

The corrosion behaviour of tubular 316L stainless steel with different wall thicknesses in 325 °C pure water under the effect of solid diffusing hydrogen

Songhan Nie^{1,2}, Entong Li^{1,2}, Lining Zhang^{1,2}, Tongming Cui^{1,2}, Junjie Chen^{1,2}, Zhanpeng Lu^{1,2,*}

¹ *Institute of Materials, School of Materials Science and Engineering, Shanghai University, Shanghai 200072, China*

² *State Key Laboratory of Advanced Special Steels, Shanghai University, Shanghai 200072, China*

* Corresponding author: zplu@t.shu.edu.cn

nsh19980725@shu.edu.cn

Abstract Austenitic alloys are widely used to fabricate critical components for pressurized water reactor (PWR) nuclear power plants. Dissolved hydrogen gas in the coolant in the primary loop can dissociate at the alloy surface as atomic hydrogen that can enter into the interior of the alloys. The atomic hydrogen would affect the service performance of these alloys in contact with high temperature water. The steam generator (SG) tube is the junction of the primary and the secondary loops. The dissolved hydrogen in the coolant of the first loop continuously diffuses through the SG tube to the second loop, and this steady state diffusion of hydrogen may affect corrosion on the secondary side. It is necessary to investigate the effect of diffusing hydrogen on corrosion of the secondary side surface of the SG tubes. Using a special external hydrogen-filled high temperature and high pressure water corrosion test device, hydrogen can continuously diffuse from one surface of 316L tubular specimens with various thicknesses to the other surface exposed to high temperature water at 325 °C. The effects of diffusing hydrogen on the composition and structure of the oxide film on the surface of 316L stainless steel tubular specimens with different wall thicknesses were investigated. The results show that in the case of the same hydrogen concentration on the hydrogen-filled side, the wall thickness has a significant effect on the morphology and composition of the oxide film on the surface of the specimen, for example, the surface oxide particles formed on the specimen with a wall thickness of 3.01 mm are significantly less than those of the 1.79 mm one, and the differences in the thickness of inner oxide film can also be observed.

Keywords 316L stainless steel, diffusing hydrogen, high temperature water, oxide film