

Advanced mitigation strategies for HLM Corrosion – GESA, AFA, HEA

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Abstract

Liquid Pb and PbBi are promising coolants for nuclear reactors operating in fast neutron spectrum. Beside its excellent neutronic properties, Pb and PbBi offer improved safety features. But, deficient compatibility of structural materials with the liquid metals especially at higher temperatures is a major challenge to be solved for the use of Pb and PbBi as coolant or heat storage material.

The major driving force for corrosion attack is the solubility of steel alloying elements like Ni, Fe and Cr in the HLM. Addition of oxygen to the HLM to provide in-situ formation of protective oxide scales is the mitigation mechanism of choice, but limits the operating temperature window. To enlarge the operation window of HLM cooled nuclear reactors advanced mitigation measures are under investigation since several years. Alloying of strong oxide formers like Al into steel surfaces can shift the operating temperature window to 600°C and even higher. FeCrAlY surface layers and bulk materials are one further option to increase the corrosion resistant in oxygen containing liquid metals. Both methods rely on the in-situ oxidation capability of the modified or changed material. Recently new classes of bulk materials alumina forming austenitic steels (AFA) and alumina forming high entropy alloys (HEA) are investigated. This presentation will briefly discuss the involved corrosion (dissolution and oxidation) mechanisms and will then focus on the advanced mitigation strategies that rely on in-situ alumina formation (surface alloying and the new advanced alumina forming bulk materials (HEA and AFA) required for reliable long term operation at higher temperatures for HLM cooled fast reactors.