Public Abstract

First Name: Kyle

Middle Name: Lucas

Last Name: Walton

Adviser's First Name: Robert

Adviser's Last Name: Tompson

Co-Adviser's First Name: Ghosh

Co-Adviser's Last Name: Tushar

Co-Adviser's First Name: Sudarshan

Co-Adviser's Last Name: Loyalka

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Department :Nuclear Engineering

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Title: Uncertainty Analysis of Steady-State Calorimetric Emissivity Measurements

Emissivity is the property of a material to lose or gain heat from electromagnetic (EM) radiation. The amount of radiant energy an object emits is proportional to its temperature to the 4^{th} power. Calorimetric measurements of emissivity measure the heat loss of a sample in an evacuated chamber. One type of calorimetric emissometer heats a sample directly using its electrical resistance to an applied AC or DC current. The heat loss is determine when the sample and chamber walls reach a equilibrium. Most of the literature addresses many issues regarding the accuracy of this design, but gives little guidance to determining the uncertainty, or precision.

This research provides a detailed uncertainty analysis for this type of calorimetric emissometer used in measuring the emissivity of various alloys intended to be used in Very High Temperature Reactors (VHTR). The uncertainty analysis here follows the guidelines of the JCGM 100:2008: The Guide to the expression to the uncertainty in measurement, or GUM. With this methodology, this work develops a general model that can be used to evaluate the uncertainty in other calorimetric emissometers of this type. The results this analysis show that the relative uncertainty in the emissivity is similar to the relative uncertainty in the electric currents. Thus, it is important to use the best practices and instrumentation for measuring the electrical current.

The uncertainty analysis here can be further developed as other sources of error are identified in specialized testing or comparative testing between several calorimetric emissometers. Knowing the emissivity of a material and its uncertainty is important in many applications like non-contact temperature measurements and heat transfer calculations for atmospheric re-entry of spacecraft and the progression of nuclear accidents.