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THE SAFE REMOVAL OF FROZEN AIR FROM THE ANNULUS OF AN LH2 STORAGE TANK

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Large Liquid Hydrogen (LH2) storage tanks are vital infrastructure for NASA. Eventually, air may leak into the evacuated and perlite filled annular region of these tanks. Although the vacuum level is monitored in this region, the extremely cold temperature causes all but the helium and neon constituents of air to freeze. A small, often unnoticeable pressure rise is the result. As the leak persists, the quantity of frozen air increases, as does the thermal conductivity of the insulation system. Consequently, a notable increase in commodity boil-off is often the first indicator of an air leak. Severe damage can result from normal draining of the tank. The warming air will sublimate which will cause a pressure rise in the annulus. When the pressure increases above the triple point, the frozen air will begin to melt and migrate downward. Collection of liquid air on the carbon steel outer shell may chill it below its ductility range, resulting in fracture.

In order to avoid a structural failure, as described above, a method for the safe removal of frozen air is needed. A thermal model of the storage tank has been created using SINDA/FLUINT modeling software. Experimental work is progressing in an attempt to characterize the thermal conductivity of a perlite/frozen nitrogen mixture. A statistical mechanics model is being developed in parallel for comparison to experimental work. The thermal model will be updated using the experimental/statistical mechanical data, and used to simulate potential removal scenarios. This paper will address methodologies and analysis techniques for evaluation of two proposed air removal methods.

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