Composite and Aluminum Wing Tank Flammability Comparison Testing

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Overview - Wing Tank Flammability Parameters

Flammability Drivers on Ground
- Top skin and ullage are heated from sun
- Hot ullage heats top layer of fuel, causing evaporation of liquid fuel
- Bulk fuel temperature however, remains relatively low

Flammability Drivers In Flight
- Decreasing pressure causes further evaporation of fuel
- Cold air flowing over the tank causes rapid cooling and condensation of fuel vapor in ullage

➢ These concepts were observed during previous testing and reported on recently (see rpt #DOT/FAA/AR-08/8)
  - The objective is to now compare flammability progression in a wing fuel tank test article with both aluminum skin and composite skin with varying topcoats and thicknesses
Test Apparatus – Airflow Induction Test Facility

- Subsonic induction type, nonreturn design wind tunnel
- Induction drive powered by two Pratt & Whitney J-57 engines
Test Apparatus – Airflow Induction Test Facility

- Test article was mounted in the high speed test section
  - 5-½ foot in diameter and 16 feet in length.

- Maximum airspeed of approximately 0.9 mach, though with the test article we measured airspeeds of approximately 0.5
Summary of Previous Results

The results of initial testing have been documented in a draft FAA report and will be available on the Fire Safety Team’s Website as soon as the internal editing process is complete.

Similar to Environmental Chamber Tests, the bare composite (black) resulted in significantly increased ullage temperatures, and therefore also higher flammability readings than the bare aluminum, however

- Once airflow over the tank was initiated, temperature and flammability profiles behaved very similarly
- When aluminum tank was heated sufficiently, and the starting temperature and flammability values were equivalent, the two tanks behaved very similarly.

Fuel temperature increase is also observed, but not as severe.
Summary of Previous Results (cont.)

- Topcoat color (black) for aluminum panel has dramatic effect on fuel temperatures and flammability profile, making it behave more like the composite

- The overall correlation of high THC measurements with high ullage temperature increases is further indication that ullage temperature changes are the driving force behind in-flight flammability for wing tanks.
  - This is contradictory to how the Fuel Tank Flammability Assessment Method calculates flammability exposure
Planned Work

- Conduct tests with aluminum panel painted white, to provide a further direct comparison of aluminum/composite.

- Conduct tests with various thickness composite panels, ranging from \( \frac{1}{4}'' \) to \( \frac{3}{4}'' \). 
Planned Work

• 727 wing surge tank testing has been re-skinned with composite material and placed alongside aluminum 727 wing surge tank.

• Ground testing will be conducted this summer to determine flammability variation with actual solar radiative heating on both the composite and aluminum fuel tanks.