IP RESEARCH REPORT

THE EFFECT OF NITRATE ANTI-SOURING TREATMENT ON CORROSION OF MILD STEEL

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INTRODUCTION AND PROJECT OBJECTIVES

The last few years have seen a major shift toward nitrate treatment for the selective control of sulphate-reducing bacteria (SRB) and associated biogenic generation of hydrogen sulphide (H_2S). The change in operator practice was boosted by the recent field successes reported in the North Sea. Currently, nitrate is used by many operators and in almost all major regions of oil production including North America, South America, Middle East and additional operators in the North Sea.

Carbon steel is still by far the most commonly used material in injection systems and the petroleum industry in general. Highly toxic organic biocides have been the traditional method of controlling corrosion in the injector. However, tougher health and safety regulations and increasing produced water re-injection (PWRI) practices have brought new challenges to, in many cases, ageing installations. The use of nitrate to both prevent and mitigate biogenic reservoir souring in the water zones of oil reservoirs has raised concern about the possible effect on the integrity of tubulars. This was further fuelled by the conflicting information available on the effect of nitrate on corrosion.

The Microbiology Committee of the Energy Institute (previously the Institute of Petroleum) commissioned this multi-phase study to investigate the effect of nitrate on corrosion. If unquantified, the concern about corrosion could lead to undesirable practices such as the concurrent injection of biocide (to control injector corrosion) and nitrate (to control reservoir souring). Such a practice would divest the nitrate technology of its two most valuable features of being environmentally friendly and comparatively inexpensive.

This independent study was a part of the Microbiology Committee's leading role in promoting good practices, greener alternatives and improved understanding of industrial microbiology. It was conducted in three consecutive stages over a three-year period:

— Phase I was an assessment of the worst-case scenario in terms of pH and carbon availability on nitrite generation.

— In Phase II, the effect of the worst-case scenario on corrosion obtained from Phase I, was further evaluated under conditions of continuous fluid replenishment.

— Phase III was an assessment of the worst-case scenario and continuous replenishment on corrosion under the simulated hydrodynamic conditions of the injector including shear stress (t_w).

Both real seawater and real produced water were used in the investigation programme. The produced water was provided by an oil company's production field in the North Sea and selected because it was free of additives that could confuse the work and affect bacterial activity.

The study also assessed the effect of various PWRI scenarios including:

1. Control (nitrate-free), SRB population.
2. Continuously nitrate-treated from onset.

3. Delayed treatment, nitrate addition to an SRB biofilm.
4. Interrupted nitrate treatment.

This document provides a summary of the experimental work and findings with guidelines to operators on the use of the nitrate to combat SRB and associated reservoir souring. For further details of the experimental work, please refer to the interim reports produced at the end of each phase.

Phase III is regarded the most representative of field conditions and as such it is given more weight ininterpreting the data particularly when some discrepancy between the results of different phases was observed.

1.1 PROJECT OBJECTIVES

The aim of the evaluation programme was to investigate the effect of nitrate anti-souring treatment on the corrosion of carbon steel injection pipework. The study was supported by chemical and microbial analyses to ensure an active microbial population representative of the commingled produced water and seawater.