

Development of De Waard-Lotz Model of CO₂/H₂S Corrosion Rate Taking the Effect of Vibration

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Abstract: Vibrations in crude oil pipelines may arise as a result of flow of crude oil, pumps, wind, earthquakes, and human actions. When these vibrations coincide with corrosive conditions and the presence of dissolved gases, they can contribute to corrosion and ultimately lead to failure. This paper aims to develop the De Waard-Lotz corrosion model to calculate the corrosion rate of CO₂ dissolved gas in crude oil solution. A new correction coefficient is developed to take the vibration effect by utilizing collected experimental vibration immersion tests alongside the artificial neural network approach. The study examines five distinct types of steel pipelines: X60, X65, X70, X80, and X100, within crude oil solutions at varying temperatures and lower pressures of dissolved CO₂ gas. The corrosion rates obtained from the vibration-immersion test have good accuracy compared to that obtained from De Waard-Lotz corrosion model after incorporation of the vibration correction factor.

1. Introduction

The pipe networks are the key arteries of delivery crude oil and its products. Crude oil contains six different corrosion components: water, carbon dioxide (CO₂), organic chlorides, organic acids, sulfur and bacteria. The dissolved CO₂ gas is considered to be one of the main sources of corrosion in transmission crude oil pipeline. It's found at different levels and the CO₂ gas dissolved into water or other aqueous materials in crude oil for the formation of dilute organic and inorganic acids or sulfur for the formation of acids (Smith *et al.*, 2005).

The vibration of crude oil pipeline results from different sources: pumps, winds, the flow crude oil and its contents especially gases, vapors, slag... etc. Vibration was found to be one of the most important factors that cause damages on the wall... of the pipe as well as have effect on the life of pipelines (Zahid *et al.*, 2016).

Various experimental and numerical methods are used to estimate the rate of corrosion, but limited of them can be used in case of vibration effects. The best method to incorporate the effect of vibration in the corrosion process is immersion corrosion testing. It's involved exposure of tested specimens to specify electrolytes for period of time, then calculation the weight losses due to corrosion and finally calculating the rate of corrosion using appropriate units (D. A. Jones, 1996). The artificial neural network method (ANN) is considered one of the best numerical methods used to