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Iron Based Scale in a Sour Oil Field: Sources Identification, Simulation, Treatment and Prevention

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Abstract

Iron based scale has been observed in deep sour oil production wells in south of Oman. The wells are fracture stimulated to achieve economic oil production from a thick, tight, silicilyte formation. The scale builds up at varying depths resulting in limited access through tubing, reduced productivity and, in worst cases, well abandonment and re-drill. Those wells produce light oil which exhibits high H2S and CO2 content in the associated gas and, except for early unloading of fracture fluids, produces water-free oil throughout their life. Reservoir formation water is initially considered immobile, therefore, the current theory is only fracture fluid, which can be up to 4000 m3, provides an environment for scale deposition, possibly after mixing with formation water increasing water saturation in the immediate vicinity of a wellbore and its hydraulic fractures.

This study discusses the mechanism of scale deposition and scale sources identification through modeling and isotope tests. Also, suitable scale clean out fluids and methodologies has been identified based on lab experiments.

Most of the scales are identified as Fe-bearing such as iron sulfides. Possible sources of iron are: proppant, cement, reservoir rock and downhole well completion. Simulation work using MoReS-PHREEQC was conducted as part of the study to forecast the types and amount of iron based scale precipitation that can be anticipated at varying reservoir and producing conditions. Preliminary results indicate that all mechanisms and different scale types precipitate in the wellbore and sand face. The iron in the scale might be from the reservoir formation or from hematite in the cement or proppants; identified using isotope tests. However, simulation results conclude that the main source of iron is completion corrosion. Although simulation results indicated that other iron sources (formation, hematite in cement and proppant) contribute to scale deposition, it does so at a limited rate.

Laboratory tests were conducted using hydrochloric acid at different ratio and concentration and four other dissolution fluids to dissolve iron sulfide scale. The influences of various acid additives on the dissolution power of the acid and the corrosion of oilfield steels were examined. Iron sulfide scale is soluble in hydrochloric acid. More iron sulfide scale can be dissolved by using high acid concentrations rather than using large amounts of solutions that contain low acid concentrations. Considering the volumes of the solvents (provided by service company) and the time of reactions, using acid results in better solubility.

Scales clean out methodologies were identified and a scale mitigation plan for existing and new wells is proposed. The study also evaluated the most cost effective and feasible ways to remove different types of scale deposits. The future scale prevention and removal strategies to be

implemented in existing and future wells are being derived in large part from the results of the work described in this study.