# AUTOMATED NONDESTRUCTIVE EVALUATION METHOD FOR CHARACTERIZING CERAMIC AND METALLIC HOT GAS FILTERS

W. A. Ellingson, E. R. Koehl, P. Pastilla,* C. Deemer, B. Wheeler, and G. A. Forster

Argonne National Laboratory, Argonne,IL, USA

*Tampere University, Tampere, Finland



Invited paper to be presented at the 5th International Symposium on Gas Cleaning at High Temperature, Morgantown, WV, September 18-20, 2002

+Work supported by the U.S. Department of Energy, Office of Fossil Energy: (1) Advanced Research and Technology Development Materials Program, and (2) Clean Coal Technology, Hot-Gas Cleanup Program, under Contract W-31-109-Eng-38.

William A. Ellingson
Argonne National Laboratory
9700 S. Cass Ave., Bldg. 212
Argonne, IL 60439
ellingson@anl.gov
Telephone: 630-252-5068
Fax: 630-252-4798

Pirjo Pastila
Institute of Materials Science
Tampere University of Technology
Korkeakoulunkatu 6
33720 Tampere, Finland
pirjo.pastila@tut.fi
Telephone: +358-3-3115 2285
Fax +358-3-3115 2330

Eugene R. Koehl
Argonne National Laboratory
9700 S. Cass Ave., Bldg. 212
Argonne, IL 60439
koehl@et.anl.gov
Telephone: 630-252-5942
Fax: 630-252-4798

Benjamin Wheeler
Argonne National Laboratory
9700 S. Cass Ave., Bldg. 212
Argonne, IL 60439
wheeler@anl.gov
Telephone: 630-252-5098
Fax: 630-252-4798

Christopher Deemer
Argonne National Laboratory
9700 S. Cass Ave., Bldg. 212
Argonne, IL 60439
deemer@anl.gov
Telephone: 630-252-1210
Fax: 630-252-4798

George A. Forster
Argonne National Laboratory
9700 S. Cass Ave., Bldg. 212
Argonne, IL 60439
forster@anl.gov
Telephone: 630-252-5918
Fax: 630-252-4798

# Automated Nondestructive Evaluation Method for Characterizing Ceramic and Metallic Hot Gas Filters

**Keywords:** Nondestructive Evaluation, Hot Gas Filters

## Objectives and Approach

In advanced coal-fired power generation, one technology under development to clean up hot gases before their use as fuel for gas turbines is rigid ceramic candle filters. These porous filters are typically 1.5 m long and 60 mm in diameter and are made of various ceramic materials, including clay-bonded SiC. The high costs of downtime in a large utility demands that nondestructive evaluation/characterization (NDE/C) methods be available. At shutdowns, data from such analysis are needed to decide which filters are still useable and which need to be replaced, and if possible, to estimate the remaining lifetimes. Thus our objective was to develop reliable low-cost NDE technology for these filters.

Our approach was to develop NDE/C technology, referred to as acousto-ultrasonics (AU), for application to hot gas filters. Lamb waves generated by the AU method were analyzed to derive a stress wave factor (SWF). This technology was tested by comparing SWF data with the measured strength for a variety of rigid ceramic filters and was shown to work on iron-aluminide filters as well but no strength data have been obtained on the iron-aluminides at this time.

Strength for the ceramic materials was determined by several measurements: internal hydrostatic burst pressure, four-point bending, C-ring compression, and O-ring compression. The filters examined by the AU method had been tested in coal pilot plant facilities and in the laboratory at 900ºC in air and in air with water vapor. The AU data correlated very well with the strength data regardless of the method used for determining the retained strength of the filters.

The first NDE/C setup used fixed-position, momentary-contact transducers (150 kHz). This setup was slow for data acquisition and was automated after the excellent correlation between AU data and measured strength was established. The first-generation automated system employs wheel transducers (150 kHz) with vertical loads monitored through load cells. A special horizontal carriage that holds the candle filters was designed and fabricated. The automated system uses LabView software as the user interface. LabView subroutines were written to automate acquisition of the exact axial position at which the NDE data were obtained, the acoustic signal, the local SWF, and other features. Data for the entire filter length (1.5 m) can be obtained as a function of axial position in less than 10 min.

Seven clay-bonded SiC hot gas filters were examined by the automated NDE method, then subjected to laboratory atmospheres known to induce damage and, hence, reduce strength. These filters were then examined by the automated NDE method, and the strength measured by the internal burst pressure. Then, the correlation between retained strength and the NDE data was determined as a function of axial length position. The correlation factor was found to be 0.97. The NDE data were also compared with average strength values for filters removed from operating pilot plants. This comparison also showed excellent correlation factors. In conclusion, our automated NDE system shows excellent promise for rapid and accurate data acquisition on full-size hot gas filters.