

Influence of different magnesium sources in doping molten salts for the mitigation of corrosion for CSP/CST technologies

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1. Introduction

The chemical and thermochemical characteristics of molten salt mixtures are one of the key points for their use as a source of thermal energy storage in a CSP/CST plant. The presence of impurities in these mixtures can affect not only their thermochemical properties but also their corrosivity. In this field, some studies indicate that the presence of magnesium (as an impurity) can slow down the corrosion process caused by molten mixtures [1, 2]. On the other hand, the use of doped molten salts has become an excellent strategy for increasing the efficiency of CSP/CST plants [3], although there are still not many studies in this area on the influence of doping agents on the corrosion of the plant's metallic materials.

This paper aims to present the first results of the study about the dopped LiNaK carbonate molten salts with magnesium from different sources and with different particle sizes (nano and micro) on the corrosion rate of stainless steel AISI 430.

2. Methodologies

2.1 Preparing the molten salt mixtures

Beyond the eutectic mixture of lithium, sodium and potassium carbonate salts (32.1:33.4:34.5 m/m), three new mixtures of these molten salts were prepared, each doped with 1% of MgO nanoparticles (99% purity, 20 nm) in a clean room; 1% of Basalt Scale 2 (BS2-3% Mg, 0.25 mm); and 1% of Basalt Rock Powder (BRP-4% Mg 0.063 mm). The basalt was obtained from the Azores islands in 2 different fractions, and the nanoparticles, from SkySpring Nanomaterials, were homogenised with the eutectic mixture in a mechanical mill for 5 min. The undoped mixture also has magnesium as an impurity.

2.2 Corrosion tests

The corrosion tests were carried out in a muffle furnace at 650 °C where the AISI 430 steel was in direct contact with each of the mixtures for 24, 240 and 1000 hours, under static conditions and atmospheric air.

3. Results

This abstract only includes the results from 240 hours of test.

From the corrosion rates obtained (Table 1), it can be observed that these values for the mixture doped with nanoparticles are lower than those of the undoped mixture. The effect with BS2 and BRP doesn't seem to be as significant.

Table 1. Corrosion rate of AISI 430 immersed in different mixtures LiNaK carbonate salt up to 240 h at 650 °C.

Salt	Without doping	With MgO nanoparticles (nano)	With Basalt Scale 2 (BS2)	With Basalt Rock Powder (BRP)
Corrosion rate ($\mu\text{m}/\text{year}$)	325 ± 59	244 ± 13	310 ± 32	322 ± 23

The examination of the XRD diffractograms demonstrates that the same oxides are formed in all mixtures, namely $\text{Li}_5\text{Fe}_5\text{O}_8$, LiFeO_2 , LiCrO_2 , and MgO .

SEM surface images (Fig. 1) demonstrate that the morphological structures of the oxides are different, depending on the type of doped salt mixture used, which is more homogeneous when nanoparticles are used compared to the two types of basalt.

SEM/EDS surface analysis also revealed that magnesium is distributed uniformly across the surface, with the tests using MgO nanoparticles exhibiting the highest levels of magnesium detection. This may explain why the corrosion rate is lower than in the other tests mentioned in this work.

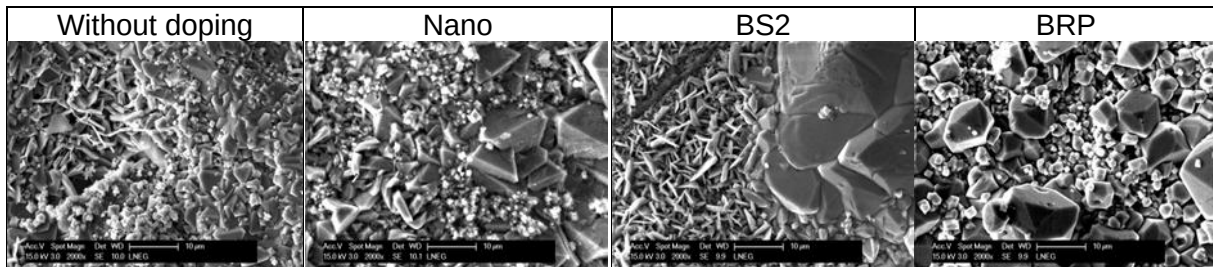


Fig. 1: SEM surface images obtained with SE detector of the oxide scales formed on AISI 430 after immersion different mixture LiNaK carbonate salt at 650 °C after 240 h.

4. Conclusions

These results show that magnesium particles, namely nanoparticles appear to have a significant impact by reducing the corrosion rate of AISI 430 stainless steel. It is necessary to study longer exposure times to understand the mechanism, the kinetics of corrosion and how these doping affect the thermophysical properties of the salt mixtures.

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