Energy Systems Modeling at the University of Wyoming

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July 24-25, 2013





UW School of Energy Resources Centers of Excellence

Carbon Management Institute

Center for Energy Economics and Public Policy

Center for Fundamentals of Subsurface Flow

Center for Photoconversion and Catalysis

Center for Biogenic Natural Gas Research

Enhanced Oil Recovery Institute

Wind Energy Research Center

Wyoming Reclamation and Restoration Center

Additional support for energy research in addition to centers



Personnel with Energy Systems Modeling Interest

David Bell

Associate Professor, Chemical Engineering

Graduate class in Advanced Coal Technology

Book: David A. Bell, Brian Towler, Maohong Fan, Coal Gasification and Its Applications, 2011 Elsevier, 412 pp.





Research

Process modeling (Aspen) and economics:

(INL collaborations)

- 1. Model for refining Fischer-Tropsch fluids using conventional petroleum refinery operations.
- The Feasibility of Siting Coal Gasification and Synfuels Plans in Wyoming, Richard Boardman, et al., INL/MIS 11-22553. 2011. Contributed IGCC modeling.
- Value-Added Products from Hybrid Systems in Wyoming, Robert Cherry, et al., INL/EXT-12-27249.
 2012. Explored process alternatives.





Current research (experimental)

- 1. Powder River Basin coal gasification kinetics at fluidized bed gasifier conditions.
- Gasification of residue from the Shenhua Direct Coal Liquefaction Process





Michael Stoellinger Assistant Professor, Mechanical Engineering

- •PhD 2010, UWYO, Mathematics
- MS 2005, Technical University of Munich, ME
- Joined UW in Fall 2012
- Teaching
- Heat and Mass Transfer (UG)
- Fluids Lab (UG)
- Fluid Mechanics (UG and Grad)
- Combustion (Grad)



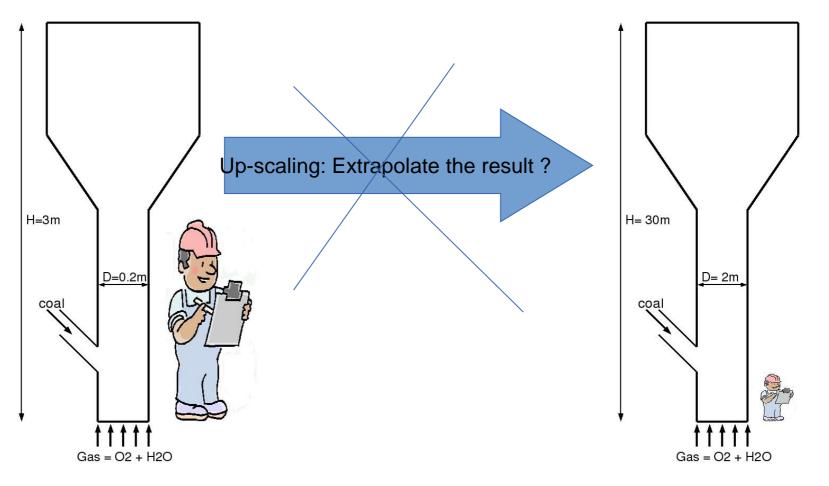


Need for CFD of turbulent reacting flows

Coal Combustion/Gasification

Small scale: 23 kg/h coal

Large scale: 80000 kg /h coal



Re = U*D/**□** 1250

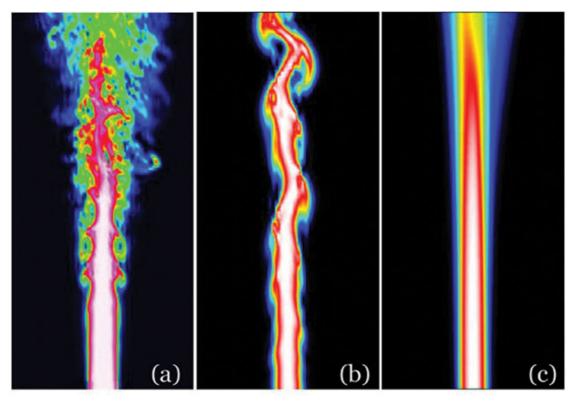
No similarity, no extrapolation!

Re = 575,000





CFD of turbulent reacting flows



(a) DNS: All scales are resolved

(b) LES: Large scales are resolved ⇒ small turbulence scales need to be modeled

(c) RANS: mean flow resolved ⇒ all turbulence scales have to be modeled





Application: Coal Combustion

Modeling challenges

- turbulent gas motion and particle dispersion
- heat and mass transfer
- gas phase reactions, heterogeneous reactions
- thermal radiation



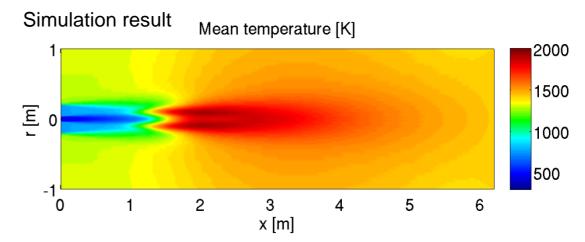


Simulation Method and Results

- Turbulent motion modeled by stochastic processes
- Averaging over many stochastic "realizations" provides useful information

Closeup of the flame in the real furnace





Quantitative comparison





Thomas Foulke

Senior Research Scientist, Agricultural and Applied Economics

- Economic assessment of energy systems.
- Team of researchers at UW Agricultural & Applied Economics includes Dr. Roger Coupal and Dr. David Taylor.
- Area of emphasis includes economic impact of energy projects in the west including pipelines, oil and gas fields, wind farms and advanced energy projects such as coal-to-liquids and hybrid energy systems (with INL). Includes firm level economic assessment and feasibility and regional economic impact (jobs and income).



Recent publications include:

- Value-Added Products from Hybrid Systems in Wyoming, Robert Cherry, et al., INL/EXT-12-27249. 2012. Economic information.
- The Feasibility of Siting Coal Gasification and Synfuels Plans in Wyoming, Richard Boardman, et al., INL/MIS 11-22553. 2011.
 Economic and background information, general editing.
- Wyoming's Uranium Industry: Economic Impact and Production Potential in a Changing World. Western Regional Science Association, 50th Annual Meeting, Monterey, CA. March 1, 2011.
- The Concise Guide to Wyoming Coal. For the Wyoming Mining Association. Years, 2003-2011 with continuing contributions, 2012, 2013.
- An Economic Impact Analysis of Proposed Tax Incentives to Attract Integrated Gasification Combined Cycle Power Generation Facilities to Wyoming. For the Wyoming Infrastructure Authority. Cheyenne, Wyoming. January 2007.

