

Preparation and hydrogen barrier mechanism of Ni-based coatings on X80 pipeline steel

Yi Qin^{1,2}, Shi Zheng², Feifei Huang¹, Ying Jin^{*1}, Li Ma^{*2}

¹National Center for Materials Service Safety, University of Science and Technology Beijing, Beijing 100083, P. R. China

²National Key Laboratory for Marine Corrosion and Protection, Luoyang Ship Material Research Institute (LSMRI), Qingdao 266237, P. R. China

Presenter's e-mail address: d202110524@xs.ustb.edu.cn

Abstract Ni, Ni-Zn, and Ni-Zn-P coatings were electrodeposited on the surface of X80 pipeline steel to explore their hydrogen barrier behavior. Hydrogen adsorption and desorption as well as the absorption and diffusion process were investigated by experiments with Devanathan-Stachurski double electrolytic cell and electrochemical impedance spectroscopy (EIS), and the kinetic parameters of hydrogen permeation were estimated via modelling and data fitting. Furthermore, the distribution, concentrations and corresponding binding energies of different hydrogen traps in the coatings and at the coating/substrate interface were measured by the glow discharge optical emission spectroscopy (GDOES) and thermal desorption spectrum (TDS). Although hydrogen is more likely to be produced and accumulated on the surface of Ni-based coatings than that of the bare X80 steel, it is confirmed that amorphous Ni-Zn and Ni-Zn-P coatings can effectively reduce the apparent hydrogen diffusion coefficient of the coated sample, with Ni-Zn-P exhibiting more pronounced effect. This is mainly attributed to the high concentration of reversible hydrogen traps at the coating and coating/substrate interface.

Keywords X80 pipeline steel, electrodeposition, Ni-Zn-P, hydrogen barrier

Reference

[1] Zheng S, Qin Y, Li W, Huang F, Qiang Y, Yang S, et al. Effect of hydrogen traps on hydrogen permeation in X80 pipeline steel — a joint experimental and modelling study. *International Journal of Hydrogen Energy*. 2023;48:4773-88.