Simultaneous Measurements of Total Hemispherical Emissivity and Thermal Conductivity of Metals at High Temperatures

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The total hemispherical emissivity is an important thermophysical parameter for thermal analyses and many types of measurements in research and engineering applications. This paper presented a method to simultaneously measure the total hemispherical emissivity and the thermal conductivity of metals at high temperatures using a steady-state calorimetric technique. The inverse problem to determine the emissivity and thermal conductivity from steady state high-temperature calorimetric experiments was established based on models for these two quantities assuming to be linear functions of temperature over a limited temperature range. The accuracy of the inverse solution was numerically analyzed for various noise levels for samples with various thermophysical properties. The noise in the total heat flux magnifies the result uncertainty so the solution accuracy was affected by not only the solution method itself, but also the noise in the "measured" data. The simulation results also illustrate that the calculation accuracies for the emissivity and thermal conductivity strongly depend on the proportions of the radiation and conduction heat fluxes in the strip sample arising due to the temperature distributions in the sample. Steady state high-temperature experiments with nickel samples were used to experimentally verify the method. The inverse solution results for the emissivity and thermal conductivity calculated from the measured data agree well with reported data in the literature. This research provides a useful reference for measuring the total hemispherical emissivity and thermal conductivity of conductive samples at high temperatures.