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Assessment of bacteria participation in deposits formation inside the steel pipeline through X-ray diffraction studies

INTRODUCTION

Microorganisms which colonize interior of drinking water distribution pipes might contribute to corrosion – Microbiologically Influenced Corrosion (MIC). The corrosion of drinking water distribution system (DWDS) pipes can lead to many problems such as:

- clogging [1];
- creating habit for pathogens or opportunity microorganisms [2];
- lowering the durability of pipelines [3];
- deterioration of organoleptic properties of provided water [4].

The X-ray diffraction (XRD) was applied in studies concerning the biofilm presence in DWDS:

- Biofilm impact on composition of crystalline phases, forming corrosion scales in conditions simulating these in DWDS [1];
- Formation and transformation of corrosion products in DWDS through microbial activity [5];
- Impact of sulfates present in water on kind of microorganisms which colonize interior of water pipeline [6];
- Relationship between the occurrence of specific corrosion products and activity of specific bacterial groups [6];
- The role of microorganisms in corrosion processes (corrosion inhibition or acceleration) [7];
- Possibility of MIC occurrence in DWDS where disinfectants are used [7].

AIM

The goal of this study was to assess the microorganisms participation in formation of deposits inside corroded fragment of steel pipe (which was removed from drinking water distribution system), as well as to indicate their role in corrosion of pipeline.

MATERIALS & METHODS

Naturally dehydrated deposits were removed from different fragments of corroded steel pipe from DWDS

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Collected deposits were homogenized in agate mortar

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Powdered samples were analyzed by Seifert – FPM XRD7 diffractometer*

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Crystalline phases were identified through the Seifert software and ICDD catalogue data (2007)

↓

Quantitative phase analysis was performed by using Rietveld Method (SIROQUANT™ software)

*XRD analysis was carried out using CoKα radiation (k= 1.79021 Å), at scanning range of 2θ from 10° to 100°

CONCLUSIONS

- The presence of mackinawite in the naturally dehydrated deposits which have been scrubbed from inside the pipe beginning can be an indicative of the activity of sulfate reducing bacteria (SRB) in analyzed sample.
- Simultaneous presence of mackinawite and siderite can indicate that mechanism called Electrical Microbially Influenced Corrosion (EMIC) occured during formation of deposits in analysed samples collected from inside of pipe beginning, where certain SRB strains have utilized electrons from the process of metallic iron oxidation.
- Simultaneous presence of anaerobic corrosion products (residues) such as mackinawite and ferric oxides (magnetite, hematite) may suggest that the secondary oxidation processes occurred in analysed samples, and that anaerobic MIC was replaced by aerobic MIC.
- The mackinawite as a product of the SRB activity was not present in deposits collected from the middle and end of pipe.

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RESULTS

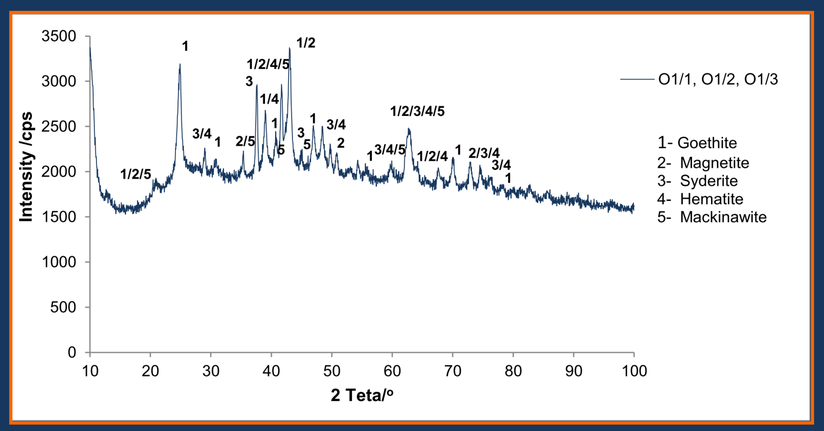

Fig.1. XRD pattern of naturally dehydrated deposits which have been scraped from beginning part of corroded steel pipe.

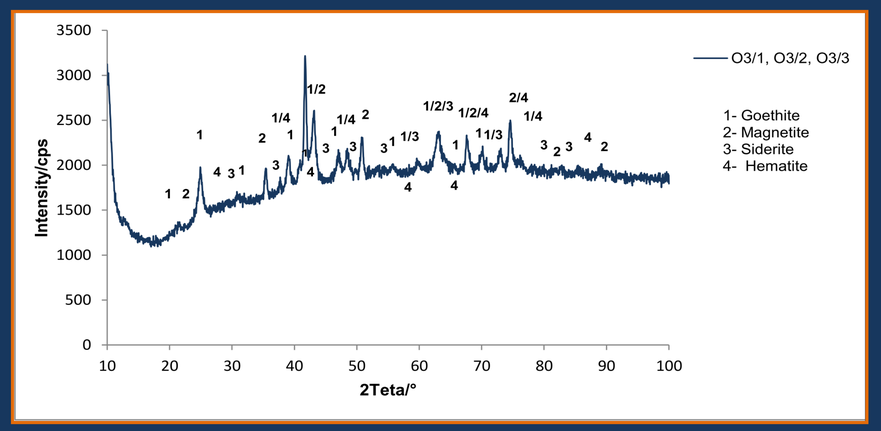

Fig.2. XRD pattern of naturally dehydrated deposits which have been scraped from the middle part of corroded steel pipe.

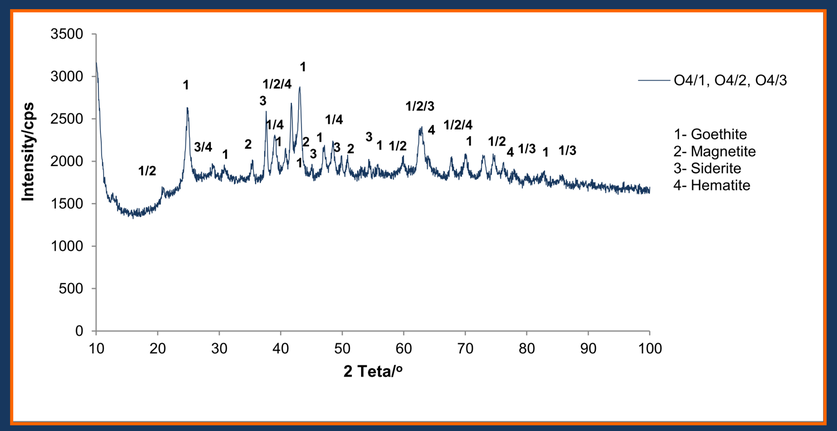

Fig.3. XRD pattern of naturally dehydrated deposits which have been scraped from the end part of corroded steel pipe.