METHODOLOGIES FOR ASSESSING CORROSION UNDER DYNAMIC CONDITIONS WITH MOLTEN SALTS IN CSP/CST APPLICATIONS

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ABSTRACT
Renewable energy implementation represents a key point in reversing global warming and climate change. In recent years, there has been an investment in Concentrated Solar Power (CSP) with Energy Storage (TES). Solar Salt is the most energy storage fluid optimized with a melting point of 223 °C and thermally stable up to about 550 °C. One of the most relevant problems in the use of fluids as thermal energy storage is their compatibility with construction materials (pipes, valves and tanks). This fact, combined with high temperatures (300-550 °C) makes the materials more susceptible to corrosion. Static immersion experiments are suited to screen and compare different candidate materials for molten salt applications (Fernández et al., 2019; Gomes et al. 2019), but corrosion rates derived from these experiments might differ significantly from the rates experienced in a real operating environment of a solar plant (Florian *et al.* 2021). There are currently no specific procedures for evaluating corrosion in molten salts under dynamic conditions, so it is important to develop more practical application conditions to validate methodologies and facilities.

The main purpose of this work is to identify the suitable procedures to make a reproducible experimental dynamic corrosion test using an experimental set-up that can vary the velocity of molten salts over a wide range.

In this work, corrosion studies on austenitic stainless steel (SS) (AISI 316L) and ferritic steel (AISI 430) under dynamic conditions (linear stirring speed of 1.3 m/s.), during 1000 h and 3000h), on 3 facilities from different institutions (CIEMAT, ENEA and LNEG) (Fig.1) were carried out to compare the influence of the set-up configurations and experimental procedures on the results of corrosion rate. The influence of surface preparation of steels (with and without silicon carbide sandpaper) and the descaling process (3 different descaling methods described in standards ISO 17245 and ISO 8407) were the different experimental procedures studied. Corrosion products by X-ray Powder Diffraction (XRD) and Scanning Electron Microscopy (SEM)/EDS on the surface and cross-section were also characterized to evaluate the corrosion mechanism.

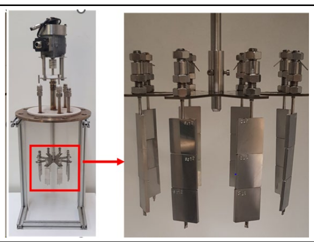		
CIEMAT set-up (moving samples)	ENEA set-up (fix samples and moving salt)	LNEG set-up (fix samples and moving salt)

Fig. 1. Experimental facilities from CIEMAT, ENEA and LNEG

As it was found that the methodology of the descaling process could influence the results of corrosion rate, a round robin was carried out between the 3 institutions. Each laboratory received specimens from each other, having carried out the same descaling process, and calculated the corrosion rate (Fig 2)

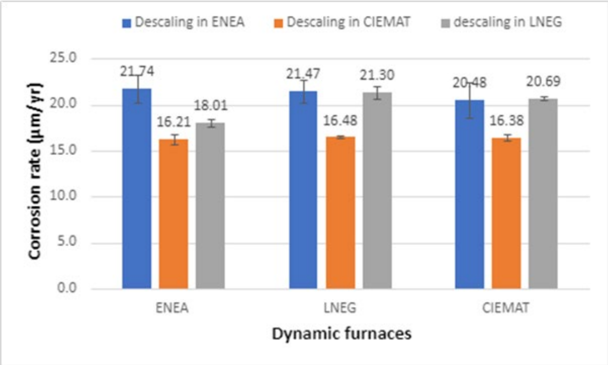

Fig. 2. Corrosion rate from round-robin corrosion test in 3 different experimental set-ups realized with AISI 316L during 1000h in contact with solar salt at a velocity of 1.3m/s.

The corrosion rate of AISI 316L and AISI 430 steels over time in Solar Salt, is shown in Figure 3.

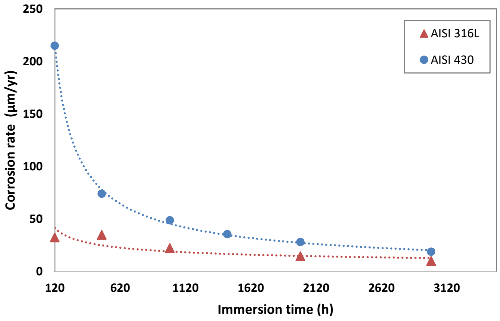

Fig. 3. Corrosion rate of AISI 316L and AISI 430 exposed to solar salt for different immersion times at 550ºC with a velocity of 1.3m/s.

The following results/conclusions can be drawn from this study:
1) The surface preparation of the steel has no significant influence on the corrosion rates obtained;
2) The descaling method selected, as well as the laboratory procedure adopted, has a significant influence on the corrosion rate results obtained;
3) Similar corrosion rates were obtained with the different facilities and configurations and also proved the importance of selecting and optimizing descaling methods in the results obtained.
4) The results of the corrosion rates under dynamic conditions for ferritic and austenitic steel, as well as their corrosion mechanism, were validated.
5) In experimental set-ups, the electrical insulation of the samples (replicas) must always be guaranteed and steels with different compositions should not be tested simultaneously.

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