Dual corrosion promotion of pipeline steel in sea mud induced by sulfate reducing bacteria: Bacteria concentration cell and electronic conduction of the biofilms covered sand grains

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Abstract Most of the subsea pipelines are laid along the seabed and often challenged by both sea mud and seawater corrosion. Microbiologically influenced corrosion (MIC) induced by sulfate reducing bacteria (SRB) is one of the main causes of pipeline failure in the marine environment[1-4]. Given the MIC suffered by subsea pipelines located at the sea mud-seawater interface, a series of experiments were carried out in this work to figure out the causes of the promoted corrosion of carbon steel by SRB in sea mud. The galvanic effect between the carbon steel in sea mud and seawater, the physicochemical properties of the SRB-containing sea mud, the number and distribution of SRB cells, and the corrosion behavior of carbon steel in sea mud were comprehensively investigated. In this work, two unique SRB induced MIC promotion mechanisms in sea mud were identified. For carbon steel at the seawater-mud interface, difference in the concentrations of sessile cells enhanced galvanic effect between the regions in seawater and sea mud[5], with the carbon steel in sea mud serving as the anode. SRB in sea mud established significant biofilms on sand grains, enabling the SRB attached on sand grains to participate in the biocatalytic cathodic process of MIC by the contact between sand grains and metal. The highly conductive SRB-containing sea mud could transfer electrons from the carbon steel to the SRB which was not in contact with the carbon steel over long distances, causing more MIC of X80 carbon steel in sea mud

Keywords Carbon steel; Sea mud; Sulfate reducing bacteria; Microbiological corrosion

Reference

[1] Tiansui Zhang, Hongfang Liu*. “Electrons-siphoning” of sulfate reducing bacteria biofilm induced sharp depletion of Al-Zn-In-Mg-Si sacrificial anode in the galvanic corrosion coupled with carbon steel. *Corrosion Science*, 2023: 111103.

[2] Tiansui Zhang, Hongfang Liu*. The corrosion promoting mechanism of *Aspergillus niger* on 5083 aluminum alloy and inhibition performance of miconazole nitrate. *Corrosion Science* 2020, 176: 108930.

[3] Tiansui Zhang, Hongfang Liu*. Dual corrosion promotion of pipeline steel in sea mud induced by sulfate reducing bacteria: Bacteria concentration cell and electronic conduction of the biofilms covered sand grains. *Corrosion Science,* 232 (2024): 112005

[4] Tiansui Zhang, Hongfang Liu*. Polyhexamethylene guanidine molybdate as an efficient antibacterial filler in epoxy coating for inhibiting sulfate reducing bacteria biofilm. *Progress in Organic Coatings*, 2023, 176: 107401.

[5] Tiansui Zhang, Hongfang Liu*. Crevice corrosion of X80 carbon steel induced by sulfate reducing bacteria in simulated seawater. *Bioelectrochemistry*, 2021, 142: 107933.