MECHANISTIC AND KINETIC STUDIES OF MICROBIOLOGICALLY INFLUENCED CORROSION (MIC) IN THE PRESENCE OF DOMINANT SULPHATE REDUCING BACTERIA (SRB) METABOLIC SPECIES

by

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ABSTRACT

Microbiologically influenced corrosion (MIC) is a serious problem in the oil and gas industry. The most common microorganism responsible for MIC is sulphate reducing bacteria (SRB) which produces detrimental sulphide ions into the environment. Therefore, many studies have been conducted to study the effect of sulphide ions on the corrosion rate of mild steel using inorganic solution chemistry but ignored the possible effects of other SRB metabolic species which are produced along with sulphide such as sulphite, lactate, acetate, pyruvate and thiosulphate. The exclusion of other metabolic species implies some deficiency of the current understanding of MIC problem. Thus, the objective of this work is to elucidate the mechanistic and kinetic of MIC with the presence of dominant SRB metabolic species by which a better MIC prediction could be formulated. The work was conducted in simulated solution containing dominant SRB metabolic species of sulphide, sulphite, lactate, acetate, pyruvate and thiosulphate. Three electrochemical measurement methods were used in this work *i.e.* linear polarization resistance (LPR) test, Tafel polarization (TP) and electrochemical impedance spectroscopy (EIS). Three surface characterization techniques *i.e.* field emission scanning electron microscopy (FESEM), energy dispersive X-rays analysis (EDAX) and X-rays photoelectron spectroscopy (XPS) were used to study the corrosion product morphology on the surface. The pre-screening study showed that the corrosion behaviour of individual species differed in the presence of other metabolic species. The interaction among metabolic species created a more aggressive environment and increased the corrosion rate. In addition, the formation of FeS film and nature of corrosion are dependent on the presence of sulphide. With sulphide concentration around 50 ppm, a thin and porous FeS film was formed which enabled corrosive species to diffuse to the steel surface and increased the corrosion rate. In high concentration of sulphide (more than 200 ppm), FeS film thickness increased substantially, resulted in lower corrosion rate and protected the steel from pitting corrosion.

The FeS formation was observed to be influenced by the presence of other metabolic species, particularly sulphite. The presence of sulphite thins the FeS film which allowed the corrosive species to diffuse to the steel surface, increased the corrosion rate and also resulted in pitting corrosion. Additionally, compared to the sole effect of sulphide on the X52 corrosion, the presence of other species changed the kinetics of sulphide corrosion and affected the formation of FeS film. The corrosion data from this study showed comparable results to the corrosion data obtained from SRB experiments as reported in the open literatures. A predictive equation that considers the SRB metabolic products was developed to predict the SRB corrosion at temperature of 25°C. Statistical analyses showed that the predictive equation has 95% level of confidence

Keywords: Sulphate reducing bacteria (SRB), metabolic products, abiotic chemistry.