Corrosion behaviour of steels in oxygen containing, liquid Pb55,5%Bi considering surface modification

Abstract

The concept of an ADS (accelerator driven system), which intended to be used for the transmutation of actinides and transuranics, combines a sub critical fission device and an accelerator driven spallation neutron source. Liquid lead or a lead bismuth alloy are candidate materials for the spallation target and the coolant. To guarantee a continuous operation the corrosion problems caused by liquid Pb and PbBi have to be controlled. It is known that protective oxide layers on steel surfaces retard the corrosion attack.

In this work, martensitic and austenitic steels are tested in stagnant and flowing Pb55,5%Bi at temperatures between 420 – 600°C. In addition samples alloyed with Al in the surface and Al containing coatings are investigated. Aim of this work is to record the corrosion behaviour of steels in liquid eutectic PbBi alloy and to show possibilities to protect the steels by developing stabile oxide scales under controlled oxygen potential. An important prerequisite for the adjustment of the oxygen concentration in PbBi via the gas phase was the study of the Pb-Bi-O system. It will be shown, that the oxygen partial pressure above the liquid PbBi has to be 2 magnitudes higher than above liquid Pb to form stabile protective layers.

No liquid metal corrosion is observed at an oxygen concentration of 5*10-7wt% in PbBi exposed up to 7223h at a temperature of 550°C. Oxide layers which spalls off grow again. At higher temperatures aluminising of the surface is needed. If the Al concentration in the surface is high enough, no detectable dissolution attack happens. Pure Al layers have no protective effect. NiCrAlY layers show low stability, because of the high solubility of the basic component Ni in the liquid metal. Therefore a FeCrAlY layer seems to be more promising. It is shown that thin coatings could be bond with the bulk material by the GESA treatment. Spalling of these coatings is not expected.