

## **Corrosion behavior of commercial Fe- and Ni-based alloys in molten nitrate salt at 600°C**

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Concentrated Solar Power (CSP) systems are qualified as one of the most promising energy generation methods owing to the possibility of coupling it with thermal energy storage (TES) systems. Molten nitrate salt mixtures are state-of-the-art as heat transfer fluids and/or storage medium. In CSP systems, solar radiation is concentrated to a receiver via heliostats and molten nitrate salts are circulated in the absorber tubes to store and transfer the thermal energy for subsequent power generation via a steam turbine. The non-eutectic composition of 60 wt.% NaNO<sub>3</sub> and 40 wt.% KNO<sub>3</sub> –also known as the solar salt– is extensively used in the field. While offering beneficial thermophysical properties such as high heat capacity and thermal conductivity, the employment of molten nitrate salts can be accompanied with a high corrosion rate. This causes the material selection to be one of the most challenging tasks for the development of the CSP technology. Ni-based alloys are widely used in CSP plants due to their high corrosion resistance against molten nitrate salts. Nevertheless, a deeper understanding of the prevailing corrosion mechanisms for different alloys might enable the employment of cheaper structural materials and thus increase the cost efficiency of CSP systems or even allow for higher operating temperatures for higher energy conversion efficiencies.

In this study, coupon samples (15x10x3 mm<sup>3</sup>) of Ni-based alloys Haynes-230 and Alloy 400, austenitic steels, DMV 310 N and Alloy 800H as well as the lower-priced ferritic-martensitic steel X20CrMoV12-1 were isothermally exposed to molten solar salt at 600°C in flowing synthetic air (4 L/h). Samples were taken out of the hot furnace after exposure durations of 100, 300 and 1000 h and rinsed in warm water to remove the salt residues. Weight change measurements indicated a higher corrosion resistance for Ni-based alloys compared to their Fe-based counterparts. Besides weight change measurements, X-ray diffraction (XRD) and electron micro-probe analysis (EPMA) were used to characterize the corrosion products. The results and their comparison with literature data showed that the extent of chloride and/or other impurities present in the salt mixture can significantly alter the corrosion kinetics. In addition, exposure of pure Fe, Ni and Cr samples to the same conditions allowed for a deeper insight into the prevailing corrosion mechanisms. The dissolution behavior of pure metals and the outcomes of the exposure tests of commercial alloys indicated that coatings can be utilized to increase the corrosion resistance of lower-priced alloys thus enable their employment as absorber tubes and increase the cost-efficiency of CSP systems.