ID de Contribution: **77** Type: **Poster**

CORROSION OF STEEL IN MOLTEN SODIUM NITRATE AT HIGH TEMPERATURE

mardi 10 mai 2016 10:15 (20 minutes)

Concentrating solar power (CSP) systems which use concentrated sunlight to produce electricity by turning steam turbines have been receiving a lot of attention in recent years. However, as we all know, solar energy is a fluctuating resource because of the daily rotation of the earth, seasons and weather conditions. The challenge here is to store this energy and release it at the right time. An innovative thermal storage solution has been developed to apply to CSP plants with direct steam generation. Principle of the storage is using a phase change material (PCM) for storing and releasing thermal energy. During the storage phase, when the sun shines, the heat transfer fluid passes through a heat exchanger and transfers its heat to the PCM, making it to change phase from solid to liquid. The releasing phase is done with the same way, the heat transfer fluid is now heated in the exchanger, and in this case, the PCM passes from the liquid phase to the solid phase.

Today, molten salt is an important solvent system for high temperature applications. Nitrates melt are privileged materials to fill the role of material storage due to the high heat capacity, low melting point, and easy availability. However, the corrosion effects occur between the molten salt and the structural material using to make heat exchanger is always a major concern as corrosion is accelerated at high temperatures. Based on good understanding about the corrosion products, kinetics and mechanism of reactions of iron in fused salt nitrate, the design, operational conditions, the thickness of heat exchangers required for operation in a given period can be calculated.

In this work, the behavior of heat exchanger's structural material (low alloy steel) in molten sodium nitrate (NaNO3) was studied. Corrosion test of steel in NaNO3 at 340℃ by weight-loss method were conducted and corrosion rate was found to follow logarithmic kinetic:

Ep.(µm)=0,53*log(time(h))-0,2

In addition, DRX and Tof-Sims analysis performed at the end of corrosion test proved the formation of an oxides layer consist of an equimolar mixture of Fe3O4 and Fe2O3 on the steel's surface following these corrosion reactions:

3Fe + 4NaNO3 = Fe3O4 + 4NaNO2 (1) 2Fe + 3NaNO3 = Fe2O3 + 3NaNO2 (2)

Besides, the electrochemical behavior of steel in NaNO3 at 340℃ comparing to a platinum electrode in the same media is also investigated by electrochemical methods. The similarity of these i-E stationary curves obtained by chronoamperometry showed that corrosion of steel lead to formation of a protective and conductive oxide layer on the steel's surface. Impedance spectroscopy measurements were also performed to have additional information on corrosion kinetics and characteristics of the layers (resistance, capacitance⋯) and a corrosion mechanism of steel in NaNO3 at 340℃ is also proposed

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Classification de Session: Poster session

Classification de thématique: Nuclear Physics