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Internal corrosion studies in hydrocarbons production pipelines located at Venezuelan Northeastern

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ABSTRACT

The demand of fossil energy has boosted the construction of new oil facilities and the preservation of the physical and mechanical integrity of the already existing infrastructure. Corrosion is the main causes of failures in the hydrocarbons industry and half of them are produced by acid gases (CO_2 and H_2S) (Kermany and Harrop, 1996). Within this framework, a monitoring device was developed by PDVSA-Intevep, in order to study the internal corrosion mechanism in a real hydrocarbons production system. The results show the advantages offered by this tool, which allowed studying thoroughly the internal corrosion mechanism present in the system and their immediate causes. In this case, the main corrosion mechanism present is under deposit corrosion, which causes pitting damage at different positions along the pipeline. According to microscopic analyses, the pitting are related to the presence of sand and solids (iron carbonates and sulphides); and the location of the damage depends basically on the internal diameter of pipelines (the hydrodynamics of the system).

Keywords: Corrosion; Hydrodynamics; Pitting; CO_2; H_2S

1. Introduction

The global demand of fossil energy has boosted the petroleum production in the world. Consequently, it is necessary to construct new facilities and to preserve the physical and mechanical integrity of the already existing infrastructure. Corrosion is the most common cause of damages in the oil and gas industry. In this way, the development of effective prevention methods is necessary in order to avoid unexpected failures in the facilities and the consequent economic losses due to equipment replacement and/or deferment of oil and gas production. The application of effective prevention methods in Venezuelan northeastern facilities has been difficult, particularly because of the absence of detailed information with respect to the corrosion mechanisms involved. In this case, the main factor responsible for the corrosion phenomenon is the presence of acid gases like CO_2 and H_2S as well as the hydrodynamics of system.

Many authors have tried to design theoretical correlations in order to predict corrosion tendencies based on parameters like CO_2 content, temperature, fluid dynamics and partial pressure of CO_2 and H_2S (Kermany and Harrop, 1996; De Waard and Milliams, 1975; Ikeda et al., 1983). Lotz et al. (1990) studied the effect of hydrocarbons on the CO_2 corrosion mechanism by testing different crude oils coming from different countries, and they found that hydrocarbons have an important role and could modify the CO_2 corrosion mechanism present in the system. More recently, some authors (Nesic et al., 2001; Dayalan et al., 1998) have developed prediction programs to estimate the corrosion rate. However, these programs do not take into account the fluid dynamics parameters, which in some cases play a very important role during the corrosion phenomenon.

In the Venezuelan oil production system, it is very common to find gas mixtures like H_2S and CO_2, in addition to species such as chlorines and naphthenic acids. In presence of water, these species may promote the corrosion phenomenon and the combination of certain parameters can even accelerate the degradation process. An example is the effect of H_2S on CO_2 corrosion, which depending on the temperature, pressure and concentration of the corrosive agents, could vary the corrosion mechanism in the system. Ikeda et al. (1985) studied this effect and they proposed three corrosion mechanisms according to the variation of temperature.

The stability of sulphides and/or carbonates on the metal surface depend mainly on the CO_2 and H_2S concentration, temperature and total pressure; however the fluid dynamic

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