



## PROJECT FACTS

UNIVERSITY OF KENTUCKY  
CENTER FOR APPLIED ENERGY RESEARCH

### ADVANCED GASIFICATION BY-PRODUCT UTILIZATION

#### PARTICIPANTS

University of Kentucky  
Center for Applied Energy  
Research (CAER)  
2540 Research Park Dr.  
Lexington, KY 40511  
10-10-2005

Penn State  
Energy Institute (EI)  
Hosler Building  
University Park, PA 16802

Charah, Inc.  
Unit M, Suite 100  
307 Townepark Circle  
Louisville, KY 40243

#### SPONSORS

US DOE /University Coal  
Research Program (UCR)  
UK CAER

#### COST SHARING

DOE-UCR...\$200,000  
UK CAER.....\$50,000

#### CONTACT

Aurora Rubel  
UK CAER  
2540 Research Park Dr.  
Lexington, KY 40511  
Tel.: (859) 257-0209  
Fax: (859) 257-0220  
[rubel@caer.uky.edu](mailto:rubel@caer.uky.edu)

The purpose of this project is to investigate the potential of waste streams from integrated gasification combined cycle (IGCC) power generation units to serve as precursors for value-added products. These by-products can be considered a new material resource from coal. The objectives are to find applications and market options for by-products produced from IGCC chars. Four samples of gasifier char carbons were acquired from two commercial gasifiers and were extensively chemically and physically characterized (proximate, ultimate, anions by ion chromatograph, forms of sulfur, BET surface area determinations, pore volumes and pore size distributions by density functional theory).

The carbon-rich gasifier chars have been assessed as adsorbents for flue gas mercury (Hg) capture using a Hg adsorption test apparatus at the CAER. Two of the four gasifier slag carbons had excellent Hg capture potential compared to an activated carbon that was developed for Hg adsorption from flue gases. Common characteristics of these two coal by-product sorbents were a surface area of 100-130 m<sup>2</sup>/g and high Cl, F, SO<sub>4</sub>, and PO<sub>4</sub> anions. Good gasifier Hg adsorbing carbons also had higher pore volumes and higher mesopore volumes than poor gasifier Hg adsorbing carbons. Mercury-laden samples of the gasifier carbon were subject to X-ray Absorption Fine Structure Spectrometry (XAFS) to define the Hg adsorption sites. The results from mercury loaded gasifier carbon indicate that even though the adsorption gas in our experiments contained only Hg<sup>0</sup>, Hg<sup>+2</sup> was the captured species and it was bound to sulfur. The results indicated that good versus poor mercury adsorbing gasifier carbons had different Cl and S speciation. The good sorbent contains elemental sulfur, thiophene and sulfate, whereas the poor mercury adsorbing gasifier carbon contained sulfur primarily as metal sulfides. Work at the CAER agrees with chemical bonding of mercury on sorbents since it is only released above 300°C during heating. The ionic binding of mercury to the surface of pores changes in the characteristics of the pores. This has been confirmed by increased micropore volume at the expense of mesopore volume in Hg loaded gasifier carbons.

The carbon-rich by-product is being evaluated as a precursor of activated carbons. The gasifier-char carbon has been subjected to thermal activation and will be tested for activated carbon uses. Chemical activation techniques will also be applied to the gasifier slag carbon and similarly tested for potential uses. The properties of the activated carbons will be characterized using state-of-the-art techniques available at the CAER and The Pennsylvania State University Energy Institute (EI).

Future work involves testing the activated gasifier carbons for Hg capture potential and all samples for NO<sub>x</sub> adsorption. The leachability of Hg captured by gasifier-char carbon will be assessed by leaching tests of Hg-laden carbons. The carbon-rich by-product will also be evaluated as a filler for conductive plastics and carbon bodies.

The CAER is the lead contractor for overall project management, administration and co-ordination of the effort and is responsible for all reporting to the sponsor. The two other participants in this work are EI and Charah, Inc.

