High-temperature molten salt corrosion and cracking behavior of 316L stainless steel under creep:Experiments and modeling

Heng Li[1] , Xiaowei Wang[1], Jianming Gong[1], Shan-Tung Tu[1,2]

[1] *School of Mechanical and Power Engineering, Nanjing Tech University, Nanjing 211816, China*

[2] *School of Mechanical and Power Engineering, East China University of Science and Technology, Shanghai 200237, China*

heng_li@njtech.edu.cn

Abstract Solar salt (60 wt% $NaNO_3$ + 40 wt% KNO_3) is widely used in state-of-the-art concentrated solar power (CSP) plants [1]. However, the corrosion cracking of the structural materials caused by molten salt corrosion and creep could lead to the premature failure of components. In this study, using a specially designed apparatus, interrupted creep tests for 316L stainless steel were performed in molten solar salt at 565 °C under the nominal stress of 270 MPa. A corrosion kinetic model was proposed to capture the effects of creep deformation on corrosion behavior. Furthermore, a damage model and the corresponding user subroutines were developed to predict the corrosion and cracking behavior. The results indicate that the stored dislocation and dislocation substructures developed during creep promote mass transfer. The accumulation of dislocations and dislocation substructures along grain boundaries (GBs) leads to a higher growth rate of oxide in GBs, which promotes the initiation and propagation of cracks. The material depletion and multiple intergranular crack paths are modeled based on the microstructure of 316L steel by implementing the damage model in UMAT and USDFLD subroutines. The predicted corrosion and cracking morphologies are in good agreement with the corrosion kinetic curves and corrosion crack morphologies.

Keywords Molten salt corrosion, creep, cracking, dislocation substructures

Reference

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