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Adaptation of the nuclear safety code CATHARE3 to supercritical helium flow.

Several international projects on nuclear fusion are in progress and comprise cryogenic systems for components such as superconducting magnets or cryopumps. Different thermal-hydraulic codes already exist for sizing and validating these devices, but there is still no qualified scientific calculation tool to perform safety thermal hydraulic analyses encountered in fusion reactors. For this purpose, we started the adaptation of the CATHARE3 system code, the reference thermal-hydraulic tool for safety studies of French Pressurised Water Reactors, developed by CEA, EDF, Framatome, and IRSN, to model supercritical Helium flows. Properties of supercritical Helium are already available in CATHARE3 with the fluid library REFPROP. We implemented suitable correlations for friction factor and heat transfer coefficient to account for high Reynolds numbers and specific hydraulic parameters typical of Helium flow in Cable In Conduit Conductors (CICC) that are used in superconducting magnets.
Several comparisons with the THEA code developed by CryoSoft were performed. We first focused on simple test cases of flow in smooth pipes, in order to identify the origin of the differences between both codes results and to assess the influence of the fluid properties database. Then we started to model a CICC, gradually increasing the complexity of thermal loads: adiabatic conditions, heat deposition relevant to burn and quench scenarios.
Simulations focusing on the behaviour of a safety device were also performed: CATHARE3 results were compared with available experimental data on supercritical Helium discharge through the safety valve of a tank in case of failure of the insulating vacuum.

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