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Reducing and Preventing Scale Formation, Deposition, Corrosion and Fouling at Oil and Water Injection and Recovery Wells

Abstract

Chemical and biological incrustation are major causes of decreased well performance and eventual failure. Acceptable Industry Practices include the application of scale inhibitors such as bactericides, bacteristats, esters, phosphonates, and polyelectrolytes to key resource areas. For water wells, the Vyredox system is a popular treatment methodology. The reduction or prevention of scale formation, deposition, corrosion and fouling at key resource areas (oil or water production wells) using *Butane Biostimulation Technologies* and *Butane-utilizing Bacteria* is a low-cost treatment alternative. The process involves the injection of butane and air into an oil-bearing reservoir or aquifer, or the injection of butanated water or recirculation water containing dissolved butane and air.

Background

Scaling is the precipitation of dense, adherent material on metal surfaces and other materials. *Scale formation at oil producing well screens eventually results in lower oil yields and well failure.* In addition, the problem of scale in water flooding occurs all the way from the water injection facilities to the producing well. In general, there are six important regions where scaling can occur during and after injection operations:

1. in the injector wellbore;
2. near the injection-well bottomhole;
3. in the reservoir between the injector and the producer;
4. at the skin of the producer well;
5. in the producer wellbore; and
6. at the surface facilities.

Calcium sulfate ($CaSO_4$), calcium carbonate ($CaCO_3$), barium sulfate ($BaSO_4$), strontium sulfate ($SrSO_4$), iron carbonate ($FeCO_3$) and iron hydroxides are the most common scales in oilfield environments. In addition, there are some scale deposits in oilfield environments that are called pseudoscale; that is, the deposit of a reaction product between two or more anthropogenic-introduced chemicals.

Bacteria in injection water and produced water can contribute to corrosion. The main types of aerobic bacteria that cause problems are slime-forming bacteria, iron-oxidizing bacteria, and sulfur-oxidizing bacteria. However, most of the oilfield corrosion problems arise from the activity of anaerobic bacteria such as sulfate-reducing bacteria.

Chemical and biological incrustation are major causes of decreased well performance and eventual failure. Fouling can be described as well screen clogging and failure due to the growth of iron and manganese bacteria including oxide and hydroxide deposition and incrustation caused by the activities of the iron and manganese bacteria. Iron bacteria produce accumulations of slimy material that have a gelatinous consistency. In addition, they precipitate dissolved iron and manganese. The dual effect of the growing bacteria and the precipitating minerals can plug and close well screen slots (especially water wells) within a relatively short period of time.

Iron bacteria, such as Crenothrix, Leptothrix, Gallionella, Clonothrix, and Pseudomonas can change dissolved iron to insoluble ferric iron, which is subsequently deposited in the sheaths of the bacterial cells. The sheaths create a gel-like slime that eventually clog well screen slots. Some of the known iron and manganese bacteria belong to a class of filamentous bacteria.

Butane and Air Injection

Since butane has a high solubility, butane enrichment enhances microbial activity by increasing substrate availability. Bacteria stimulated by butane produce a diverse group of enzymes, many of which are capable of oxidizing metals. By oxidizing and precipitating metal oxides and hydroxides out of a flow stream, lower concentrations of dissolved metal oxides and hydroxides will be available for transport through the reservoir or aquifer to the recovery wells where they are then pumped to the surface. By progressively lowering metal concentrations in recovered water, fouling at the injection and recovery well screens will diminish over time, key resource areas will be protected, and corrosion should be reduced by reducing the activity of anaerobic bacteria. Although oxygen dissolved in aqueous solutions even in low concentrations is a leading cause of corrosion problems such a pitting, injected oxygen will be quickly utilized as a terminal electron acceptor during the metabolism of butane by butane-utilizing bacteria in the subsurface environment. Butane-utilizers do seem to be ubiquitous in overburden soils and aquifer systems. However, a simple laboratory bench-scale test can be conducted to confirm or deny the presence of butane-utilizing organisms in a soil or groundwater sample. Although many oil-bearing reservoirs are associated with brine or heavily saturated salt water, butane-utilizing bacteria have been isolated from both fresh and salt water systems; thus the likelihood that butane-utilizing bacteria are present within oil-bearing reservoirs appears high.

Secondary Benefits of Butane and Air Injection

Butane injection will also increase the miscibility of oil and water. Butane can be used to create a miscible flood within the oil-bearing reservoir. This will inherently promote enhanced oil recovery and increase oil production beyond that achievable with primary and secondary methods.

Many oil production and refining facilities have become polluted over time. Butane Biostimulation Technologies have been demonstrated to effectively degrade in soil and groundwater a variety of environmental pollutants including chlorinated solvents, petroleum hydrocarbons, and methyl tertiary butyl ether (MTBE).

References

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