Composite and Aluminum Wing Tank Flammability Comparison Testing

Steve Summer
Federal Aviation Administration
Fire Safety Branch
http://www.fire.tc.faa.gov

Federal Aviation Administration

International Aircraft Systems Fire Protection Working Group
Koeln, Germany
May 11, 2011

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 ¼″ to ¾″.

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.