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### NAPHTHENIC CORROSION USING ELECTROCHEMICAL AND ANALYTICAL TECHNIQUES

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## ABSTRACT

Naphthenic acid corrosion of steel was studied in a stagnant, biphasic oil/aqueous phase system, by means of electrochemical measurements and surface analysis. Corrosion was restricted to the region of the aqueous phase, as crater-shaped pits that eventually coalesced, generating a nearly uniform attack in the vicinity of the oil phase. In-situ electrochemical impedance spectroscopy (EIS) reveals the processes occurring at the aqueous phase, which nevertheless increase with the fraction of oil phase and with degree of acidity of the oil.

Keywords: EIS, LEIS, SECM, Naphthenic acid, Corrosion

## 1. INTRODUCTION

Early corrosion failure of steel structures dealing with crude oil/seawater mixtures is commonly induced by naphthenic acids (HNap), which are naturally present in many crude oils and constitute an important class of corrosion-inducing contaminants [1]. In the present work this phenomenon was studied using EIS. Because of the high impedance of the oil phase and of the risk of contamination, EIS is commonly excluded from the reported studies. In our work we use a setup using a homemade cell, in which the sample is exposed vertically from the outside, compressed against an o-ring. The aqueous solution was poured first and then the oil was added dropwise, to prevent contamination of the bottom part of the steel plate, while leaving the metal exposed to both phases. The samples were inspected at the end of the tests, by electron microscopy and infrared analysis (FTIR).

## 2. DESCRIPTION

The results give a good correlation of the charge transfer resistance and the fraction of oil in the system – Fig. 1. Further, addition of 1% and 5% of HNap caused a decrease of the size of the impedance arc, while the SEM inspection shows that the attack is mostly located at the aqueous phase. The conclusions are supported by the FTIR analysis and suggest that the impedance measured is due to the electrochemical activity at aqueous interface only, resulting from the oil phase ohmic resistance.

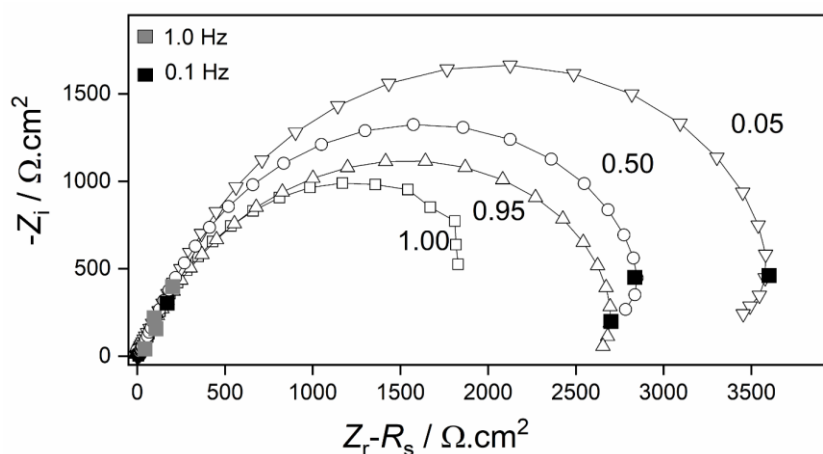


Fig. 1 – EIS of steel in the biphasic medium, for various area fractions exposed to the solution,  $X_{aq}$ . Ohmic resistance subtracted from the spectra.

### 3. CONCLUSIONS

The corrosion rate in a biphasic medium using crude oil and sodium sulphate solution is correlated with both the content of acid and the oil/water volume ratio. The attack starts in the aqueous phase, in close vicinity of the oil, in the form of pits that grow into a nearly uniform attack. A setup was developed for laboratory electrochemical testing, which allows measurements in the aqueous phase, with the indirect effect of the oil and without the effect of oxygen.

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