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Transients in two-phase helium natural circulation loops

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Some superconducting magnets, such as the CMS or R3B-GLAD, are passively cooled in helium two-phase natural circulation loop configuration. Whereas a good knowledge of steady state operation of such systems is available, transient phenomena taking place during non-stationary solicitation of such cooling systems, by sudden heat load increase, are still in course of study.
We performed experiments on a liquid helium natural circulation loop. Different types of heated sections (vertical straight tubes and a horizontal spiral tube) have been used. Heat load transients were driven by piloting the electric current flowing along a wire glued to the heated section. Evolution of parietal temperature along the heated section, total mass flow rate and pressure drop were measured in order to infer the flow and heat transfer regimes taking place.
We investigated the main thermo-hydraulic features of transients at different power ranges, on loops composed by the different heated sections mentioned above. We study the transient development of nucleate boiling and boiling crisis, as well as mass flow rate evolution. Furthermore, we study how initial conditions (initial heat flux or initial mass flow rate) can affect the transient boiling regimes. Moreover, we analyze the effect of the presence of a riser at the end of the ascending branch, both in steady and transient regimes.
The objective is, through the analysis of the time evolution of representative physical magnitudes, to identify the most relevant phenomena in order to conceive simple dynamic models for future design and operation purposes.

Primary author: Mr FURCI, Hernan (CEA Saclay)

Co-authors: Mr FOUR, Aurelien (CEA Saclay); Dr BAUDOUY, Bertrand (CEA Saclay); Dr MEURIS, Chantal (CEA Saclay)

Presenter: Dr BAUDOUY, Bertrand (CEA Saclay)

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