Modeling Wing Tank Flammability

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Fuel tank flammability has been a focus of R&D aviation safety since the fatal accident of TWA 800 in 1996. Results of extensive research showed that the heat from the environmental conditioning system heated the fuel in the center wing tank (CWT) creating a flammable mixture. Several similar incidents have occurred, the most recent of which occurring in India on May 4, 2006 when a Transmile Airlines B-727 cargo airplane's left wing fuel tank exploded while waiting to be towed. The source of ignition seems to be from electric sparking, which ignited a flammable mixture of fuel vapors in the jet wing tank. More recently, the Federal Aviation Administration (FAA) is conducting research to determine the conditions under which a flammable ullage could exist within a wing fuel tank.

The objective of this research is to determine temperature correlations with total hydrocarbon count (THC) to aid in improving available flammability models for a Wing Tank ullage. The configuration under investigation involves a commercial jet wing tank heated from above. The wing tank flammability is measured after placing the setup either in an altitude chamber or a wind tunnel. The effects of change in altitude or cross flow around the tank on flammability are determined. The conditions under which the fuel tank is flammable can be determined by examining the experimental results as well as correlating with both simple and more complex heat transfer models.

In addition, a computational model will be constructed using simple and complex heat and mass transfer correlations based on a previously developed model used to simulate conditions of JP-8 fuel in an aircraft CWT. The CWT model assumed that the flow field was driven by natural convection between the heated liquid fuel on the floor and the unheated ceiling and sidewalls. The vapor within the tank ullage was considered to be well mixed. The Wing Tank model's heat source heats the top of the tank hence, the flow field is no longer driven by natural convection and the flow field is stagnant with layers of gas comprised of various compositions. The heat transfer in this model is mainly governed by conduction between the layers of gases. The heat and mass transport analogies are expressed using empirical heat transfer correlations. The results from this comparison will help in determining the conditions under which a flammable atmosphere could exist within a fuel tank.