

Bill Cavage

Inerting of a Vented Aircraft Fuel Tank with Nitrogen Enriched Air

A series of experiments designed to determine the quantity and purity of nitrogen enriched air (NEA) required to inert a vented aircraft fuel tank were performed. NEA generated by a hollow fiber membrane gas separation system was used to inert a laboratory fuel tank with a single vent on top designed to simulate a single bay of a transport category airplane fuel tank. Several inerting runs were performed with varying NEA gas oxygen concentrations (purities) and flow rates. The data was nondimensionalized in terms of NEA purity, volume flow rate, and fuel tank size to provide one universal inerting curve.

To determine the applicability of this data to a complex geometric tank (as most commercial transport airplane fuel tanks are), a scale replica of a Boeing B-747 SP fuel tank was built and inerted with NEA. The tank was inerted in a manner as to balance the in-flow and out-flow of each bay to allow for comparison with the single bay ullage washing data. Comparisons were made with both the single bay data and data acquired from inerting a Boeing BBJ CWT (B-737 derivative). Results from all tests were compared with mathematical models to validate the predictability of ullage washing performance of a complex, compartmentalized geometry.

The replica fuel tank was then utilized to vary the inerting gas deposit location and quantity in the tank to minimize the amount of NEA needed to obtain the desired oxygen concentration. This minimum NEA required configuration was then tested to determine the sensitivity of the configuration to the NEA purity (oxygen concentration) and total inerting gas flow rate. This data was used to design and build a manifold to inert a Boeing B-747 SP center wing tank. Full-scale inerting data was compared with data from the scale model to illustrate the effectiveness of scale modeling as a method of developing a NEA distribution systems for fuel tanks with a complex geometry.