Evaluation of mineral oils as matrices for AISI/SAE–1020 steel naphthenic corrosion study

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Abstract. Petrochemical industry has suffered great economic impact due to light crude oil reserves reduction, so refineries have been processing high acidity heavy crude oils. Studies of corrosion caused by naphthenic acids are interfered by presence of other corrosive agents contained in real crude oils, so naphthenic phenomenon must be isolated using synthetic crude oils. For this reason, in present work two high purity mineral oils were used to evaluate their efficiency as synthetic crude oil matrices in AISI/SAE–1020 steel naphthenic corrosion study. Temperature levels evaluated were 200 °C, 250 °C, and 300 °C, while exposure times evaluated were 5, 10 and 15 hours. Surface morphological characterization of AISI/SAE–1020 steel was carried out using scanning electron microscopy and X–ray diffraction. Gravimetric tests showed that AISI/SAE–1020 steel naphthenic corrosion rate increases with temperature and exposure time for one of the synthetic crude oils. However, results obtained for the other synthetic crude oil did not show increasing behaviour due to presence of sulfur traces in the oil, which caused an interference with AISI/SAE–1020 steel naphthenic corrosion study, reducing the reliability of gravimetric results so they cannot be extrapolated to operating conditions in distillation units.

1. Introduction

In petrochemical industry, corrosion phenomenon is strongly associated with processing of heavy crude oil due to its high content of corrosive agents [1]. Naphthenic acids are among the main causes of this phenomenon, which are potentially corrosive and affect preheating furnaces, transfer lines and atmospheric and vacuum distillation units, causing fouling and decreasing the quality of middle distillates obtained [2].

Naphthenic corrosion is influenced by multiple variables such as temperature (generally occurs above 220 °C), exposure time, concentration and type of naphthenic acids and the presence of organic sulfur compounds, among others. This phenomenon is caused by reaction of naphthenic acids (RCOOH) with iron (Fe) from metallic surfaces, generating iron naphthenates ($Fe(RCOO)_2$) that are soluble in crude oil and cause a constant material loss, giving place to appearance of pitting corrosion in the exposed materials [3].

Currently, there are several alternatives for naphthenic corrosion prevention and mitigation such as: blending, which consists of mixing crude oil with others with lower naphthenic acids content to reduce the acidity; chemical neutralization of naphthenic acids; and metallurgy upgrade through selection of materials with greater corrosion resistance [3]. Evaluation of these methods is carried out in its initial