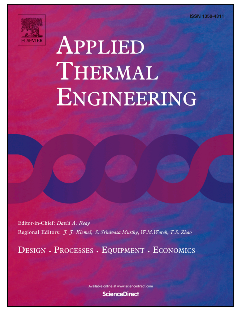
Accepted Manuscript



Influence of wall ribs on the thermal stratification and self-pressurization in a cryogenic liquid tank

Juan Fu , Bengt Sunden , Xiaoqian Chen

PII: S1359-4311(14)00462-1

DOI: 10.1016/j.applthermaleng.2014.05.086

Reference: ATE 5689

To appear in: *Applied Thermal Engineering*

Received Date: 15 January 2014

Revised Date: 15 May 2014

Accepted Date: 17 May 2014

Please cite this article as: J. Fu, B. Sunden, X. Chen, Influence of wall ribs on the thermal stratification and self-pressurization in a cryogenic liquid tank, *Applied Thermal Engineering* (2014), doi: 10.1016/j.applthermaleng.2014.05.086.

Influence of wall ribs on the thermal stratification and self-pressurization in a cryogenic liquid tank

Juan Fu [1,2], Bengt Sunden*[2], Xiaoqian Chen [1]

[1] College of Aerospace Science and Engineering, National University of Defense Technology, Changsha 410073, Hunan, P.R. China

[2] Department of Energy Sciences, Lund University, Lund 22100, Sweden

(*Corresponding author: bengt.sunden@energy.lth.se, Phone: +46 46 222 8605, Fax: +46 46 222 4717)

Abstract

Self-pressurization in a cylindrical ribbed tank which is partially filled with liquid hydrogen is investigated numerically under different rib spacing-to-height ratios. The Volume of Fluid (VOF) method is employed as well as a phase change model. Appropriate models are incorporated into the Ansys Fluent by the user-defined functions to carry out the computations. The ribbed surface is modeled as a finned surface and a conjugate transient heat transfer problem is formulated for predicting fluid flow currents and heat transfer. The effect of rib material and shapes is also studied. Numerical results indicate that the pressure rise can be reduced by ribs mounted on the tank wall. This phenomenon is more pronounced as the rib spacing-to-height ratio is reduced. A vortex is observed in the downstream region of each rib when the spacing-to-height has a relatively high value. Evaporation occurs as time elapses due to heat accumulation at the rib surfaces. Pressure starts to rise later with high thermal conductivity ribs and becomes higher with low thermal conductivity ribs when the ribs are of identical configuration in geometry. The final pressure rise seems to be monotonically versus increasing time. The semicircular ribs perform better than rectangular ones in control of the pressure rise and thermal stratification for identical cross sectional area and if the locations are kept the same.

Keywords: cryogenic liquid storage tank, wall ribs, thermal stratification, pressure rise