ENERGETICS

MUR DM 117/Newcleo - Experimental and numerical study of a bayonet tube heat exchanger for decay heat removal in LFR

Funded By	NEWCLEO S.R.L. [P.iva/CF:12517780016] MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	Simulation and physical modelling of reactor components, validation against experiments Progetto finanziato nell'ambito del PNRR - DM 117/2023 - CUP E14D23001950004
Objectives	After reactor shutdown, residual heat is still released from activated materials produced during normal operation. Although this source of thermal power is only a small fraction of the nominal power, it must be removed to prevent loss of integrity of the structures containing the radioactive materials, and in particular, to ensure the confinement of the fission products within the fuel rods. The DHRS can be made of different sub-systems working redundantly or in complementary way. In LFRs, typical DHRS are represented by Reactor Vessel Air Cooling System (RVACS) and dip coolers. newcleo is working on innovative and passive heat exchangers of the bayonet type, capable of cooling down the molten lead that fills the reactor pool while avoiding lead freezing at the same time. Such exchangers are composed by a stack of shell and bayonet tubes submerged in lead (primary fluid). The secondary fluid is represented by water entering by gravity at atmospheric conditions, which is heated undergoing phase change, leaving then the bayonet tube as superheated steam. An experimental campaign is planned at the thermal-hydraulic laboratory of the Department of Energy of the Politecnico di Torino to optimize the design of the exchangers and to verify the expected performances. The first goal of this campaign is to improve the thermal sizing of the component, verifying the assumptions made in terms of, e.g., critical quality and two-phase heat transfer coefficients. The tests will focus on both the steady state and transient component behavior, as well as on the start-up performance of the

	system, that is having cold water suddenly in contact with the hot bayonet walls. The campaign also aims at performing a hydraulic assessment of the bayonet tubes and of the DHR circuits, possibly identifying the conditions for the development of flow instabilities which might hinder the integrity of the component. The present PhD proposal focuses on the analysis of the experimental data adopting numerical models of increasing complexity, starting from simple handbook equations and then moving towards 1-D system codes, such as AC2-ATHLET. The availability of experimental data also represents an excellent opportunity for the development and validation of models coupling system level thermal-hydraulics (for the pipings) and CFD (for the bayonet tube itself), keeping in mind that two-phase CFD is currently a field of active scientific research. Quarterly reports will track the advancement and progress of the work. The preparation of scientific publications is requested as part of the research program.

Skills and competencies for the development of the activity	Fundamentals in Computational Fluid Dynamics and Thermal-hydraulics. Computer skills (already present or willing to learn): LATEX, Python, bash, Linux-OS.