Interaction of Pipeline Materials with Molten Fluoride Salts

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Molten fluoride salts are very promising carriers for the transport of large amounts of heat for example from a high temperature nuclear reactor to a plant which generates hydrogen by chemical processes or from a nuclear reactor to a heat exchanger being a part of the equipment needed to realize the Brayton cycle with a very high power efficiency.

Therefore, in the framework of our project, experimental and theoretical investigations of the interactions of fluoride salts as heat carriers needed as high potential and structural materials for pipelines in order to transport heat at temperatures above 600 °C were started.

Experimental investigations of Fe-based and Ni-based materials in molten fluoride salts at high temperatures and with different exposure times were performed. Two components salts (LiF-NaF and NaF-$NaBF_4$) and three components salts (LiF-NaF-ZrF_4 and LiF-NaF-RbF) were chosen in the experiments. The salt analysis was focussed on the content of metallic elements before and after the exposure of the samples to the salt melts. It was done by inductively coupled plasma-optical emission spectrometry (ICP-OES) and by titrimetric techniques.

The thickness of the material zone affected by the salt melts, characterized by an enriched / reduced content of elements in comparison to the mean original content, and the material attacked zone, characterized by very tiny channels or chains of pores or pits formed preferably at grain boundaries, were the subject of the analysis performed by electron microscopy / microprobe techniques. Theoretical models for the transport of elements in the material samples exposed to salt melts using experimental data were also developed.

Key words: Fluoride Salts; Materials; High Temperature Interactions.