 2020. Before replacement, the first stage differential pressure of Brand A RO was as high as 8 bar, feed EC was 44,500 $\mu\text{s}/\text{cm}$, permeate EC 4,240 $\mu\text{s}/\text{cm}$, rejection was only 90%. After the train was replaced with PRO-LF1 elements, the first stage DP reduced to 1bar, rejection was around 99%. In the feed

CODcr 500-1,200 mg/L condition, PRO-LF1 system normalized DP increased 50% to 1.5 bar after two months and conducted the first CIP. With general acid and caustic solutions, normalized DP reduced to 1bar (Fig.4). The normalized salt passage has kept less than 1% (Fig. 5).

Fig. 4 PRO-LF1

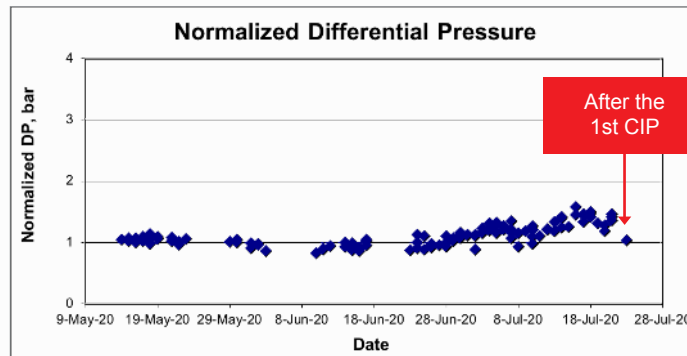
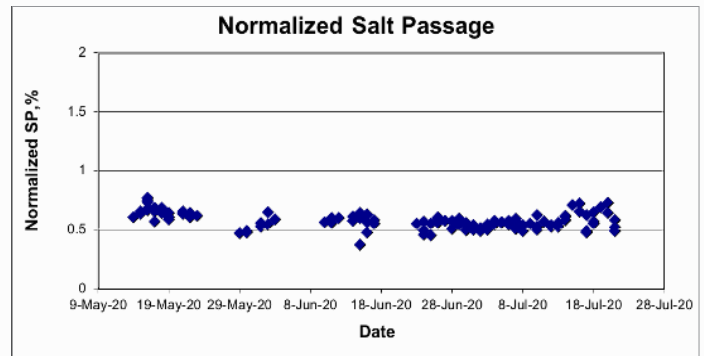


Fig. 5 PRO-LF1



PRO-XP1 and PRO-LF1 were chosen to replace brand A's equivalent elements in the CTX MLD project. After the installation of PRO-XP1 and PRO-LF1 elements, rejection rate increased to 99% from 90-93%.

CIP frequency reduced from once per 3-5 days to once per 30-60 days, that is 10 times decrease in CIPs. The performance of PRO series elements' surpassed the expectations of the customer.

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About Hydranautics

Since our founding in 1963, Hydranautics has been committed to the highest standards of technology research, product excellence and customer fulfillment. Hydranautics entered the Reverse Osmosis (RO) water treatment field in 1970 and is now one of the global leaders in Integrated Membrane Solutions. Hydranautics became a part of the Nitto Group in 1987. Nitto is Japan's leading diversified materials manufacturer. The group offers over 13,000 high value specialty products worldwide including optical films for liquid crystal displays, automotive materials, reverse osmosis membranes for desalination and transversal drug delivery patches.

As leaders of high quality membrane solutions, we believe our commitments extend beyond manufacturing and selling our products. Our skilled staff of technicians, engineers and service professionals assist in designing, operating and maintaining a robust, reliable and efficient membrane system to meet your requirements and exceed your expectations.