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Experimental study of stability and transients in a horizontally heated boiling helium thermosyphon

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Boiling helium natural circulation loops are being used as the cooling systems of large magnet systems because they provide inherent safety and maintenance advantages. It is the case of the CMS detector magnet at CERN (already in operation) or R3B-GLAD spectrometer at GSI (in installation phase). Such cooling systems are mainly composed by a top helium reservoir that provides the coolant by one or several descending feeding branches to the bottom of a hydraulic network in contact with the magnet to be cooled. The heat transferred to the fluid produces vapor in this element of the circuit, and the resulting buoyant force creates a flow. The behavior of such systems has been studied before for loops with a vertical heated branch, but only preliminary studies were conducted on loops with a horizontal heated section.
In this work experiments were conducted on a liquid helium thermosyphon facility with a 4 m length horizontal heated section. Wall temperatures on the heated section, mass flow rate and pressure drop were measured in steady and transient regimes and the stability limits of such a loop have been found. Also, different heating configurations were explored and their drawbacks and benefits were observed.
The result is that the loop is stable only above a non-zero low power and below a certain upper power limit for certain configurations. The distance from the heating to the vertical riser plays a very important role on stability. It has been found that even the low power instabilities can produce considerable temperature oscillations, potentially dangerous from the magnet protection point of view. The values of critical heat flux were found too for stable and instable cases.

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