Abstract Book

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Investigation of the Structural Integrity of a Cryogenic Tank with Sunken Marks by Finite Element Analysis

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Cryogenic liquids are liquefied gases that are compressed and kept in the liquid state at very low temperatures, typically below -90ºC. Common cryogenic liquids include oxygen, argon, nitrogen, hydrogen, and helium. These gases are commonly transported and stored as liquids because a higher amount of product can be stored in the liquid state. Cryogenic tanks are containers for storing cryogenic liquids. They are designed to minimize the heat transfer from the surroundings to the cryogenic liquid stored inside. A cryogenic tank usually consists of two cylindrical vessels with vacuum in the annular space.

Recently, there have been observations in the industry that sunken marks were witnessed on the surface of the outer vessel of some cryogenic tanks during operation. All stakeholders of these cryogenic tanks, i.e. owners, distributors and manufacturers, were worried that the sunken marks would affect the structural integrity of their tanks. In this work, we investigated the structural integrity of a cryogenic tank which sunken marks were observed on its outer vessel. Finite element analysis (FEA) was employed as a main tool to simulate the operating conditions of this tank.

The temperature difference between the cryogenic liquid and the ambient is the source of thermal stress loading to the tank. The FEA started from the steady-state heat transfer simulation to determine the temperature distribution in the tank. Subsequently, the resultant temperature distribution was used as the thermal stress load to calculate the stress distribution in the tank. The stress values obtained from the FEA were used to estimate the fatigue life. The results suggest that the cryogenic tank investigated still possesses good structural integrity despite having sunken marks on its outer vessel.