

Design of Zero Boil-off Cryogenic Storage Vessel Using Stirling Cryocooler for Cryogenic Rocket Engine Tanks

M.M. Shyam and B.T. Kuzhiveli, Centre for Advanced Studies in Cryogenics, Department of Mechanical Engineering, National Institute of Technology, Calicut, India

Heat inleak into the cryogenic vessel is a major problem that occurred during the cryogenic storage. With the help of cryogenic insulation, the heat inleak can be reduced to a considerable amount. Among different cryogenic insulation, the Multilayer Insulation (MLI) ensures minimum heat inleak. The optimum layer density of MLI depends upon the parameters such as emissivity of shield, number of layers, the pressure of entrapped gas between the layers, etc. Even so, using MLI still there will be some boil-off of cryogen takes place inside the storage vessel. This boil-off creates a huge volume of vapour resulting in thermal stratification and self-pressurization which may lead to pump cavitation. This can be avoided by designing a zero-boil-off system with the help of a cryocooler. The cooling effect produced by the cryocooler is made to circulate around the insulations of the cryogenic storage vessel continuously to maintain a lower temperature and thereby ensure zero boil-off. The heat inleak to the MLI can be obtained by knowing the outer temperature with the help of a computer program. A Stirling-type cryocooler is used here for producing the zero boil-off condition. With the help of SAGE11 software, the Stirling cryocooler is designed and optimized for the above application. The feasibility study of the proposed system is checked in SIMSCAPE.