Characterization of corrosion scales formed in the production tubes used in the oil and gas

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Corrosion and scale formation is a common problem in the oil and gas industry, which reduces the lifetime of oilfield production wells. An extensive internal corrosion in the wells often leads to replacement of used materials to more corrosion resistance alloys, increasing the operational expenses. Due to corrosion and/or inorganic scale formation, the internal diameter of the production pipe is reduced, leading to declination of the oil/gas production. In addition, deposition of the corrosion/scale products on the steel surface might also enhance the corrosion processes underneath [1][2], leading to pitting corrosion.

The conditions present in the wells are complex and the severity of corrosion depends on various environmental (e.g. $CO_2/H_2S/O_2$, temperature, pressure, liquid flow velocity, chemistry of produced water) and material variables (e.g. chemical composition, microstructure). Additionally, well interventions, such as acid treatments and/or mechanical scale removal might contribute to increased corrosion rates [3]. Therefore, the corrosion observed in the wells often involves several mechanisms, which are difficult to predict. In order to choose efficient mitigation techniques, it is crucial to understand, which processes and mechanisms govern the corrosion behavior of wells.

Consequently, the objective of this study was to analyze the morphology of the corrosion scales as well as the corrosion features observed in the production tubing after operation in the Danish sector of the North Sea. Based on the obtained results, possible governing corrosion mechanisms were proposed.

The characterization of the corrosion scales was performed by means of high resolution scanning electron microscopy (SEM), Energy Dispersive X-Ray Spectroscopy (EDS), Transmission electron microscopy (TEM) and X-ray diffraction (XRD) techniques.

The results showed that depending on the operational conditions in the oilfield, analyzed scales consisted of one or multiple layers with apparent differences in morphology, indicating differences in scale formation mechanisms. The results showed that major phases measured in the scales were iron oxy-hydroxide, iron hydroxide and chloride-rich products. In addition, in some production tubings iron sulfide, cupper sulfide, and barite were identified as well.

References

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