

Sulfate Removal System

Effectively and efficiently remove divalent sulfate ions from seawater down to the required level for injection

APPLICATIONS

- Removal of divalent sulfate ions from seawater to enable injection

ADVANTAGES

- High-quality injection water
- Avoidance of well workover
- Reduced HSE hazards
- Reduced need for biocides
- Reduced scaling in piping and equipment
- More effective squeeze treatments
- Control of bacterial well souring
- Lower operating costs
- Increased productivity

Increased technological and environmental demands are being placed on the oil and gas industry to find cost-effective methods to control scale formation apparent as a result of waterflood.

Where seawater contains sulfate and formation water contains barium and strontium, there is a potential for significant barium and strontium sulfate scaling and reservoir souring. Scale deposits are a common problem in water injection, and the type and severity of scaling varies between fields.

Sulfate reduction technology can help solve the problem at the source, allowing increased productivity and lower operating costs. Removing sulfate before injection reduces the potential for barium and strontium sulfate scaling and helps to prevent reservoir souring.

Schlumberger offers membrane separation solutions for sulfate removal, either as stand-alone or turnkey systems depending on the customer's specific requirements. The solutions provide a cost-effective solution for

- vertical production wells
- gravel-pack wells
- dilution water in HPHT environments
- horizontal wells with subsea tiebacks
- floating production systems
- reservoir souring control.



Modules for Shell Ursa field, Gulf of Mexico.



One of seven sulfate reduction modules capable of producing 50,000 bbl/d (330 m³/h) of low-sulfate seawater for Kizomba A Field, West Africa.

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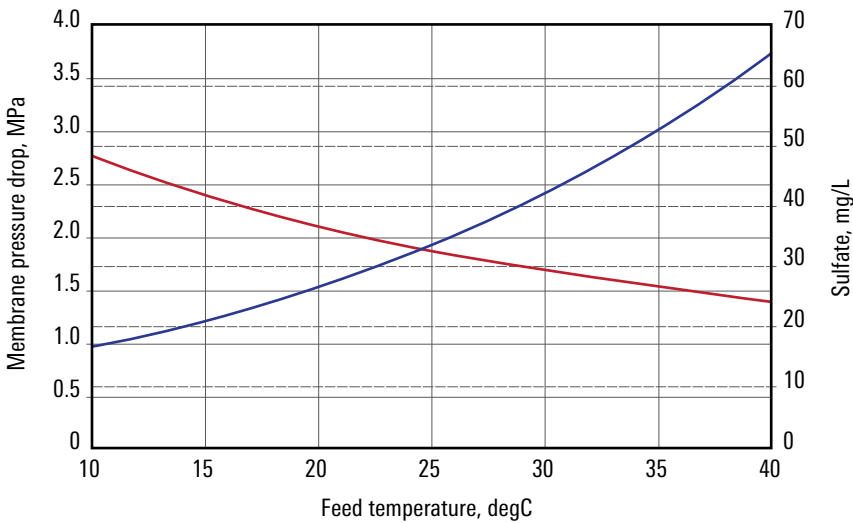
Membrane separation is a method of sulfate reduction that is efficient and environmentally sound.

The low-sulfate seawater product is typically in the order of 40 mg/L and dependent on water temperature and other operating parameters. The percentage of product from feedwater is 75%.



First sulfate reduction package installed on floating production unit.

Sulfate Removal Package (One Pass, Two Stage)			
	Feed, mg/L	Reject, mg/L	Permeate, mg/L
Potassium	460	583	419
Sodium	10,897	13,461	10,042
Magnesium	1,368	5,269	68
Calcium	428	1,495	72
Strontium	8	30	1
Carbon trioxide	13	44	4
Bicarbonate	124	255	80
Chlorine	19,700	30,443	16,119
Sulfate	2,960	11,750	30
Silicon dioxide	1	3	0
Carbon dioxide	1	1	1
Total dissolved solids	36,959	63,332	26,835
pH	8	8.17	7.81



Typical sulfate reduction plant — performance vs. temperature.

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Cost savings

Overall, the efficient removal of sulfate by membrane separation can reduce the risk of lost and deferred production. Considerable cost savings can be gained by the reduction, and in some cases elimination, of ineffective squeeze treatments.

The process is also considered the best overall solution given the complex nature of many recent developments—barium-present, deep subsea wells; long perforation intervals; and monitoring challenges.

Complete systems

To gain the maximum performance from membrane separation systems, correct pretreatment is important. It is normally recommended that the pretreatment and membrane packages are managed as a single system because of the complex process, control, and operating interfaces.

After-sales service

Deployed by a dedicated team of experienced personnel, our service agreements include

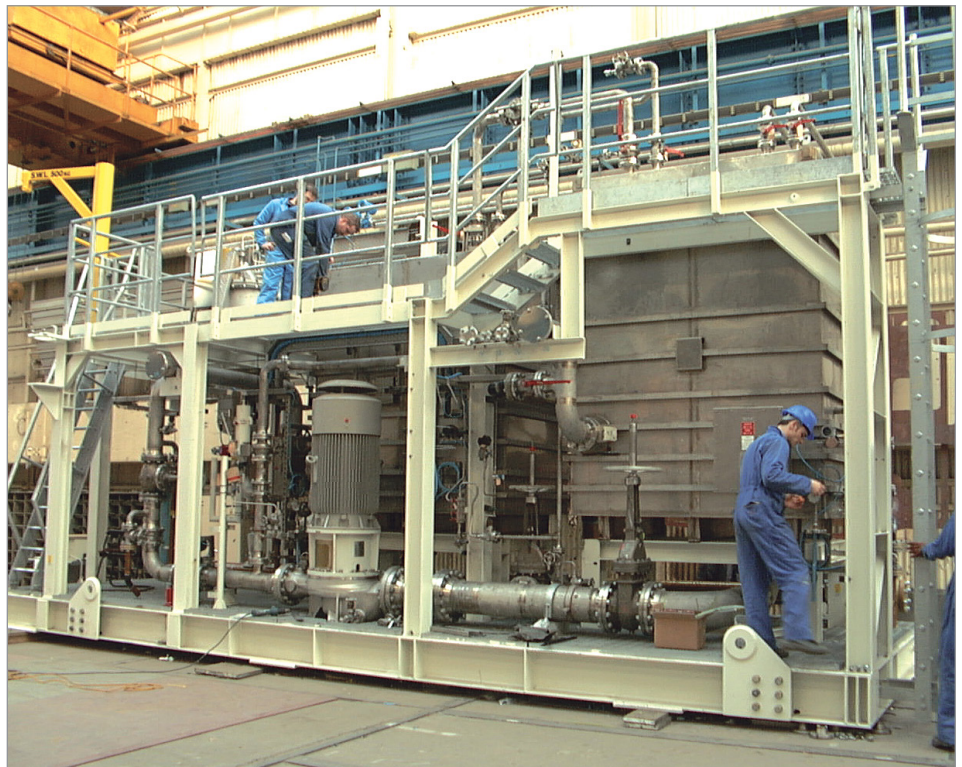
- monitoring and diagnostic analysis of equipment performance
- prompt mobilization of onsite engineering assistance
- planned maintenance and survey regimes
- regular customer training of operational personnel.

Training

Schlumberger has the resources to provide both bespoke formal classroom and onsite training on the practical aspects of operating and maintaining these systems.

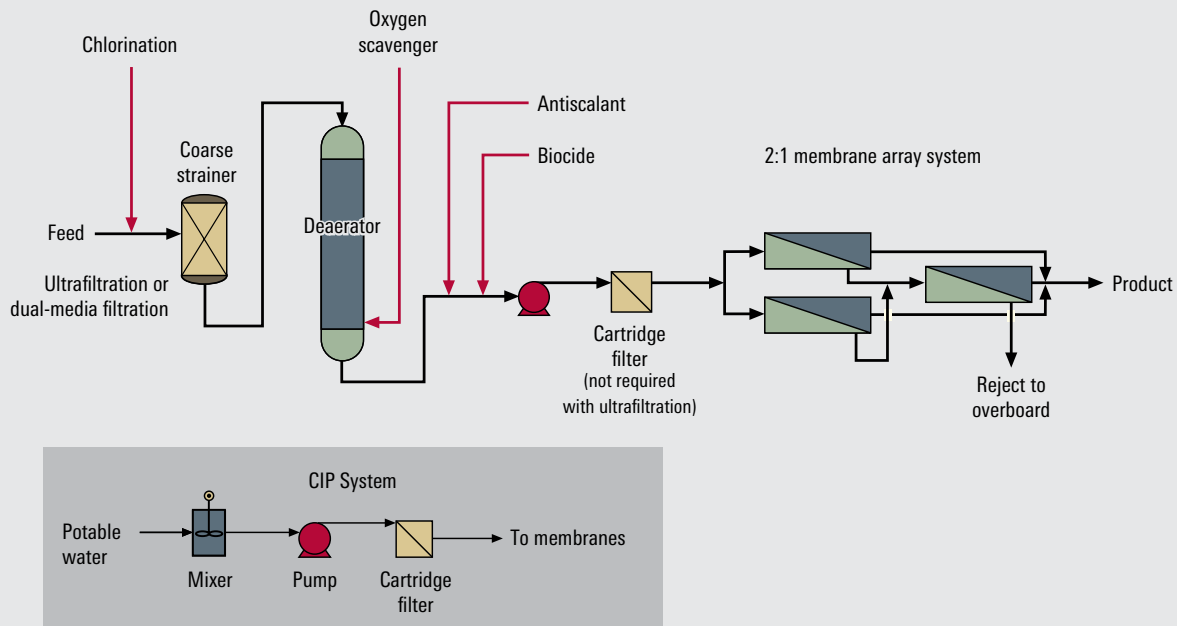


Sulfate-reduction package installed on Statoil Heidrun platform.



Membrane cleaning in place (CIP) for Statoil Heidrun.

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Typical process flow schematic.



End view of membrane pressure vessels.

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