Effect of LNG Tank Shape on Release Rates

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Abstract

Predicting release rates, which are generally a function of time, is the first step in consequence analysis. Inaccuracy in this step is reflected in predictions for all subsequent phenomena, such as fires or vapor dispersion. The variation of release rate with time depends on the shape of the tank containing the fluid. LNG is stored at or close to ambient pressure, so its release from tanks is driven by the liquid head. Onshore LNG tanks are generally cylindrical, providing the simplest modeling since they have a constant cross-sectional area. The tanks on some LNG ships are spherical, whereas the membrane ship tanks have an octagonal cross-section. With these tanks, the cross-sectional area varies with the liquid level as a release proceeds.

This paper includes the equations relating the remaining liquid volume to the liquid level for spherical and membrane tanks. These equations are used with the Bernoulli equation to predict the release rate as a function of time. Solving for the liquid level corresponding to a given volume in the tank involves solving a cubic equation for spherical tanks or a quadratic equation for membrane tanks. Release rate versus time relationships are compared for cylindrical, spherical, and membrane tanks (for conventional, Q Flex, and Q Max ships).