POOL-LOOP: EXPERIMENTAL FACILITY FOR NATURAL CONVECTION FLOW IN A POOL WITH IMMERSED HEAT EXCHANGERS (PASSIVE SYSTEM)

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The POOL-LOOP facility is a stainless-steel pool operating at atmospheric pressure, designed for the Spent Fuel Storage Pool application. This facility is dedicated to characterizing the use of Immersed Heat Exchanger (IHX) inside a pool, where a natural convection flow is expected to passively transfer heat from the hot source (the spent fuel assemblies, represented by electrical heaters) to the IHX, which functions as the cold source. The facility dimensions are 7 meters in height, 2.5 meters in length, and 1.6 meters in width. The principal aim is to demonstrate the establishment of a natural convection loop within the pool, including the IHX, and to assess the IHX's performance in passively dissipating heat. The secondary aim is to validate local CFD models at the experimental scale of POOL-LOOP, with the intention of transposing these models to an industrial scale. Several parameters within the facility are variable: type of IHX (horizontal or vertical tubes, plates, etc.), vertical position within the pool, location and size of the chimney guiding flow below the IHX, power of the heating assemblies (maximum power of 300 kW), flow rate and temperature conditions at the IHX active secondary side inlet. The facility is fully instrumented, measuring global parameters: power injected at the hot source and power evacuated by the IHX by monitoring flow rate and inlet-outlet temperature within the tubes. A set of windows are implemented allowing visual observations of phenomena in the pool. Local parameters are measured to provide CFD validation data: temperature fields within the pool, utilizing numerous thermocouples (approximately 300) and velocity probes in the racks and IHX zones. POOL-LOOP is an adaptable facility designed to meet diverse needs. It is designed to be modular, allowing for various experimental configurations. One potential future experiment could involve replacing the current active cold source (flow driven by a pump within the IHX tubes) with a fully passive system based on two-phase flow thermosyphon or heat pipes. This configuration would enable passive heat evacuation through two consecutive systems: a passive loop within the pool and a passive circulation within the cooling circuit. Another prospective study could focus on two-phase flow phenomena within the pool by reaching the saturation temperature. Additionally, an external pipe could be connected to the pool to reproduce components such as safety condensers. This configuration enables the analysis of physical interactions between these systems: thermal stratification and potential dynamic flow instabilities.

113_abstract