

Dynamic simulation of high transients in forced flow Supercritical helium loop for the sizing of an experimental set-up dedicated to the study of loss of vacuum.

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In fusion reactors, large and complex systems of cryolines distribute supercritical helium to the different cryogenic users. Space constraints often impose to deport the pressure relief equipment several meters away from the protected volumes.

The loss of insulating vacuum is a major accidental situation for cryogenics systems. As the driving parameter for sizing the pressure relief devices is the heat flux transmitted to fluid, several studies have been carried out to measure the heat flux received by supercritical helium during the loss of the insulating vacuum. However, up to now the experiments found in the literature were performed only on storage vessels. Hence, to ensure a reliable sizing of pressure relief systems, the heat flux received by supercritical helium in case of loss of vacuum has also to be measured in forced flow configuration.

In this context, an experimental test bench with forced flow supercritical helium loop, named HELIOS, is being modified in CEA Grenoble to perform controlled loss of insulating vacuum around a cryoline and to measure the heat flux received by the fluid according to initial conditions of the flow. The new design of the HELIOS loop has been modelled with the system code CATHARE3. CATHARE 3 is the actual reference thermal-hydraulic tool to perform safety studies for the French Pressurised Water fission reactors and has been adapted to consider helium flow . The numerical model has been used to size the new experimental set-up. The modelling work also supported the assessment of the methodology to quantify the heat flux received by supercritical Helium resulting from vacuum break. Experimental results that will be measured on the HELIOS loop will be used in the qualification process of CATHARE3 with helium.

Category

Multi-scale and multi physics design methods

Keywords

Supercritical helium loop / Loss of insulating vacuum / Pressure Relief systems / Discharge line / Fusion reactors / Experimental setup / CATHARE-3 code

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