

**RECLAMATION OF
PRODUCED WATER USING
REVERSE OSMOSIS**

Case study

*Producing Highest Permeate Quality using RO
Membranes in Upper Stream Oil and Gas Process*

The

PROBLEM

Produced water is the waste effluent that is brought to the surface as part of the oil and gas extraction process. The composition of produced water varies as a function of geological formation, water used for injection, and the hydrocarbon properties present in various reservoirs. Despite the variability in exact composition, all produced water will contain high levels of dissolved salts and other organic and inorganic contaminants.

Both the high volume of produced water generated during extraction, along with the water's poor quality, makes it challenging to

treat or even dispose of it in a way that will conform with its strict governing regulations. Historically, the primary method for dealing with produced water is reinjection; however, this process is limited by the capacity of the injection well which in turn limits the capacity of oil production.

An oil production field in California generated more than eight barrels of produced water for every barrel of oil during their extraction process. The full development of their oil field had been restricted due to the limited capacity of their injection zone.



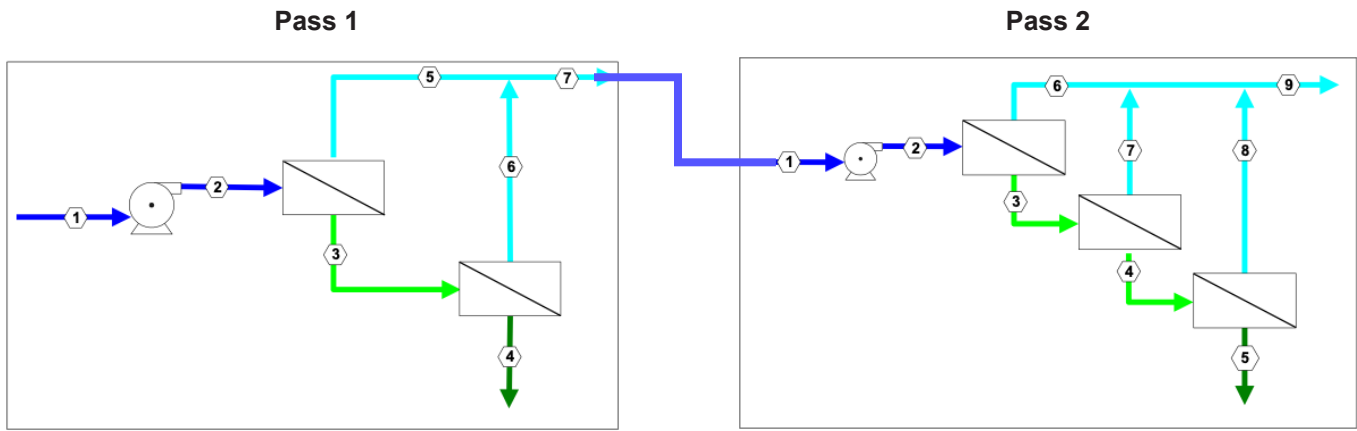
The

SOLUTION

To increase their oil production capability, a two pass RO treatment facility was commissioned to allow a portion of the produced water to be treated and discharged to a shallow freshwater aquifer. In order to produce the highest permeate quality, SWC5-LD membrane elements were installed.

Due to the high fouling nature of the produced water, extensive pretreatment was implemented

before the RO. The pretreatment included: oil removal, hardness reduction, and reduction of suspended solids. The water temperature was then decreased below 45°C to stay within the operation limits of standard RO membranes before caustic injection to raise incoming pH to avoid silica scaling and organic fouling.



	Pass 1	Pass 2
Membrane	SWC5-LD	SWC5-LD
pH	10.7	11.2
Temp (C)	37	35-43
Feed	45.0 ppb of mixed hydrocarbons 6860 ppm TDS 60 ppm TOC SDI = 1 to 6	Permeate from Pass 1 500 to 600 ppm TDS 1.7 ppm TOC
Trains	3	3
Stages	2	3
Total Elements per Pass	252	108
Recovery (%)	80	90

The

IMPACT

The produced water reclamation two pass RO system generated high quality permeate water with significantly reduced concentrations of Boron, Chloride, Nitrate, Sodium and Sulfate.

The first pass SWC5-LD elements generated a stable, high quality permeate over two years of operation when treating the high fouling produced water. After being further treated by the second pass RO system, the system's final permeate quality was significantly better than what the oil field's WDR permit limits required for surface discharge.

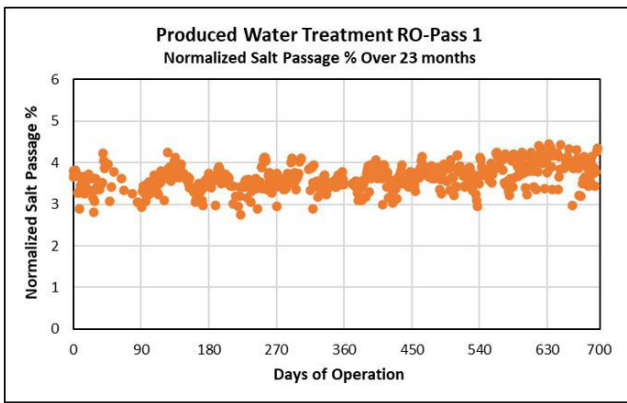
By utilizing RO membranes to treat their produced water, the California oil field was no longer chained to the capacity of their injection wells and were free to further increase their production capacity.

The first pass SWC5-LD elements in this application were cleaned once every 3 to 6 months as needed and the second pass RO elements were able to run without cleaning for the first 2 years. For this application, the typical life of the first pass SWC5-LD elements has been 2 to 3 years when treating the high fouling produced water. The second pass elements can last for 5 to 7 years treating the very high quality permeate from the first pass.

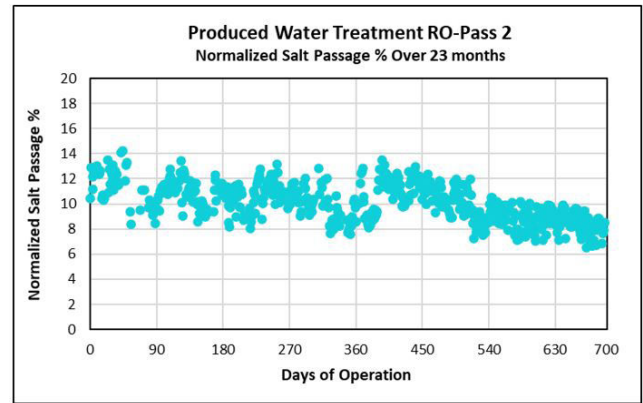
Produced water that is reclaimed and treated with RO can be used for environmental augmentation, agriculture irrigation, boiler feed, surface discharge, and ground aquifer replenishment.

Hydranautics RO membranes have been successfully reclaiming high fouling produced water in central California since 2007.

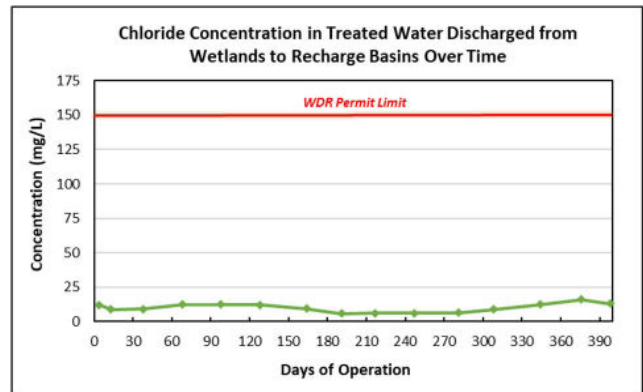
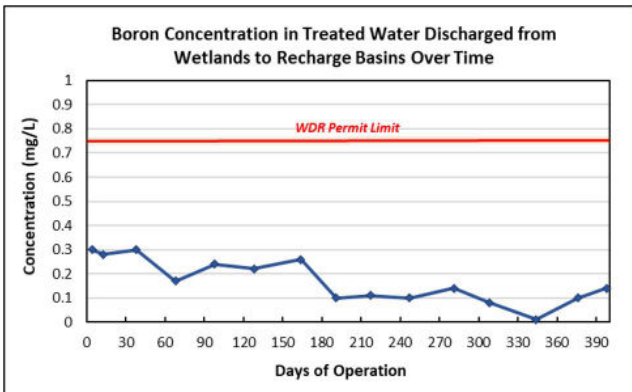
Pass 1 Performance



Pass 2 Performance



Water Quality of Final Effluent Discharged to Wetlands



For more information about Hydranautics case studies, contact us at hy-marketing@nitto.com or visit our website at membranes.com

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.