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Design the cold box of the helium liquefier / refrigerator

Content :

Performance of helium refrigerator or liquefier is affected significantly due to different kinds of losses associated with the Cold Box and Dewar. The main losses are pressure loss and heat in-leak from surroundings. The pressure loss can be reduced by minimizing the number of bends, elbows, length of the pipes etc. This leads to develop a compact cold box but make the system difficult to fabricate. The heat in-leak can be minimized by proper design of the support system, piping systems, MLI, valves, turbines and Dewar body mainly at necking region. The design of internal piping and support system is important to reduce different losses to the system. Therefore, a 3-D model of internal cold box is developed in order to visualise the internal system by using Solid Works software. Based on this 3-D model, heat in-leak due to conduction, molecular conduction and radiation are studied and accordingly support system of the heat exchangers is optimized by using Ansys software. Placement of different components is planned on the basis of their temperature distribution from 300 K to cryogenic temperature. As a test case, a Liquid Helium (LHe) Dewar is modelled and subsequently heat transfer analysis is done for different LHe level in Dewar. Evaporation loss and temperature distribution inside Dewar are estimated based on the following boundary conditions.

1. Heat leak from the outer wall to the inner wall of the Dewar vessels through the MLI.
2. Conduction heat leak from the Dewar vessels through the neck of the Dewar.
3. Constant temperature inside the inner wall in contact with liquid helium.

The same approach will be followed for heat in-leak calculation in the cold box considering heat conduction through the support system, radiation heat loss and molecular conduction in annular space.

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