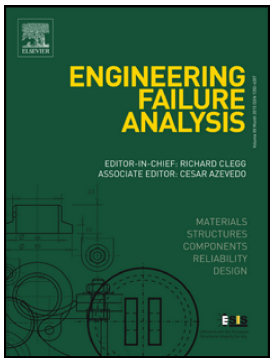

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Characterization of corrosion products formed on mild steel in deoxygenated water by Raman spectroscopy and energy dispersive x-ray spectrometry

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Abstract

The corrosion of steel parts of heating systems is nowadays not commonly observed failure because of the lack of oxygen in circulated media. In rare cases corrosion rapidly initiates and propagates due to various, mostly unexplained mechanisms. A voluminous corrosion product that was found in the vicinity of a perforation to a pipe wall was investigated in order to understand the reasons for the observed rapid corrosion processes. Raman spectroscopy and energy dispersive X-ray microanalysis were used to examine this corrosion product across the whole cross-section of the pipe. It was observed that the inner part of the corrosion product at the contact with the pipe's inner surface mostly consisted of magnetite. The outer part of the corrosion product, which was in contact with the water in the pipe, was mostly goethite. These findings confirmed the hypothesis that the magnetite sediments on the surface of the new pipe caused oxygen concentration cell formation, which triggered corrosion dissolution of the pipe wall and led to a rapid perforation.

Key words: corrosion, deoxygenated water, carbon steel, Raman spectroscopy, energy dispersive x-ray spectrometry

1. Introduction

In recent decades the corrosion of parts of heating systems made from mild steel has not been a commonly observed phenomenon, even though steel has a strong tendency to corrode when exposed to oxygenated water [1]. In most cases such corrosion was attributed to poor design and/or an aggressive environment containing corrosion contaminants. For this reason, the perforation of pipes made from non-alloyed low carbon steel after only half of year of operation of the heating system was a surprise, so that the investigation of the reasons for it, which are presented in this paper, was not straightforward.

The pipes of heating systems are most commonly made from copper or mild steel. Copper and its alloys are used due to their good corrosion resistance and easy workability. However, much cheaper unprotected carbon steel of various qualities is sometimes used for the same