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P4.184 Thermal-hydraulic and thermo-mechanical simulations of Water-Heavy Liquid Metal interactions towards the DEMO WCLL Breeding Blanket design

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Within the framework of the EU-DEMO Breeding Blanket (BB) research activities, the Water-Cooled Lithium Lead (WCLL) BB concept is the only one which adopts pressurized sub-cooled water as coolant and a Heavy Liquid Metal (HLM), namely Pb-15.7Li alloy, as breeder and neutron multiplier.
Cooling water, characterized by operative conditions typical of PWR fission reactors (temperature in the range of 295-328 ℃ and pressure of 15.5 MPa), is foreseen to flow inside the cooling circuit housed within the breeder and deputed to remove the heat power therein generated. Hence, as a consequence of possible in-box LOCAs occurring within the breeder zone, water-HLM interactions might take place whose investigation has to be considered pivotal for the reactor safety analysis and mandatory during design activities.
Within this framework, C.R. ENEA-Brasimone has adopted the LIFUS5 facility for the investigation of water-HLM interactions, carrying out several experimental campaigns and starting validation activities of numerical codes in order to predict both the thermal-hydraulic and thermo-mechanical performances of breeding blanket components under such accidental scenario.
Thermal-hydraulic analyses reproducing experimental tests have been carried out by means of the SIMMER-III code, a numerical tool able to investigate effects of water-HLM interactions in terms of fluid-dynamic and thermal behaviour during postulated transient LOCA scenarios. From the thermo-mechanical point of view, a numerical approach based on the ABAQUS Finite Element code has been adopted in order to reproduce the aforementioned experimental tests in term of test section stress and strain fields. Finally, results obtained from numerical simulations have been benchmarked against experimental measurements to validate the numerical models set-up, with the aim of assessing and improving their reliability.
Numerical results obtained together with their benchmark against experimental data are herewith reported and critically discussed.

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