Effects of Thermal Conductivity on Flame Spread over Carbon-fiber Composites

Haiqing Guo [1], Richard N. Walters[2], Richard E. Lyon[2], James G. Quintiere[3], Sean Crowley[2]

[1] C-Far Services, Marmora, NJ, USA

[2]Fire Safety Branch, Federal Aviation Administration Technical Center, Atlantic City, NJ, USA

[2] Dept. of Fire Protection Engineering, University of Maryland, College Park, MD, USA

ABSTRACT

Carbon fiber-reinforced composite materials have been widely used in industry, especially in the aerospace industry. Due to its non-isotropic properties, the flammability of the composite material is more complex. There is an increased interest in a better understanding on the composite material's flammability for safety consideration in the aerospace industry. In particular, this work studies a 3KPW/TCR type carbon fiber composite. The flammability of the composite was characterized using the standard microscale and bench scale test methods. The composite starts to decompose above 250 °C and has an ignition temperature of 400 °C. Due to high concentration of the carbon fiber, this type of composite has a low heat of combustion of 7.8 kJ/g, making the sample less flammable. Bench scale fire tests at varied radiant heat flux yield peak heat release rates ranging between 200 – 350 kw/m^2. A customized downward flame spread apparatus is used to measure the spread rate of fire on composite of different thickness under different heat fluxes. The flame spread rate was measured between a range of 0.1 – 2 mm/s; and the spread rate increases as external heat flux increases, and increases as the sample thickness decreases. In-plane thermal conductivity was found to have a substantial impact on the spread rate as well as the flame front shape. A 2-D model based on the pure conduction theory is implemented and reasonable agreement was found between the measurements and the model.