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NEW NUMERICAL METHOD FOR PREDICTING TRANSIENT HEAT TRANSFER IN COMPOSITE MATERIALS

Sogol Sadoghi
Bank of Industry and Mine, Iran

A method is developed for obtaining transient temperature distribution in a cooling semitransparent layer of ceramic. The layer is emitting, absorbing, isotropically scattering and heat conducting with a refractive index ranging from 1 to 2. The solution involves solving simultaneously the energy equation and the integral equation for the radiative flux gradient. The energy equation is solved using an implicit finite volume scheme and the integral equation of radiative heat transfer is solved using the singularity technique and Gaussian integration. The effects of scattering are investigated. Fiber reinforced composite materials are widely used in various fields of engineering. The need for high temperature reinforcing fibers has led to the development of ceramic fibers. Ceramic fibers such as alumina fibers and silicon carbide fibers exhibit superior durability and combine high strength and elastic modulus with high temperature capability, which implies their potential to revolutionize gas-turbine technology. Accurate prediction of temperature distributions in ceramic and other fibrous and semitransparent materials (STM) at high temperature are essential during various fabricating operations. Within a semitransparent medium, the temperature and heat flux distributions are affected by radiation in addition to heat conduction. The radiation effects become more important when the STM is at elevated temperatures, in high temperature surroundings or subjected to large incident radiation, and the radiation fluxes depend strongly on the temperature level. To obtain transient solutions numerical procedures such as finite difference and finite element methods, discrete ordinates with the method, have been used to solve the radiative transfer relations coupled transient energy equation. The transient thermal behaviour of a single and multiple layers of semi-transparent materials have been studied for variety of cases. A common approach is to use approximate methods such as the two-flux method and diffusion and differential approximation. Unfortunately, approximate methods are usually subject to certain constraints. Under certain conditions, the methods may not be valid. This paper presents a direct numerical procedure for obtaining accurate transient temperature distribution in a semitransparent layer of ceramic fiber.

sogoli_sos@yahoo.com