IHCP Filter Solution for Heat Flux Measurement by Directional Flame Thermometer

Hamidreza Najafi[1]
Mechanical Engineering Department
The University of Alabama
Tuscaloosa, AL, USA

Keith A. Woodbury
Mechanical Engineering Department
The University of Alabama
Tuscaloosa, AL, USA

Ned R. Keltner
F.I.R.E.S, Inc
Albuquerque, NM, USA

James V. Beck
Department of Mechanical Engineering
Michigan State University
East Lansing, MI, USA

Abstract

For efficient operation of high-temperature process furnaces, accurate and stable temperature measurements are needed. In an example for coal-fired electrical generating plants, Iverson and Weiss [1995] note that a 1% high temperature reading leads to a 3.7% loss in high-pressure turbine efficiency in an electric power plants. This loss of efficiency translates to increased fuel costs on the order of $1,000,000 per year for a 1000 MWe coal fired plant. Direction Flame Thermometers, or DFTs, offer the ability to use both temperature and heat flux measurements for furnace control. The original DFT design involved a thin metal disk mounted in a steel tube. To minimize heat loss from the unexposed surface of the disk, multiple radiation shields and some ceramic fiber insulation were mounted behind the front disk. Sandia National Laboratories adapted DFTs for use in large pool fire and other tests, the goal was to provide both transient and quasi-steady heat transfer measurements in various fire environments. Presently, analysis of dynamic temperature data from the DFTs to compute heat flux information must be performed off-line at the conclusion of data-gathering. Availability of a near real-time algorithm for accurate reduction of the data will allow for continual monitoring of the furnace during operation. This will result in better furnace control and significant savings in energy and cost. In this paper, a filter form of the inverse heat conduction algorithm is developed for utilization in

[1] Corresponding Author, Email: hnajafi@crimson.ua.edu

DFTs. The filter concept uses filter coefficients in a convolution integral and has several advantages including simplicity and continuous operation. The solution uses two sets of temperature data obtained by DFT to estimate the heat flux in the furnace. A numerical experiment is used to show the utility of the technique. Results from a furnace experiment are analyzed.