R & D facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Gasification Technologies

10/2008

Coal Particulate Partitioning During Gasification

Background

The goal of this project is to better understand the impact of the non-homogeneous nature of coal on coal gasification systems and to develop better modeling tools to improve reliability and efficiency of coal gasifiers. It is well known that the mineral and organic components in coals, known as macerals, vary widely in their composition, distribution, and occurrence. These components have different physical and chemical makeup. When ground to the fine sizes required for advanced gasification systems, some of these components will separate to form particles enriched in individual minerals or macerals which respond completely different than the aggregate or average coal particles. These outliers can lead to process inefficiencies, fouling, and other reliability problems. Coals will be fractionated by hardness and density and those fractions will be characterized, gasified, and the resulting information will be used to develop validated computer models.

Accomplishments

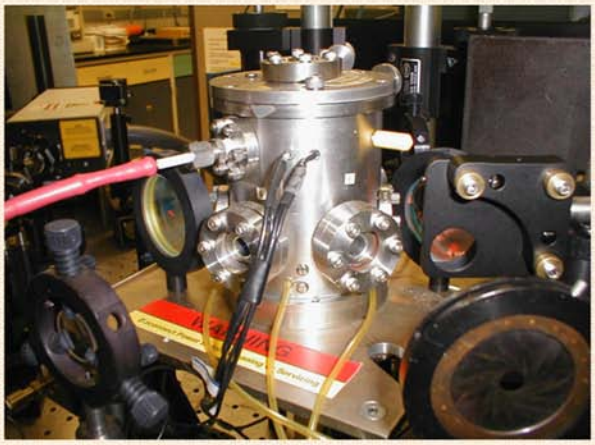
A project was initiated at the end of FY2006 to improve the understanding of slag formation during coal gasification as a response to coal outlier particles. A team of experts in relevant disciplines have been assembled as part of the National Energy Technology Laboratory's (NETL) Collaboratory of Multiphase Flow Research. This team comprises researchers from NETL, West Virginia University, Carnegie Mellon University, Pennsylvania State University, SRI International, Niksa Energy Associates, REM Engineering Services, and Leonardo Technologies, Inc. including experts in coal science, high temperature mineral chemistry, high pressure gasification, hydrodynamics, single particle characterization, computational fluid dynamics, and coal partition modeling.

CONTACTS

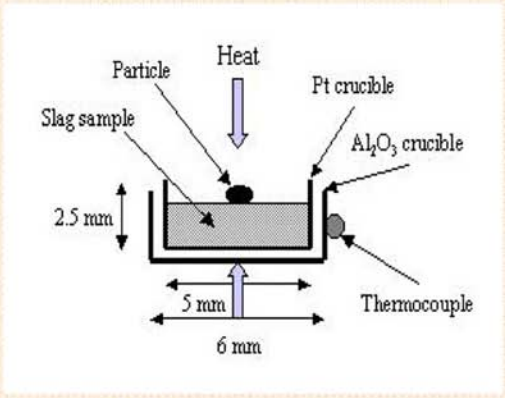
Lawrence Shadle
Computational Science Division
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4647
lawrence.shadle@netl.doe.gov

Chris Guenther
Computational Science Division
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4483
chris.guenther@netl.doe.gov

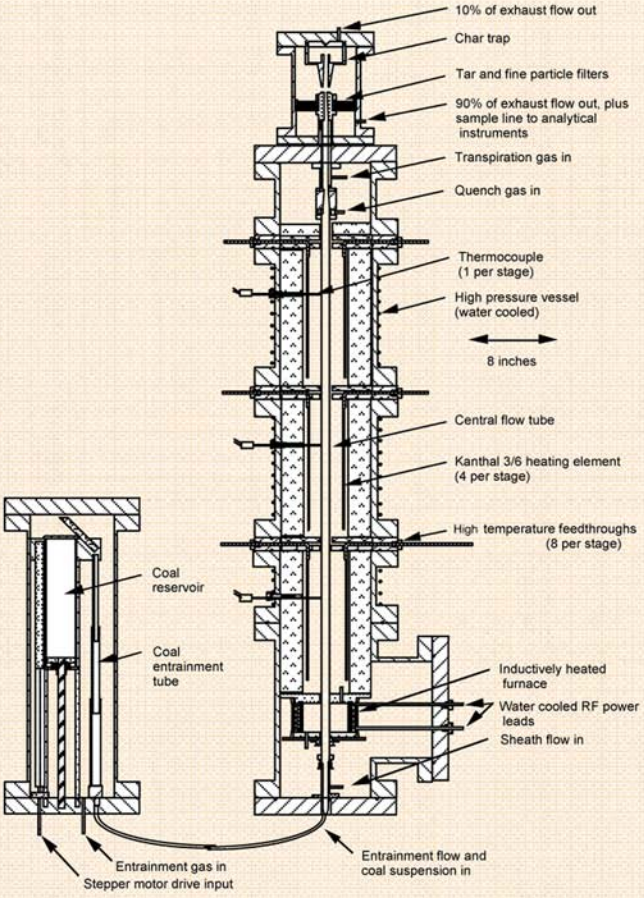
Gary Stiegel
Office of Coal & Power R&D
Gasification Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4499
gary.stiegel@netl.doe.gov



NETL's Electrodynamic Balance Facility



CMU Hot stage microscopy



SRI High P Gasifier

Figure 1. Experimental facilities at NETL, SRI, and CMU used to characterize individual coal particles, gasify coal fractions, and characterize the interactions of gasified char and minerals with slag.

Benefits

Coal mineral behavior in an entrained gasifier (including mineral partitioning, ash chemical and physical transformations at temperature and pressure, particle fragmentation, and conversion) will be incorporated into gasifier models to determine the impact on slagging and potential flyash formation for a sample coal. We will use this to evaluate the potential for adjusting mineral preparation procedures to reduce fouling and process inefficiencies. Computer submodels will be developed for fragmentation and conversion of coals in high pressure high temperature gasifiers, drag of poly-disperse coal and char particles, mineral transformations and slagging, and wall boundary determining slag acceptance or rejection. The project offers the potential to define a research and development approach to improve the heat rate and reliability of gasification-based power systems. Models will be developed from this project including both partitioning and computational fluid dynamic (CFD) submodels for slag formation and growth. CFD tools capable of simulating individual coal size and density fractions will be developed including: trajectories, chemical and physical transformations, and incorporation or rejection from a slag layer, in a typical coal gasifier.

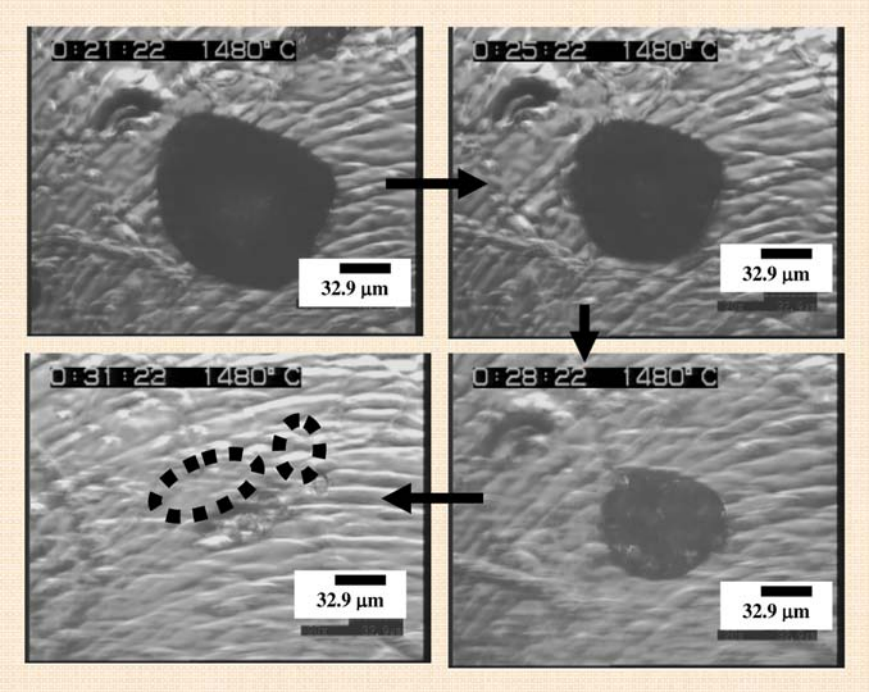


Figure 2. Mineral particle incorporation into high temperature slag.

COLLABORATORS

Pete Rozelle
Forrestal Building
Germantown, MA

Stewart Clayton
Forrestal Building
Germantown, MA

PARTNERS

John Kuhlman
West Virginia University
Mechanical & Aerospace Engineering Department
Morgantown, WV 26506-6106

Seetharaman Sridhar
Carnegie Mellon University
Department of Materials Science and Engineering
Pittsburgh, PA. 15213

Richard Fruehan
Carnegie Mellon University
Department of Materials Science and Engineering
Pittsburgh, PA. 15213

Stephen Niksa
Niksa Energy Associates
1745 Terrace Drive
Belmont, CA 94002

Monazam, Esmail
REM Engineering Services
Morgantown, WV 26507

Dolence, Robert
LTI - Leonardo Technologies, Inc
Pittsburgh, PA

Pisupati, Sarma
Pennsylvania State University
Department of Energy and GeoEnvironmental Engineering
State College, PA 16802

Malhotra, Ripu
SRI International
Menlo Park, CA 94025

ADDRESS

National Energy Technology Laboratory
1450 Queen Avenue SW
Albany, OR 97321-2198
541-967-5892

2175 University Avenue South
Suite 201
Fairbanks, AK 99709
907-452-2559

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

One West Third Street,
Suite 1400
Tulsa, OK 74103-3519
918-699-2000

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Opportunities

Coal suppliers, utilities, and gasifier developers are desired who can provide coal samples and gasifier performance results to enable validation of the simulations and experimental test results. There is potential to develop a Cooperative Research and Development Agreement or other means of partnership for this type of collaboration.

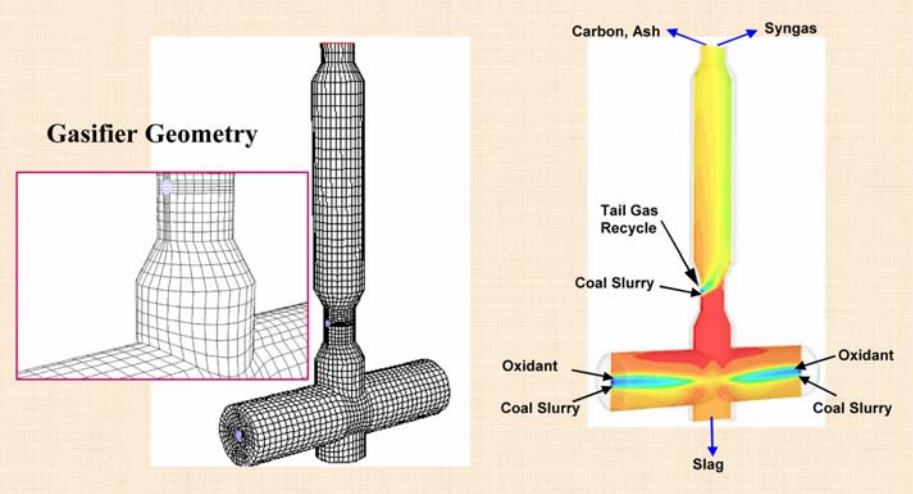


Figure 3. NETL grid and simulation results mapping temperature gradients in an entrained-flow coal gasifier.