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Light Weight Fly Ash Based Composite Material for Thermal Insulation Applications

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Abstract : Lightweight, low thermal conductivity and high temperature resistant materials or the system with moderate mechanical properties and capable of taking high heating rates are needed in both commercial and military applications. A single material with these attributes is very difficult to find and one needs to come with innovative ideas to make such material system using what is available. To bring down the cost of the system, one has to be conscious about the cost of basic materials. Such a material system can be called as the thermal barrier system. This paper focuses on developing, testing and characterization of material system for thermal barrier applications. The material developed is porous, low density, low thermal conductivity of 0.1062 W/m C and glass transition temperature about 310 C. Also, the thermal properties of the developed material was measured in both longitudinal and thickness direction to highlight the fact that the material shows isotropic behavior. The material is called modified Eco-Core which uses only less than 9% weight of high-char resin in the composite. The filler (reinforcing material) is a component of fly ash called Cenosphere, they are hollow micro-bubbles made of ceramic materials. Special mixing-technique is used to surface coat the fillers with a thin layer of resin to develop a point-to-point contact of particles. One could use commercial ceramic micro-bubbles instead of Cenospheres, but it is expensive. The bulk density of Cenospheres is about 0.35 g/cc and we could accomplish the composite density of about 0.4 g/cc. One percent filler weight of 3mm length standard drywall grade fibers was used to bring the added toughness. Both thermal and mechanical characterization was performed and properties are documented. For higher temperature applications (up to 1,000 C), a hybrid system was developed using an aerogel mat. Properties of combined material was characterized and documented. Thermal tests were conducted on both the bare modified Eco-Core and hybrid materials to assess the suitability of the material to a thermal barrier application. The hybrid material system was found to meet the requirement of the application.

Keywords : aerogel, fly ash, porous material, thermal barrier
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