Title: **Fundamental Investigations of Fuel Transformations in Pulverized Coal Combustion and Gasification Technologies**

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Grant No.: DE-FG26-00-NT40815

Performance Period: 1 October 2000 – 30 September 2003

Abstract

This project has two main objectives: (a) to provide fundamental support for high pressure coal combustion and gasification technologies, and (b) to provide fundamental support for combustion of a wide variety of low-quality solid fuels.

High pressure thermogravimetric analysis (HP-TGA) of chars formed in an atmospheric flat-flame burner (FFB) have shown that the intrinsic carbon-O_2 reaction order stays constant at 0.7 at conditions spanning over two orders of magnitude in oxygen partial pressure. This conflicts with many theories, including many Langmuir-type mechanisms. We are currently generating high temperature, high heating rate chars at different pressures and performing HP-TGA experiments to test the effects of char preparation conditions on pyrolysis, char morphology, and char reaction rate.

Char reactivity trends at atmospheric pressure are well established for coals, but there have been no analogous comparative studies on large sets of the diverse alternate fuels. Reactivity measurements were performed at atmospheric pressure for chars formed at 700°C and 1000°C for 31 materials, including 20 solid fuels (international coals, petroleum cokes, tires, wood, agricultural residues and

refuse derived fuel) and 11 organic model materials chosen for their low levels of potentially catalytic inorganic matter (graphites, petroleum pitches, resins, commercial organic chemical reagents, and microcrystalline cellulose). Standard reactivities at 500°C in air varied by over 4 orders of magnitude and correlate poorly with organic elemental composition or char surface area. The essentially noncatalytic model materials exhibit uniformly low reactivities that fall in a narrow band as a function of wt-%C (daf) and correlate reasonably well with char surface area. A model was developed that combines statistical analysis of the data with chemical insights from the literature on the form and dispersion of catalytic inorganic matter to explain most of the observed reactivity variation. The model indicates that catalytic effects are significant for almost all of the practical solid fuels, due most particularly to the presence of nano-dispersed potassium, calcium, and magnesium.

Publications

Lang, T., Hurt, R.H. "Char Combustion Reactivities for a Suite of Diverse Solid Fuels and Char-Forming Organic Model Compounds, " submitted to the 29th International Symposium on Combustion, 2001.

Lu, W., and Calo, J.M., "The Effects of Hydrogen During Steam Gasification," *ACS Div. Fuel Chem. Prepr.* **46(2)** 524 (2001).

Presentations

Lang, T., Hurt, R.H., Standard Combustion Reactivities of Chars from Diverse Solid Fuel Types, 2002 Australian Symposium on Combustion and Seventh Australian Flame Days, Adelaide, February 2002.

Lu, W., and Calo, J.M., "The Effects of Hydrogen During Steam Gasification," presented at ACS National Meeting, Chicago, IL, August 2001.

Fletcher, T. H., Zeng, D., Adams, M., Crenshaw, B., and Hecker, W. C., "High Pressure Coal Combustion," presented at the 16th Annual ACERC Conference, Provo, Utah (March 14-15, 2002).

Students Receiving Support

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