



Short communication

An overview of naphthenic acid corrosion in a vacuum distillation plant

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ABSTRACT

After 5 years processing about 6500 m³/day of reduced crude oil with an average total acid number of 1.2 mg KOH/g and total sulfur content of 0.8 wt%, a vacuum distillation plant had its operations interrupted to suffer maintenance and inspection. Following theoretical considerations, this work shows the inspection outcome and tries to stress the several morphologies resulting from the naphthenic acid attack as well as different types of action by which the naphthenic acid corrosion occurs in a vacuum distillation plant.

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1. Introduction

The most vulnerable unit of naphthenic acid corrosion (NAC) in a crude oil refinery is the vacuum distillation plant. Although naphthenic acids with several molar masses may be present in crude oil, in general they tend to concentrate in the range with molar mass that corresponds to hydrocarbon fractions with boiling points coincidental to those which are found in vacuum plants [1]. This fact occurs in heavy vacuum gas oil (HVGO), which is the fraction that normally acquires the highest total acid number (TAN).

The reliability of such plants is strongly dependent on their metallurgy. Their critical points as furnace tubes and elbows, transfer line, walls, and trays of vacuum column must be built with Mo-bearing stainless steel such as AISI 316 and AISI 317 stainless steels [2]. Under certain circumstances and at given molybdenum content (particularly for the AISI 316 steel with less than 2.5 wt%), none of these materials can resist the NAC attack, therefore molybdenum richer alloys are necessary.

2. Theory: mechanism and interfering variables

The chemical reaction that is known to represent NAC to iron alloys is:



where R denotes the naphthenic radical (one or more cyclopentane or cyclohexane saturated ring) linked to carboxyl groups through n (typically >12) units CH₂, and the corrosion products, the complex Fe(R[CH₂] _{n} COO)₂, is soluble in oil. It must be observed that the acid tends to dissociate as R[CH₂] _{n} COO[−] and H⁺ even in an organic liquid environment [2,3].

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