Experiments to assess the transport of fibrous insulation debris

A. Seeliger[1], G. M. Cartland Glover[2], E. Krepper[2] S. Renger[1], W. Kästner[1] and H. Kryk[2]

[1] Hochschule Zittau/Görlitz, Institute of Process Technology, Process Automation and Measuring Technology, P.O. Box 1455, D-02754, Zittau, Germany

[2] Helmholtz-Zentrum Dresden-Rossendorf, Institute of Safety Research, P.O. Box 510119, D-01314, Dresden, Germany

ASeeliger@hs-zigr.de, g.glover@fzd.de, e.krepper@fzd.de, srenger@hs-zigr.de

Abstract

Loss of coolant accidents (LOCA) in the primary cooling circuit of a nuclear reactor may result in damage to insulation materials that are located near to the leak. The insulation materials released may compromise the operation of the emergency core cooling system (ECCS). Insulation material in the form of mineral wool fibre agglomerates (MWFA) maybe transported to the containment sump strainers mounted at the inlet of the emergency cooling pumps, where the insulation fibres may block or penetrate the strainers. In addition to the impact of MWFA on the pressure drop across the strainers, corrosion products formed over time may also accumulate in the fibre cakes on the strainers, which can lead to a significant increase in the strainer pressure drop and result in cavitation in the ECCS. Thus, knowledge of transport characteristics of the damaged insulation materials in various scenarios is required to help plan for the long-term operability of nuclear reactors, which undergo LOCA.

An experimental and theoretical study performed by the Helmholtz-Zentrum Dresden-Rossendorf and the Hochschule Zittau/Görlitz[1] is investigating the phenomena that maybe observed in the containment vessel during a LOCA. The study entails the generation of fibre agglomerates, the determination of their transport properties in single and multi-effect experiments and the long-term effect that corrosion of the containment internals by the coolant has on the strainer pressure drop.

The focus of this presentation is on the experiments performed that characterize the horizontal transport of MWFA, whereas the corresponding CFD simulations are described in an accompanying contribution (see abstract of Cartland Glover et al.). The experiments were performed a racetrack type channel that provided a near uniform horizontal flow. The channel is 0.1 wide by 1.2 m high with a straight length of 5 m and two bends of 0.5 m. The measurement techniques include particle imaging (both wide-angle and macro lens), concurrent particle image velocimetry, ultra-velocimetry, laser detection sensors to sense the presence of absence of MWFA and pertinent measurements of the MWFA concentration and quiescent settling characteristics. The transport of the MWFA was observed at velocities of 0.1 and 0.25 m s^{-1} to verify numerical model behaviour in and just beyond expected velocities in the containment sump of a nuclear reactor.

Keywords: Mineral Wool Fibre Agglomerates, Loss of Coolant Accidents, Containment Sump, Particle Imaging, Particle Image Velocimetry,

[1] The reported investigations are funded by the German Federal Ministry of Economics and Technology (BMWi) under Contract No. 1501360 and 1501363.