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NACIE-UP: a HLM loop facility for natural circulation experiments

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The NACIE-UP facility at ENEA-Brasimone R.C. is a large scale loop operating with Lead Bismuth Eutectic (LBE) in the range of 180°C-450°C in free and mixed convection. The difference in height between heat source and heat sink is about 4.5 m and allows the establishment of natural circulation regime inside the loop. Moreover, a gas-lift system provides the pressure head to enhance the circulation. The facility comprises also a secondary system in pressurized water with air-cooler to cool the primary LBE. The primary side is instrumented with a prototypical thermal flow meter, a pressure transducer to measure pressure drops across the test section and several thermocouples.

A wire-spaced 19-pins fuel bundle is actually installed inside the NACIE-UP loop. The pin bundle has a maximum wall heat flux of 1Mw/m² and is equipped with 67 thermocouples to monitor temperatures and analyze the heat transfer coefficient in different sub-channels and axial positions. Another test section has been designed in order to study the thermal-hydraulic behavior of a pin fuel bundle cooled by HLM in a flow blockage accident scenario. The bundle is composed of 19-pins with two spacer grids and is equipped with 100 thermocouples in order to monitor pin wall temperatures both with and without blockage, the presence of hot spots and to evaluate the thermal mixing above the pin bundle. The experimental campaigns related to these two sections aim to study outstanding thermal-hydraulic phenomena such as the heat transfer during transient from forced to natural circulation flow and the flow blockage accident in a fuel assembly. These activities are in support of the front-end engineering design (FEED) of GEN. IV/ADS prototypes and demonstrators. Some experimental data on heat transfer coefficient obtained in mixed and natural circulation flow regime are also presented in the paper.

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