# Abstract

The use of liquid cryogens like LNG, liquid hydrogen, liquid oxygen, etc., has been increasing in diverse sectors like space, defense, energy, medical, agriculture, steel, cement, etc. These cryogens have low boiling points and low heats of vaporization. Therefore, special containers called dewars are used to store the cryogens. Such an arrangement reduces the operating cost as well as makes the operations more environment friendly and safer. The storage requirements and conditions in various applications could be very different; thus, design modifications to the conventional dewars become imperative to meet the newer technical specifications. One must understand the existing design methodologies of dewars to propose modifications. However, though dewars have been in commercial use for long, no design guideline is available due to proprietary reasons.

Insulation and support systems are the key components that dictate the storability of cryogens in dewars as they significantly affect the heat inleak into the dewar. On the other hand, the liquid sloshing during the transport of liquid cryogens seems to augment the liquid boil-off further. The dewar support should be strong enough to withstand the dynamic load due to liquid sloshing and the movement of the carrier vehicle. Therefore, for a given insulation, it becomes necessary to make a detailed study on the effects of support system design and liquid sloshing on the storability of the liquid cryogens in dewars. Such a study will help improve the dewar design by cutting down the heat inleak while ensuring the mechanical robustness of the dewar and minimal disturbance to the liquid cryogen by sloshing.

In view of the above, this thesis includes theoretical and experimental studies on the (1) Heat inleak characteristics through the support and insulation systems, (2) Design and optimization of the support system, and (3) Effects of sloshing on the liquid boil-off characteristics of cryogens. The salient conclusions of the thesis are (1) The support system contributes significantly to the heat inleak, (2) Sloshing causes significant liquid cryogen boil-off, and (3) Optimizing the support system can bring about drastic material savings.



**Keywords:** Dewar, cryogen, storage, transport, support, sloshing, boil-off, storability, optimization