TechBrief

Liqui-Cel® MEMBRANE CONTACTORS

Chemical Cost Comparison of a Conventional Deaerator vs a Liqui-Cel® Membrane Contactor System

Mixed bed ion exchange is often used to polish Reverse Osmosis (RO) permeate in many industrial water systems. This process has been utilized for several years and it is well known that the management of the dissolved Carbon Dioxide (CO2) in the water is critical for an efficient operation.

CO2 typically accounts for the largest anion load in a DI system and it is normally handled using one of the following methods:

1) Conventional degasifying unit, such as a Forced Draft Tower
2) Liqui-Cel® Membrane Contactors

This technical brief compares the performance and operating costs of membrane contactors with conventional forced draft tower technology for CO2 removal. This brief will also show why membrane degassing is the economical and value added technology of choice for oxygen and carbon dioxide removal from water.

This comparison is based on an actual water system currently operating at a plant in China. The system consists of three 110 m^3/hr lines each line consisting of an RO+Mixed Bed system. Due to high chemical (HCL and NaOH) regeneration costs the plant considered deaerating the water prior to the Mixed Bed. The plant evaluated two system designs:

RO+Forced Draft Degassing Tower+Mixed Bed and RO+Liqui-Cel®+Mixed Bed.

Lanxess' Lewatit 4.17 software was used to size the mixed-beds and calculate the chemical consumption for three 110m^3/hr system designs:

1) RO+Mixed Bed (Current System)
2) RO+Forced Draft Tower+Mixed Bed
3) RO+Liqui-Cel®+Mixed Bed

The software was validated by comparing the actual chemical consumption at the plant to the chemical consumption calculated by the software. The calculation was verified as matching the actual operating consumption.

Table 1: Mixed Bed Regeneration Chemical Consumption Per Cycle

					Chemical Consumption per Cycle		Neutralization HCL Consumption
System Configuration	Outlet CO2	MB Size	MB Gross Product Water	Net Volume	30% HCL (Kg)	100% NaOH	30% HCL
Without CO2 Removal	20 ppm	D2700xH3700	2755 m^3 (727,794 gal)	2640 m^3 (697,414 gal)	860	516	556
With CO2 Removal (FDA Removal)	8 ppm	D2400xH3350	2723 m^3 (719,341 gal)	2640 m^3 (697,414 gal)	620	372	450
With CO2 Removal (Liqui-Cel)	1.5 ppm	D2100xH3300	2702 m^3 (713,793 gal)	2640 m^3 (697,414 gal)	466	278	376

Notes:

1) Forced Draft Tower outlet CO2 was set as 8.0 ppm taking into account seasonal temperature fluctuations impacting the towers performance in cooler weather.
2) Liqui-Cel® CO2 outlet was set at 1.5 ppm to reduce capital costs of the system. Lower CO2 outlets are achievable and may be considered depending on the needs of the plant.

As shown in table 2 the chemical cost savings of using a membrane system are over 120,000 RMB (15,578 USD) per year compared to a traditional deaeration system. This figure does not even include the added costs associated with waste water treatment and additional water required to operate the larger IX systems. There can also be additional capital cost savings because a smaller mixed bed system can be considered.

Membrane systems also have additional value added benefits to consider. The membrane acts as a barrier between the gas and liquid phase. This prevents particles and other contaminants in the air from contaminating the RO permeate. This is especially important in an environment where a deaerator may not be practical due to ambient air contamination. The membrane system is also modular and can be easily expanded to meet plant water demand growth.

Table 2: Chemical Costs Per 110 m^3/hr System

System Configuration	30% HCL Consumption (metric ton)	HCL Cost[1] RMB (USD)[3]	NaOH Consumption[2] (metric ton)	NaOH Cost RMB (USD)	Total Regeneration Cost[4] RMB (USD)	Total Yearly Regeneration Cost[4] RMB (USD)
Without CO2 Removal	1.416	878 (129)	0.516	1032 (151)	1910 (280)	697,150 (102,138)
With CO2 Removal (FDA Removal)	1.070	663 (97)	0.372	744 (109)	1407 (206)	513,555 (75,240)
With CO2 Removal (Liqui-Cel)	0.842	522 (75)	0.278	556 (81)	1078 (158)	393,470 (57,647)

Notes:
1) HCl costs based on 620 RMB/metric ton ($91/metric ton)
2) NaOH costs based on 2000 RMB/metric ton ($293/ metric ton)
3) Conversion rate for RMB to USD was 0.146481 on 11/2008
4) Total costs are based on 365 days/year

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