Underground Coal Thermal Treatment Research at the University of Utah

6th Annual International Conference & Workshop on Underground Coal Gasification, 23rd – 24th March 2011

Prof. Ron Pugmire
Dept. of Chemical Engineering and Institute for Clean and Secure Energy
University of Utah
Salt Lake City, Utah, USA
Overview of UCTT at Utah

- **Project Scope and Objectives**
  - Examining fundamental and applied aspects of Underground Coal Pyrolysis
  - Current objective is to maximize SNG yields
  - Project divides into 3 main areas: bench-scale experiments, numerical simulation and technology evaluation

- **PI’s**
  - Prof. Ron Pugmire
  - Prof. Phil Smith
  - Prof. Adel Sarofim
  - Prof. Eric Eddings
  - Prof. Milind Deo
  - Prof. Tom Fletcher (BYU)

- **Research Staff and Graduate Students**
  - Dr. Hongzhi Zhang
  - Dr. Michal Hradisky
  - Keith Gneshin
  - Robert Krumm
  - Prashanth Mandalaparty
Overview of UCTT at Utah

• The UCTT program is part of a much larger area of emphasis in subsurface processes at the University of Utah

• Research spans all levels of inquiry from atomistic-scale to field demonstrations
Pros & Cons of UCTT

• Advantages
  – Pyrolysis yields liquid and gaseous products with higher H:C ratio than parent coal
  – Large fraction of carbon remains in the ground and thus will not have to be sequestered
  – Residual carbon matrix can be used for sequestration of CO$_2$

• Disadvantages
  – Requires energy input to drive pyrolysis
  – Does not recover all available energy in the seam
Relevance of UCTT Research to UCG

• Deeper understanding of pyrolysis effects in deep coal seams
• Studies with large coal blocks approach offers additional insight into heat, mass transfer effects vs. powdered coal studies
• Development of advanced simulation tools for pyrolysis in deep coal seams
• Development of experimental reactors for simulating UCTT, UCG
Scales of Experimental Work

HP/FBR $\rightarrow$ Block Reactor $\rightarrow$ HP Coal Bed Reactor
HP/FBR Experimental Work

- High-pressure fixed-bed reactor
- Operating temperatures to 1200°C
- Operating pressures to 60 bar
- Heating rates to 10°C/min
- N₂, CO₂, H₂O, Ar atmospheres
- Capable of heating chunks or cores up to ¾” in diameter, 6” long bed in heater core
- Used for product evolution studies, porosity characterization

Exhaust End

Injection End
Block Reactor Experiments

• Unique reactor for studying block coal rather than pulverized coal
• Capable of heating coal blocks of 6”x6”x6” via embedded cartridge heaters
• Can be used for product evolution studies
• Currently used for characterization of porosity development
Porosity Analysis via SEM

- Doctoral thesis project of Keith Gneshin (advised by Eric Eddings)
- Supported by a graduate fellowship from U.S. Dept. of Energy Office of Science
- Aimed at quantifying pore size distribution changes in coal blocks during pyrolysis via SEM image analysis
- Important for understanding product evolution (e.g. tar cracking in clogged pores), CO$_2$ sequestration aspects of UCTT

Unheated Utah Bituminous Coal

Pyrolyzed Utah Bituminous Coal

(Images courtesy of K. Gneshin)
High Pressure Coal Bed Reactor

- Primarily intended to provide data for model validation of UCTT simulations; under construction
- 6” x 27” coal bed w/ 3 embedded tubular heaters
- Working pressures to 1500 psi
- Sampling ports for product measurement
- Injection ports for various atmospheres
Acknowledgments

• This material is based upon work supported by the U.S. Department of Energy under Award Number DE-NT0005015