CONTAMINATED INSULATION FLAMMABILITY

The fire resistance of aircraft thermal-acoustic insulation is critically important because most serious aircraft in-flight fires originate in hidden areas lined with insulation. In 2005, an FAA regulation requiring a more stringent flammability test method for thermal-acoustic insulation, developed by the Fire Safety Team, went into effect. Another aspect of the flammability of insulation is the effect of contamination that may accrue on the surface from various sources during service. FAA recommends that the insulation blankets be examined periodically to remove any contamination.

Thermal-acoustic insulation blankets having visible contamination were removed from a commercial passenger airplane which had experienced an in-flight smoke incident. The level of contamination on the polyester film encapsulating the fiberglass insulation was weighed, ranked by visual inspection, and characterized by microscale combustion calorimetry to determine the thermal combustion properties and fire hazard. The areal weight of the visible contamination was as high as 167 grams per square meter of film surface and its average heat of combustion was 13 kJ/g. Previous analysis by the aircraft manufacturer had determined that the contamination consisted of dried liquid corrosion inhibiting compounds and particulate matter that included glass fibers, synthetic and natural fibers, animal hair, cotton fibers, mineral particles, plastic, Styrofoam, metal fragments and insects.

The present study determined that the inert/mineral component of the contamination accounted for about 1/3 of the weight and was mostly broken glass fibers. The pyrolyzable (volatile) component accounted for the remaining 2/3 of the contamination weight and the specific heat of combustion of these volatile compounds ranged from 19-28 kJ/g, which is comparable to the polyester film. Insulation blankets and films were also tested for flame resistance and flame spread using the less stringent FAA regulatory standard in effect when the airplane was certificated. Tests were also conducted with a voluntary standard employed by industry. All samples of insulation blankets passed the 12 second vertical Bunsen burner flame resistance requirement of FAR 25.853 and FAR 25.855, but highly contaminated blankets failed the non-regulatory (voluntary) screening test for flame spread using a cotton swab ignition source. The attached photograph shows how a cotton swab soaked in alcohol was used to ignite the insulation blankets, and the results of test for uncontaminated, moderately contaminated and highly contaminated samples at 1 minute after ignition. Numerical modeling of the burning rate using the FAA-developed ThermaKin code, suggests that the flame-spread on contaminated samples, which tends to be erratic, may be associated with the non-uniform combustion properties of the contamination. Moreover, it was determined that insulation blankets with the highest levels of contamination would not be compliant with the current stringent FAA fire test requirement.

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Contaminated Thermal-Acoustic Insulation Fire Tests