



Sulfate Removal from Injection Water in Oil Production

The DOW FILMTEC™ SR90 nanofiltration membrane (and the resultant sulfate removal technology) has been developed in a cooperative effort between The Dow Chemical Company and the Marathon Oil Company to selectively remove sulfate from seawater that is used for waterflood injection operations.

There are two major advantages in the removal of sulfate from injected seawater.

- Prevention of barium and strontium sulfate scale precipitation. When normal high sulfate seawater is injected into reservoirs which have formation water containing barium and strontium, mixing occurs forming a supersaturated barium and / or strontium sulfate solution. Upon pressure decreases in and around the production wells, the supersaturated barium and / or strontium sulfate solution is no longer stable and precipitation occurs. The result is scale formation in the production tubing and / or plugging of reservoir rock around the production well. Petroleum reserves are often lost. By removing sulfate from injected seawater, the potential for scaling is prevented. This is contrasted with traditional scale remediation treatments and procedures addressing scale problems after they occur. In deep water and other complex oil developments, sulfate removal, and the subsequent prevention of scale, provides significant cost advantages.
- Souring Control / Mitigation in reservoirs. By removing the sulfate in the injected seawater, there simply is a reduced source of sulfur that can be converted to hydrogen sulfide by thermophilic sulfate reducing bacteria. Consequently, the risk of well souring is reduced. Several examples of sweet oilfields that became sour upon waterflood breakthrough following the injection of high sulfate seawater. By removing the sulfate from the injection water providing subsequent souring control, there is a reduced need for sour safe metallurgy, costly hydrogen sulfide removal equipment, and health and safety concerns.
- The nanofiltration membrane also removes all particles greater than one one-thousands of a micron resulting in high quality injection water free of silica and bacterial materials thereby insuring continued injection rates reflective of initial reservoir conditions.



Sulfate removal provides maximum benefits in oil developments exhibiting the following characteristics. a) Deep water operations with subsea vs. dry well heads. Chemical squeeze inhibitor treatments generally cannot be applied when access to a dry well head is not available. b) Horizontal or multilateral reservoir developments where there is difficulty / risk in the placement of chemical squeeze inhibitors. c) Costly production wells where the loss of one well due to scaling could approximate the cost of a sulfate removal unit. d) Mild / Moderate scaling potential in combination with costly and / or complex reservoir developments.

Sulfate removal is now accepted as the “default” scale control technique in most West African and Brazilian operations. The total sulfate removal capacity is currently above 7m BWPD, with a proven performance of the more than 50 units that are now in operation or under construction.

Products

DOW FILMTEC™ SR90-400i, DOW FILMTEC™ SR90-440i and DOW FILMTEC™ SR90HR-440i nanofiltration membranes are the industry standard and are used exclusively in offshore oilfield applications. In addition to the membrane elements, the product includes end use know-how, proprietary operation procedures, risk assessments, detailed system designs. Extensive field experience, product technical manual and continuous research has resulted in a one-third reduction in weight, space, and cost requirements since the inception of the technology. Systems are designed specifically to ensure the elimination of scale and for particular platform requirements and reservoir characteristics.

Features

Eliminating Scale

Removal of sulfate eliminates the sulfate component from injection water that causes scale formation. Reducing or eliminating scale:

1. Eliminates the existing scale inhibitor squeeze treatments. a. Cost of such treatments. b. Deferred oil production during squeeze treatments. c. Necessary monitoring of residual scale inhibitors. d. Potential reservoir damage from these treatments. e. Discharge of scale inhibitors and resultant environmental concerns.
2. Eliminates potential coprecipitation of radium 226 which results in radioactive barium sulfate scale and resultant handling and disposal costs.
3. Potential loss of a well (reservoir reserves) due to scaling and resultant unsuccessful well workovers.
4. The cost of a well workover. In some areas, two or three well workovers often equal the cost of a sulfate removal facility.

Eliminating Hydrogen Sulfide

An auxiliary benefit is that by reducing sulfate injected, one eliminates the source of sulfur that is converted to hydrogen sulfide by sulfate reducing bacteria. Eliminating hydrogen sulfide generation:

1. Reduces safety, health, and environmental concerns by eliminating the production of deadly hydrogen sulfide.
2. Reduces the cost related to sour gas and oil treatment or dedicated “sour safe” pipelines.
3. Allows use of less costly metallurgy for the operation due to reduced stress cracking and corrosion.
4. Reduces sulfide scale problems (ferric sulfide is exceptionally troublesome).
5. Reduces the potential for necessary addition equipment on a platform or FPSO with limited space and weight capacities.
6. Improves the economics of a discovery to “tip the scales” in pursuing v. abandoning a new prospect via risk analysis.

To learn about solutions and products, visit www.dowwaterandprocess.com



NOTICE: No freedom from infringement of any patent owned by Dow or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring that Customer's workplace and disposal practices are in compliance with applicable laws and other government enactments. The product shown in this literature may not be available for sale and/or available in all geographies where Dow is represented. The claims made may not have been approved for use in all countries. Dow assumes no obligation or liability for the information in this document. References to "Dow" or the "Company" mean The Dow Chemical Company and its consolidated subsidiaries unless otherwise expressly noted. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

Form No. 609-04029 CDP August 2012