Corrosion behaviour of Inconel 625 in hydrothermal phosphate molten salts in supercritical water

Ke Li [1], Jiquan Chen [1],Zitao Lin[1], Xingying Tang[2]

[1]School of Resources, Environment, and Materials, Guangxi University, Nanning 530004, China

[2] Guangxi Laboratory on the Study of Coral Reefs in the South China Sea, Guangxi University, Nanning 530004, China

Presenter's e-mail address: 17373122919@163.com

Abstract Nickel-based alloys are one of the best reactor materials for SCWO due to their excellent mechanical strength, resistance to pitting, creep, high temperature and stress corrosion cracking, but they are still susceptible to material failure in a number of complex environments, so this paper presents a comparative study of the corrosion behavior of Inconel 625 in supercritical water at various oxygen levels and phosphate phases. The study reveals that the oxide film formed after corrosion consists of three different layers. The outer layer is formed by outward diffusion of metal cations, the middle layer is a metal phosphate passivation layer, which blocks the diffusion of Fe, Ni, etc., and the inner layer is formed by inward oxidation of oxygen ions, which compete with oxygen ions in the dissolved phase phosphate. Molten phosphates facilitate the dissolution of the oxide film and the subsequent conversion of Cr_2O_3 to soluble Cr^{3+}, a process that is intensified by the presence of oxygen. In oxygen-free and oxygenated phosphate molten salt settings, oxide growth is dominated by the dissolution-precipitation mechanism. However, in the presence of dissolved-phase oxygenated phosphates, oxide formation is primarily controlled by the solid-phase growth mechanism.

Keywords Supercritical water oxidation; Inconel 625; Phosphate; Corrosion

Reference

[1] J. Yang, S. Wang, Y. Li, D. Xu, Under-deposit corrosion of ni-based alloy 825 and Fe-Ni based alloy 800 in supercritical water oxidation environment, Corros. Sci. 167 (2020) 108493.

[2] Z. Zhu, Y. Li, C. Ma, X. Liu, G. Liu, S. Wang, H. Xu, N. Zhang, The corrosion behavior of Nickel-based alloy inconel 740 h in supercritical water, Corros. Sci. 192 (2021).

[3] X. Tang, S. Wang, D. Xu, Y. Gong, J. Zhang, Y. Wang, Corrosion behavior of Ni-based alloys in supercritical water containing high concentrations of salt and oxygen, Ind. Eng. Chem. Res. 52 (2013) 18241-18250.