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Seminarium Zakładu Energetyki Jądrowej i Analiz Środowiska (UZ3) Departament Badań Układów Złożonych (DUZ)

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CFD study within the IVMR project of heat transfer in a metal layer with prescribed top and bottom boundary conditions

Abstract:

During the course of severe accident for Light Water Reactor, the phenomena of appearance of a light metal layer on the top of the corium melt pool can occur. The IVMR (In-Vessel Melt Retention) project carried out under the Horizon 2020 program in 2015-2019 was aiming at better understanding the thermo-hydraulic phenomena related to corium pool stratification and heat exchange with its surroundings. At NCBJ the calculations of the thin metallic layer were performed, with the use of Computational Fluid Dynamics software – ANSYS Fluent, for the layer with prescribed bottom and top heat flux and fixed temperature at the external vertical wall.

The calculations contained 25 cases for varying metal layer heights and top heat transfer ratio (η). The calculations enabled to analyze the set of thermal-hydraulics parameters of the prototypical metallic layer: temperatures for average volume, top zone and surface, top and bottom zones modules of velocities and velocity streamlines.

From the data extracted from computational software, the lateral heat transfer coefficient and Nusselt number were calculated. On the basis of those, two correlations were proposed for layer heights below and above 10 cm, where distinctive flow regime change was observed.

The simulations performed show prevailing convection heat transfer mechanism for the increasing layer heights and top heat transfer ratio η . The full domain one cell flow pattern was detected for lower layer heights, while for higher ones the convective cells were dominant.

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