The corrosion of 316 stainless steel in molten salts

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Abstract The 316 stainless steel (316 SS) as one kind of high-temperature materials has applications to the molten salt reactors (MSR) and concentrating solar power (CSP) plants. Molten fluoride salts can be used as the fuel and coolant for MSR. Molten chloride salts and nitrate salts can be used as the heat transfer fluid in the CSP. The corrosion resistance of 316 SS in molten salts is one of critical issues for the liftertime and safety of MSR and CSP. Therefore, the corrosion of 316 SS in molten nitrate salts, chloride salts, and fluoride salts at high temperature were investigated. (1) The corrosion of 316 SS in molten $NaNO_3$-KNO_3 salt can form oxides and then decrease the corrosion rate. The evolution of corrosion depth with time indicates that the corrosion rate of 316 SS in $NaNO_3$-KNO_3 salt at 565℃ is less than 10 μm/year. (2) The corrosion of 316 SS in molten NaCl-KCl-$MgCl_2$ salt is mainly attributed to the impurities in salt. Among these impurities, the H_2O is critical to drive the intergranular corrosion of 316 SS. The corrosion rate of 316 SS in molten NaCl-KCl-$MgCl_2$ salt at 700 ℃ can be decreased from >100 μm (for 100 h) to 5μm (for 3000 h) by removing the impurities from salt. (3) The corrosion of 316 SS in molten LiF-NaF-KF salt is also attributed to the impurities in salt. There are Ni-containing and Fe-containing impurities in the purified fluoride salts. These impurities in the purified LiF-NaF-KF salt can drive the intergranular corrosion of 316 SS. Based on the corrosion mechanism of 316 SS in molten fluoride salts, the corrosion rate of 316 SS in molten fluoride salts can also be decreased. Finally, slight uniform corrosion occurres in the 316 SS at 700 ℃ if the impurities in molten fluoride salts are controlled.

Keywords: Stainless Steel; Corrosion; Molten Salt; CSP; MSR