Wing Tank Flammability Evaluation Experiments
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Because of recent events and changes in regulatory requirements, it is becoming increasingly important to understand wing tank flammability. Most of the existing calculation models being used by the FAA were designed considering a small amount of fuel being heated from the bottom. Some high flammability conditions have been observed in wing tanks seem to be centered on hot sunny days which heat the top surface of the wing, and eventually the fuel and the ullage. Experiments were performed to quantify this radiant top heat flammability growth under a variety of tank conditions such as fuel load height, starting ambient fuel temperature, and ambient air temperature. Separately, the effect of convective heat transfer on a tank surface was also studied. The progression of this flammability as the aircraft ascends (pressure and temperature drops) was also studied.

To study these phenomena, experiments were performed on a scale 17 ft^3 fuel tank in an environmental chamber examining the progression of flammability under top radiant heating as well as severe conductive cooling during a typical flight ascent (decrease in static pressure) conditions. Separately, a small section of a 727 wing was placed inside the Fire Safety Section Induction Wind Tunnel Facility to examine the convective cooling of this tank at sea level with similar initial conditions studied in the 17 ft^3 tank. 747 SCA flight testing data as well as other ground data was used to bracket the range of top and ambient temperatures tested.

Flight test data (during ground operation) with above average flash point fuels (>130 deg F) in an aluminum wing aircraft have suggested that even intense top heat for long periods of time in hot weather does not allow for significant wing tank flammability during long ground operations (3 hours plus). Lab tests with below average flash point fuels (<115 deg F) suggest that these same intense ambient conditions will generate a flammable ullage only with ground times greater than 3 hours and hot ambient temperatures (90 deg F). The loading of fuel during ground operations will only make these times greater.

The top surface of an aluminum wing fuel tank (inside) under radiant heating conditions probably does not get hotter than CWT ullage temperatures measured in the past. Measurements and observations lead us to conclude this is a less efficient process than bottom heated CWTs for generating flammability. However, both methods appear to be more effective than isothermal heat soaking at generating flammability. Lab experiments have illustrated that <u>very</u> severe top heating can halve these times (similar to empty CWT times), but exposure of a commercial transport aircraft to these conditions is probably a very rare event.

Ambient temperature has a profound effect on the generation of flammability for all fuel tanks because it controls the rate at which heat is rejected from the tank. This drives how fast the fuel and ullage heat up, and thus the generation of fuel vapor. Although it is possible to obtain flammable conditions at moderate or even average day temperatures (~80 deg F), given enough top heat and time, top heating the scale aluminum fuel tank in the lab with a below average flash point fuel was only effective at ambient temperatures in excess of 85-90 degrees F.

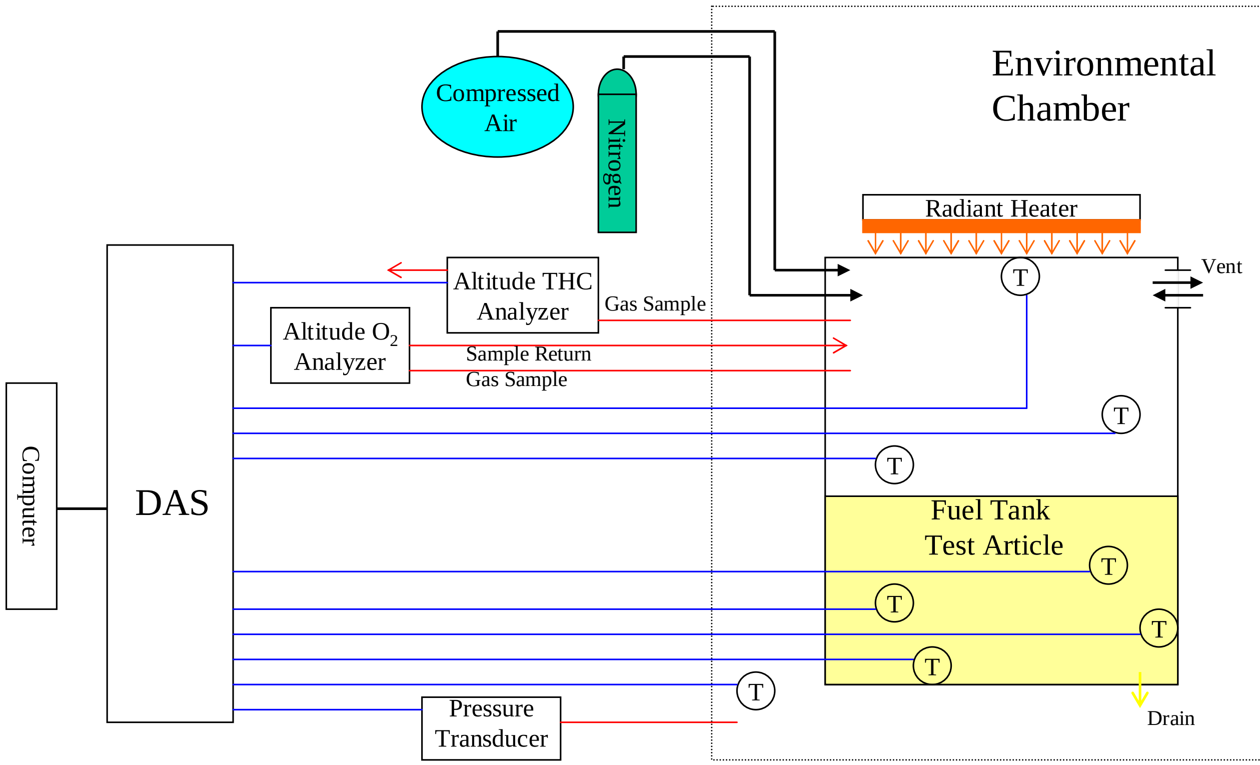

Figure 2. Block Diagram of 17 ft3 Fuel Tank with Instrumentation in the Environmental Chamber

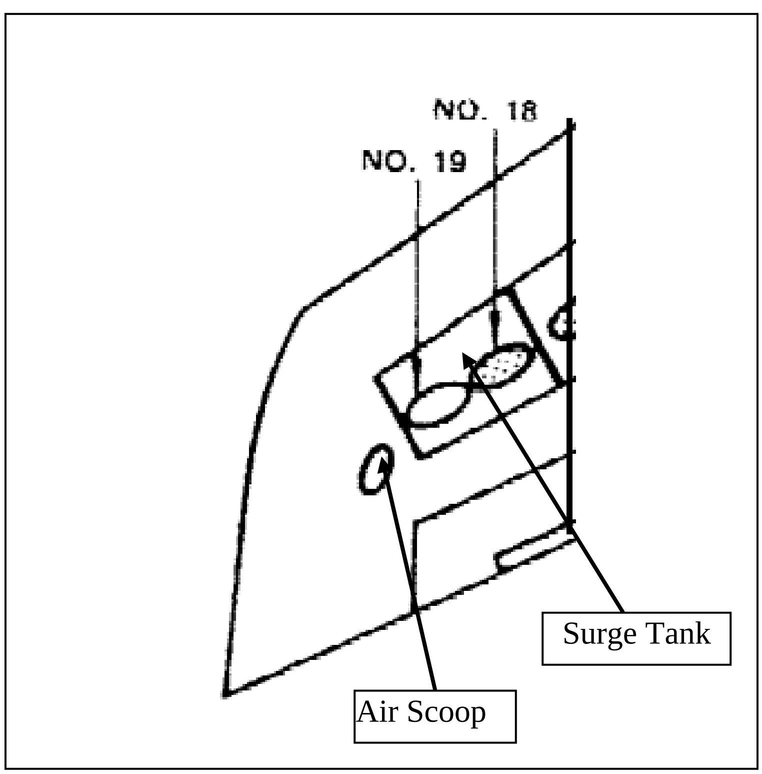

Figure 3. Approximate Wing Section to be Used as the Wing Tank Test Article