OPTICAL FIBER SENSOR INSTRUMENTATION FOR SLAGGING COAL GASIFIERS

Kristie L. Cooper, Anbo Wang
Center for Photonics Technology
Virginia Polytechnic Institute & State University
460 Turner Street, Suite 303 (0287)
Blacksburg, Virginia 24060
Voice: 540/231.9366
Fax: 540/231.2158
klcooper@vt.edu
DE-FG26-05NT42532
20 July 2005 – 19 July 2008

OBJECTIVE

The objective of this program is to develop an optical fiber sensing system to monitor refractory thickness and temperature in a slagging coal gasifier for improved reliability and advanced process control in the coal fired power plants of today as well as the FutureGen power generation systems of the future. A silica-based fiber sensor head, suitable for operation up to 800-900º will be utilized for monitoring the refractory wall thickness and a sapphire-based fiber sensor head will provide temperature data from inside the gasifier, building directly on several key technologies developed at Virginia Tech, including a novel white light interferometry data processing algorithm, silica-to-sapphire fiber connectorization, and sapphire-to-sapphire material bonding.

ACCOMPLISHMENTS TO DATE

Temperature monitoring is achieved using an extrinsic Fabry-Perot interferometer (EFPI) formed by a sapphire fiber and wafer. The sensor design was finalized and a sensor head is currently being fabricated in preparation for laboratory testing up to 1500°C.

The corrosion rate of the refractory wall is measured by optical time domain reflectometry (OTDR) using an embedded length of optical fiber. Over the past year, our efforts were focused on improving the thickness sensor data acquisition and analysis software, analyzing system repeatability, and determining the conditions required for higher resolution distance measurements. The principles of OTDR dictate that the two reflection points in the fiber be well-balanced in order to maximize the SNR and thus measurement resolution. Environmental chamber testing demonstrated that we can expect resolution up to 1mm if we can introduce a good reflection point. The quality and repeatability of the reflection point fabrication thus became a key element in the project. Five different methods were evaluated and a longitudinal misalignment scheme selected.

Room temperature, fixed length experiments were designed to determine the best parameter settings for the measuring system.

Packaged sensors were evaluated at temperatures from ambient to 1000°C. The improved packaging process does not deteriorate sensor accuracy. To simulate the fiber damage produced by corrosion in the gasifier, measurements have been taken following repeated cuts of the entire package. We are currently evaluating the effect of a noncleaved end; preliminary results indicate that resolutions below 1 mm can still be achieved with a corroded fiber endface.

FUTURE WORK

We will be continuing high temperature testing and spectral analysis at 1000°C. The sensor package and signal processing algorithm will be thoroughly evaluated prior to integration of the temperature and refractory thickness data interfaces.

PAPERS PUBLISHED/STUDENTS SUPPORTED UNDER THIS GRANT

Sponsored Students:

Yongxin Wang
Jiajun Wang