

---

## Study of In-situ electrochemical corrosion behavior and microscopic corrosion mechanisms of X80 pipeline steel in a supercritical CO<sub>2</sub> environment

Ruidong Li<sup>1</sup>, Xiaodan Wang<sup>2</sup>, Jianna Li<sup>1</sup>, Yueshe Wang<sup>2</sup>, Jun Hu<sup>1\*</sup>

<sup>1</sup>*School of Chemical Engineeringg, Northwest University, Xi'an 710069, PR China*

<sup>2</sup>*State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an 710049, PR, China*

*Email: liruidong@nwu.edu.cn*

**Abstract** The present study conducted an in-depth investigation of the electrochemical corrosion behavior and microscopic corrosion mechanisms of X80 steel under a supercritical CO<sub>2</sub> (sCO<sub>2</sub>) environment at 60°C and 9 MPa. Building upon the traditional three-electrode setup, the researchers innovatively designed two novel in-situ electrochemical testing circuits, one under a CO<sub>2</sub>-enriched environment and the other under a H<sub>2</sub>O-enriched environment. Through electrochemical impedance spectroscopy, the study revealed the distinct differences in the interfacial corrosion of X80 steel under the CO<sub>2</sub>-enriched and H<sub>2</sub>O-enriched environments, which corresponded to the varying corrosion conditions within different regions of the pipeline. Coupled with the analysis of surface evolution, the study provided a detailed elucidation of the deposition and development mechanisms of the corrosion products. Furthermore, the researchers employed micro-scale density functional theory (DFT) calculations to explore the three-step hydrolysis mechanism of sCO<sub>2</sub> on the Fe surface and the potential formation pathways of the FeCO<sub>3</sub> product, which offered valuable theoretical insights into understanding the corrosion behavior of carbon steel under the supercritical CO<sub>2</sub> environment.

**Keywords** Supercritical CO<sub>2</sub> ; Corrosion; Microscopic mechanism; DFT study