Experimental and Numerical Investigation of Mist Cooling for the Electra Hibachi

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An experimental and numerical investigation has been conducted to examine the effectiveness of gas/liquid mist as a means of cooling the Electra hibachi structure. The aim is to quantify the effect of various operating and design parameters, *viz.* gas/liquid combination, gas velocity, liquid mass fraction, and liquid atomization nozzle design (*i.e.* spray geometry, cone angle, and droplet size distribution), on mist cooling effectiveness. The data are used to validate a mechanistic model which can be used to predict the hibachi foil's response under prototypical pulsed operating conditions.

A fully-instrumented experimental test facility has been designed and constructed. The facility includes three electrically-heated test sections, two of which are cylindrical, while the third is rectangular with prototypical Electra hibachi dimensions. Water is used as the mist liquid, with air, or helium, as the carrier gas. Three mist generating nozzles with significantly different spray characteristics are used. The carrier gas flow rate and inlet mixture conditions are varied within the expected parameter ranges dictated by circulating power constraints and the need to limit electron beam attenuation through the coolant and thin liquid film expected to form on the surface of the hibachi foils. Values of the local heat transfer coefficient along the channel surface are measured. The data indicate that mist cooling can increase the heat transfer coefficients by nearly an order of magnitude compared to forced convection using only the carrier gas. Comparison has been made between the data and predictions of a mechanistic three-dimensional computer program for transient two-phase flow in the channel coupled with heat conduction in the surrounding structure; excellent agreement has been obtained. The results indicate that gas/liquid mist can effectively cool the Electra hibachi structure within the design constraints imposed on circulating power requirements and electron beam attenuation.