Effect of Cr as an alloying element on CO_2 corrosion resistance of carbon steels

Kapil K. Gupta[*,1], Saber Haratian[1], Maalek Mohamed-said[2], Bruce Cowe[2], Rajan Ambat[1]

[1] *Section of Materials and Surface Engineering, Department of Civil and Mechanical Engineering, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark*

[2] *TotalEnergies, One Tech - Corrosion Manager Offshore and New Energies Team, CSTJF - Avenue Larribau - 64018 - Pau – France*

**kkgup@dtu.dk*

One of the major causes of pipeline failure is CO_2 corrosion and scaling in production steel wells. Generally speaking, the addition of Cr as a constituent alloying element in steels is known to improve their corrosion resistance. However, adding alloying elements in high quantities increases the material's cost, making it unsuitable for low-yield fields. Thus, a particular quantity of Cr could be added to the low-alloy steel for enhancing its corrosion resistance and making it more cost-effective. During the last few decades, researchers studied the effect of Cr and how Cr enrichment in the corrosion products may influence the protectiveness of the underlying material. However, limited investigations have focused on determining the impact of Cr on corrosion behavior of steels in environments comparable with realistic conditions (formation water chemistry containing Ca^{2+} ions).

The goal of this research was to understand the effect of Cr as an alloying element on CO_2 corrosion behavior and scaling of low-alloy steels. Conventional L80 steels with various content of Cr were electrochemically subjected to CO_2-saturated simulated formation water chemistry. DC polarization and AC impedance techniques were used to assess the steels' electrochemical and corrosion behavior. The results of characterization of the corrosion scale obtained by employing electron microscopy and X-ray Diffraction applied on the end-product are presented. Furthermore, the results of the X-ray (micro-) computed tomography for determining mode of corrosion by evaluating the surface of material underneath the corrosion scale and visualizing the scale morphology in 3D are thoroughly discussed in relation to CO_2-electrochemical response of steels with different content of Cr.