HEAT FLUX CALIBRATION FLOW AND CONDUCTION FACILITIES: STATUS REPORT

K. Steckler and W. Grosshandler
Building and Fire Research laboratory
National Institute of Standards and Technology

ABSTRACT

Standard methods exist at NIST for calibrating thermal radiation detectors up to 10 kW/m^2 using blackbody cavities, and up to 40 kW/m^2 using a monochromatic laser source. Heat flux transducers, however, are often used under conditions where convection dominates, where radiation emanates from a source with a different spectral character, or where flux levels exceed 40 kW/m^2. The objective of this project is to extend NIST heat flux calibration capabilities to, at least, a limited range of the latter conditions. Convective and conductive heat transfer facilities are being designed and constructed for this purpose.

Channel-Flow Facility

A laboratory-scale, 3.2 m-long, low speed wind tunnel, having a 0.2 m (l) x 0.3 m (w) x 0.01 m (h) test section, will be used to calibrate heat flux gauges under convective heat transfer, boundary-layer flow conditions. The test section will have a heated wall in which a heat flux gauge can be mounted flush. Cooler flow-conditioned air will pass through the test section. Air temperature and velocity will be variable, with heat fluxes at the surface designed to be preset between 0.5 and 5.0 kW/m^2 with an uncertainty of less than ± 5 percent. Flow visualization, hot-wire probing, thermocouples, and temperature-sensitive liquid crystals will be used to measure the temperature fields in the air and on the surface adjacent to the flux gauge.

The 3.0 m-long flow-conditioning part of the wind tunnel has been designed, fabricated, and assembled. This part contains heat exchangers, honeycomb and screen turbulence-control sections, and a 30/1, two-dimensional, contraction section. The test section is being designed. Its heated surface will contain an array of guarded, foil, resistance heaters designed to maintain the surface at a uniform temperature. Numerical simulations by co-workers in other NIST laboratories (CSTL and EEEL) of the energy transfer are being used to refine the design and minimize uncertainties. The final design will be included in this presentation.

The tools necessary for the hot-wire velocity measurements have been gathered and shakedown experiments are underway. Subsequently, the velocity field at the exit of the contraction will be mapped.

Gas-Phase Conduction Facility

A guarded hot-plate concept has been extrapolated to produce heat fluxes up to 100 kw/m^2. Figure 1 shows a 1.0 mm-thick layer of helium separating two flat, polished, copper plates maintained at a temperature difference of several hundred degrees. This arrangement avoids contact-resistance on the helium side of the gauge and should produce the necessary high level of conductive flux with trivial radiative component. The conduction apparatus has been designed and fabrication is about 75 percent complete. Details of the design and, if available, preliminary shakedown results will be included in this presentation.

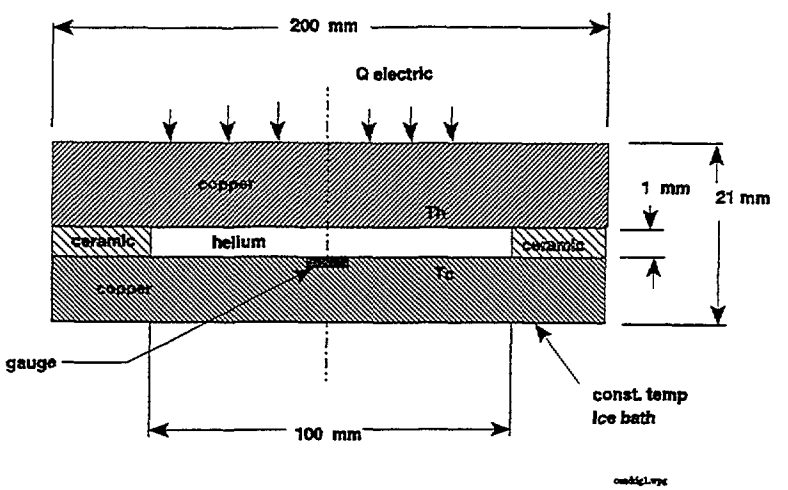

Figure 1. Schematic of conduction apparatus (elevation).