Contribution ID: **23026** Type: **Paper**

Effect of heating configuration on plenum-to-plenum thermal hydraulics of buoyancy driven air

Wednesday, 15 November 2023 09:40 (20 minutes)

Plenum-to-plenum thermal hydraulics in a Prismatic Modular Reactor (PMR) during loss of flow accidents (LOFA) has been of high interest for several researchers. Accordingly, this study aims to study the effect of uniform and non-uniform heating configurations on the buoyancy driven air in a vertical dual channel plenum-to-plenum facility (P2PF) representing the PMR core geometry. Advanced measurement techniques such as hot wire anemometry, T-type thermocouples, and micro-foil sensors are integrated to enable thermal and flow fields measurements at different axial and radial locations along the electrically heated channel of the P2PF. Results show that surface temperature as well as air temperature and velocity increase from the leading edge followed by a reduction within the axial range of ($0.6 < Z/L < 0.8$) depending on the heating profile. This reduction could be attributed to the conduction heat losses through the flange connecting the hot channel to the upper plenum in addition to expected flow reversal and back mixing at the exit of the hot channel leading to flow destabilization. Indeed, it is concluded that the distribution of air temperature and velocity along the heated channel is significantly affected by the heating intensity and configuration applied to the channel. Present findings will overcome the lack of insufficient experimental data for studying the thermal hydraulics in PMR and for validating computational fluid dynamics codes.

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Session Classification: Day 3- Parallel Session - I : Thermal-Hydraulics

Track Classification: Nuclear Thermal-hydraulics