

## **A synergistic experimental and computational study on CO<sub>2</sub> corrosion of X65 carbon steel under dispersed droplets within oil/water mixtures**

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**Abstract** In the oil and gas industry, the presence of oil/water mixtures is common during transportation pipelines, but which suffers complex corrosion for different water cuts<sup>[1-2]</sup>. At low water cuts, the average corrosion rate of steel, wetted by the bulk oil solution and dispersed water-in-oil droplets, is low. Contrarily, at high water cuts, the steel is seriously corroded, due to that it is wetted by the bulk water solution and dispersed oil-in-water droplets. Though, the previous research have built a tight relationship between average corrosion rate and wetting phenomenon of steel<sup>[3-6]</sup>, the localized corrosion behaviour, which is mainly attributed to the dispersed oil-in-water or water-in-oil droplets, has not attracted much attention. Consequently, the CO<sub>2</sub> corrosion behaviour of X65 carbon steel under water-in-oil droplet and oil-in-water droplet was systematically investigated by a combination of scanning electron microscopy, Raman spectroscopy, NPFLex3D and COMSOL simulation in present research. Under the water-in-oil droplet, crystalline FeCO<sub>3</sub> was found, caused by the high concentration of Fe<sup>2+</sup> and CO<sub>3</sub><sup>2-</sup>, according to COMOSL simulation results. Notably, around the oil/water interface, a ridge consisting of compact FeCO<sub>3</sub> was observed, because the precipitation of FeCO<sub>3</sub> is accelerated by the short diffusion path of CO<sub>2</sub> near the edge of the droplet. Under the oil-in-water droplet, corrosion islands caused by the invasion of water can be found, indicating that small water droplets emphasised the development of localized corrosion underneath the oil droplet. The novel research findings contribute to further understanding of localized corrosion mechanism of pipeline exposed to oil/water mixture.

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**Keywords** Carbon Steel, CO<sub>2</sub> Corrosion, Dispersed Droplet, Oil/Water Flow

**Reference**

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