The Fossil Report

Oak Ridge National Laboratory Fossil Energy Program Spring 2002

Energy Technology for the Future...and for the World

Computer Simulations Offer Promise of More Efficient Fluidized-Bed Reactors

Fluidized-bed reactors are widely used in the chemical industry for the production of specialty chemicals, such as petroleum, polymers, and pigments.

Fluidized-beds will also be widely used in the next generation of power plants, aiding the conversion of coal to clean gas.

Our understanding of the complex, multi-phase flows involved in the operation of these devices, however, is still very limited.

The acquisition of real-time experimental data is problematic, as multi-phase flows are very difficult to monitor and there is a lack of well-developed, non-intrusive diagnostic tools.

Computational approaches are an attractive alternative for the investigation of these complex processes. They also enable the examination of issues usually encountered when attempting to scale up to industrial levels and configurations.

Although computational techniques have made great strides in single-phase flows, they are not fully mature in the analysis of multi-phase flows.

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ORNL and SGL Carbon: A Partnership for New Carbon Materials

SGL Carbon Group, a leading supplier of carbon, graphite, and related materials for industrial, aerospace, and defense applications, has joined forces with Oak Ridge National Laboratory to apply slurry molding technology to the development of novel carbon and graphite materials.

In recent years, ORNL has developed a slurry molding technology for the

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UNITED WE STAND

Cyanobacteria Illuminated with New Hybrid Solar Collector

The Engineering Science and Technology Division at Oak Ridge National Laboratory has completed the development of a one-square-meter hybrid solar collector and light distribution system for the DOE Office of Fossil Energy. The system illuminates cyanobacteria in an engineered photobioreactor being developed by Ohio University.

[*Please see the* ***Spring 2001*** *issue of The Fossil Report for a report on cyanobacteria, entitled "****The Oldest Fossils****".*]

The system more than quadruples the algae-growing surface area that can be effectively illuminated by direct, nondiffuse sunlight, virtually eliminating the common problem of photosynthetic saturation that occurs in surface-based raceway cultivators.

In the future, the ORNL system will also provide needed electrical

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The Fossil Report **is published quarterly.**

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power to operate portions of the harvesting system in the engineered photobioreactor by separating and converting the infrared portion of the solar spectrum into electricity through thermophotovoltaics.

The research team, which includes Jeff Muhs, Duncan Earl, Curt Maxey, Dave Beshears, Supriya Jaiswal, and Mike Cates, will testing the light collection and delivery system in the coming weeks.

Several industrial partners contributed to the system design, including 3M, Array Technologies, Enhancement Electronics, and ROC Glassworks.

This work is part of research to demonstrate the lab-scale feasibility of using solar remote source lighting systems to enhance the overall sunlight utilization and biomass production rates of photobioreactors.

Hybrid solar collector and light distribution system

The ultimate objective is to demonstrate that low-risk methods of carbon dioxide mitigation, based on the use of existing biological organisms in an optimal way, are capable of significant carbon dioxide uptake and offer a valid near-term solution for carbon dioxide sequestration.

*For more information on this research, please contact **Jeff Muhs**, Oak Ridge National Laboratory.*

*The work is supported by the **DOE Office of Fossil Energy, National Energy Technology Laboratory.***

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manufacture of porous, high-surface-area carbon fiber composite molecular sieves and carbon fiber preforms.

The joint effort is designed to see if this technology can also be used to manufacture porous adsorbent carbon materials, low-pressure-drop adsorbent carbon composites, ultra-fine-grained graphite, and carbon-fiber-reinforced graphite.

*To learn more about the work of this exciting new partnership, please contact **Tim Burchell**, Oak Ridge National Laboratory.*

This work is jointly sponsored by the DOE Office of Fossil Energy, National Energy Technology Laboratory and SGL Carbon Group.

Assessing Electronic Needs for Solid Oxide Fuel Cells

With fuel cells, particularly solid oxide fuel cells, becoming more and more prevalent in meeting the power needs of small and large technologies, there is an increasing need to understand and predict needs related to the power and electronic requirements of fuel cells themselves.

Even with tremendous advances in power electronics technologies over the last few years—with better devices, packaging, and manufacturing processes—electronics systems fall short of the goals for reliability, performance, cost, and suitability for certain applications.

A number of these issues are critical, technical barriers specific to solid oxide fuel cell applications

Researchers in Oak Ridge National Laboratory's **Power Electronics and Electric Machinery Research Center** are seeking to close this gap.

Assessments of the specific power electronics needs for solid oxide fuel cells will form a large part of the effort at PEEMRC.

An integral part of the assessments will be evaluations of existing and expected near-term, power electronics technologies to meet these needs.

*For more information on this work, please contact **Don Adams**, Oak Ridge National Laboratory.*

*This work is supported by the **DOE Office of Fossil Energy, National Energy Technology Laboratory.***

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In particular, existing computer simulations are not sufficiently accurate—or rapid—to serve as the primary approach to the design, optimization, and control of industrial-scale fluidized-bed reactors.

Sophisticated, three-dimensional computer models, capable of accurately treating the complex interactions between different phases, would be an important step toward the level of simulation necessary for the design of new-generation, efficient fluidized-bed designs.

Two projects, led by **Ed D'Azevedo** and **Sreekanth Pannala** in Oak Ridge National Laboratory's Computer Science and Mathematics Division, are striving toward this goal.

In the one project, a multiphase computer model, termed the **Multiphase Flow with Interphase eXchanges (MFIX) Model**, developed at the DOE National Energy Technology Laboratory, is capable of describing the hydrodynamics, heat transfer, and chemical reactions in fluid-solids systems.

MFIX calculations give transient data on the three-dimensional distribution of pressure, velocity, temperature, and species mass fractions.

This first project is focused on tailoring the MFIX code for application to the specific problem of industrial-scale fluidized-beds. For example, one enhancement will be to develop a fast, parallel version of the MFIX code.

Ed D'Azevedo

In the second project, a low-order bubble model, a model used for understanding bubble behavior in fluidized beds based on experimental observations of bubble interactions, will undergo further development. The aim is real-time diagnosis and control of industrial-scale fluidized beds.

Sreekanth Pannala

The insight obtained through the low-order bubble model enhancement will lead to development of component models for a full 3-D simulation using the MFIX code. The incorporation of simple component models into the MFIX code will address the effects of unresolved scales in coarse, large-scale fluidize-bed simulations. This approach will enable the efficient and timely simulation of industrial-scale beds.

Fluidized-Bed Steam Generator - courtesy Foster Wheeler

This exciting new work, the development of high-performance simulation tools in combination with carefully designed experiments, will have a significant positive impact on energy efficiency and, hence, competitiveness of U.S. chemical and energy industries.

*For more information on this work, please contact **Ed D'Azevedo** or **Sreekanth Pannala** at the Oak Ridge National Laboratory.*

*This work is sponsored by the **DOE Office of Fossil Energy** and the **DOE National Energy Technology Laboratory**.*

New Technology Used for Monitoring Metals in Gases and Aerosols

Sensitive elemental measurement of gaseous and aerosol samples can be made *in-situ*, and in real time, by using a recently-patented technology.

The technology, aerosol-focusing laser-induced plasma spectrometry, was developed under the leadership of **Mengdawn Cheng** of Oak Ridge National Laboratory's Environmental Sciences Division and will be used for continuous monitoring of the release of metals in gas and/or in aerosol forms.

The focusing technology concentrates aerosol particles, forming a laser microplasma. The microplasma, in turn, is used as the excitation energy for time-resolved laser emission spectroscopy, which then is used to identify and quantity the elemental composition of the sample.

The small. portable system has a low duty cycle and low power requirements. Field-testing and demonstration are ongoing.

Mengdawn Cheng

For more information on this exciting new technology, please contact ***Mengdawn Cheng****, Oak Ridge National Laboratory.*

This work was supported by the ***DOE Fossil Energy****,* ***National Energy Technology Laboratory****,* ***National Petroleum Technology Office****.*

Largest Oil Deposit Ever in Gulf of Mexico

The energy independence of the U.S. was given a big boost in early 2001 with the discovery of a huge oil deposit in the U.S. Gulf of Mexico.

The Thunder Horse Oil Field, 125 miles off the coast of New Orleans, is the largest oil field ever found in the U.S. Gulf of Mexico. Experts now estimate that there are upwards of 3 billion barrels of oil waiting to be claimed.

Drillship which carried out the appraisal drilling of the Thunder Horse Oil Field - courtesy Offshore Technology

ExxonMobil and BP have formed a partnership to tap the huge deposit, residing in two separate fields, five miles apart.

Originally named the Crazy Horse Oil Field, in honor of the Lakota warrior and spiritual leader, BP recently assigned the field its current name, after being made aware that, in Lakota tradition, the use of a name outside of a spiritual context is sacrilegious.

For anyone who has pulled up to the pump in recent months, it is readily apparent that we are susceptible, more and more, to the uncertainties in the world oil market.

The current conflict in the Middle East, with threats from Iraq to embargo oil shipments to any country sympathetic to Israel, and the fluctuation of the oil production ceilings on the part of OPEC underscore the need to capitalize on U.S.-derived oil.

Current estimates are for oil to start flowing from the Thunder Horse fields as soon as 2005, with predicted pumping rates of 250,000 barrels per day.