The Fossil Report

Oak Ridge National Laboratory Fossil Energy Program — Winter 2001

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

Carbon Dioxide Sequestration and Methane Production Focus of New Work

Exciting new research on CO_2 sequestration in subterranean coal beds will soon be underway in Oak Ridge National Laboratory's Fossil Energy Program.

The work, *Effects of Temperature and Gas Mixing on Formation Pressure, CO_2 Sequestration and Methane Production in Underground Coal Beds*, will be led by **James G. Blencoe** of ORNL's Chemical Sciences Division.

The laboratory data and theoretical models generated by the research will be vital in assessing the feasibility of injecting CO_2 into deep, unmineable coal beds. This promising new technology has two central objectives—long-term storage of CO_2 in the coal layers, and production of greater amounts of methane gas.

The work will complement in an important way ongoing DOE efforts to identify an effective, affordable, and environmentally- acceptable means of sequestering CO_2 in geologic reservoirs.

Sequestering CO_2 in deep, unmineable coal seams is highly effective, because CO_2 is strongly adsorbed on coal surfaces.

After injection into an underground coal bed, CO_2 remains trapped in the bed for hundreds, perhaps even thousands, of years.

Injection of CO_2 into a subterranean coal bed enhances methane production because, as the CO_2 sorbs onto coal surfaces, methane sticking to those surfaces is released (desorbed). This liberated methane subsequently

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UNITED WE STAND

"Let every nation know, whether it wishes us well or ill, that we shall pay any price, bear any burden, meet any hardship, support any friend, oppose any foe, in order to assure the survival and the success of liberty."

John Fitzgerald Kennedy

Counter-Terrorism Budget: A Dramatic Increase

In the aftermath of the September 11th terrorist attacks on the United States and the subsequent, subversive horror of the threat of anthrax warfare, President Bush and Congress have united in proposing a counter-terrorism budget nearly three times the level appropriated in FY 2001.

The FY 2002 counter-terrorism budget, on the order of $1.5 billion, represents a whopping 156.5% increase over the $579 million enacted in FY 2001.

Remarkably, this increase is in contrast to a proposed cut in the counter-

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flows through coal cleats (open fractures) into a production well, where it can be recovered for subsequent sale.

Blencoe's research on CO_2-enhanced coal bed methane production will focus on measuring the densities and viscosities of the gas mixtures that are produced when either pure CO_2 or deoxygenated flue gas (largely a mixture of CO_2 and nitrogen) is injected into deep, unmineable coal layers.

Quantitative knowledge of these gas properties will enable rigorous computer modeling of gas adsorption and desorption, and flow through coal cleats, during and after CO_2 injection.

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

*For more information on this work, contact **Jim Blencoe**, Oak Ridge National Laboratory.*

James G. (Jim) Blencoe is a research geochemist in the Chemical Sciences Division at Oak Ridge National Laboratory. During his 30-year professional career, he has conducted numerous experimental/theoretical investigations of the thermodynamics and phase relations of synthetic solids and fluids that serve as chemical analogs for natural Earth materials (rocks and hydrothermal solutions) found at great depths below the surface.

Jim earned a B.Sc. in Mining Engineering from the University of Wisconsin, Madison, in 1968, and a Ph.D. in Geology from Stanford University in 1974. Between 1974 and 1983, he was a postdoctoral fellow and assistant professor of geochemistry at The Pennsylvania State University.

Jim accepted a position at ORNL in 1983 to join a team of researchers responsible for providing technical assistance to the Nuclear Regulatory Commission. The objective of the work was to evaluate the technical feasibility of constructing, operating, and decommissioning a geological repository for permanent disposal of high-level nuclear wastes generated by energy production at commercial nuclear power plants.

In 1987, Jim resumed his basic research on rock-forming minerals, silicate melts, and mixed-volatile fluids. In recent years, his attention has been focused on determining the thermodynamics and phase relations of C-O-H-N fluids at elevated temperatures and pressures.

Jim has reported the results of his research in peer-reviewed articles published in leading geoscientific journals and has been active in various professional organizations, including the Mineralogical Society of America, for which he is currently serving as Treasurer.

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terrorism budget proposed by the President in the preliminary budget proposal, prepared prior to the September 11 attacks.

Approximately half of the total budget derives from a $40 billion emergency response fund created after September 11.

**We will not tire,
we will not falter,
and we will not fail.**

***George W. Bush
September 20, 2001***

Eleven federal agencies will receive counter-terrorism funds this year. The Department of Energy's share of this budget is $194 million.

DOE's research and development for counter-terrorism covers radiation detection, biological threats, and chemical and biological detectors. In addition, DOE will receive funds to upgrade security in its national laboratory infrastructure, as well as $78 million for nonproliferation R&D to combat potential nuclear terrorism.

Reliability of Solid Oxide Fuel Cell Components Goal of New Work

Over the past 170 years, fuel cells have distinguished themselves as sources of clean, environmentally friendly power. A wide variety of types has emerged over the intervening years, and the current favorite for a large number of applications is the solid oxide fuel cell.

Edgar Lara-Curzio

Solid oxide fuel cells use ceramic, solid-phase electrolytes, which eliminate many of the problems associated with managing liquid electrolytes. However, a solid oxide fuel cell, comprised of ceramic electrolytes, must operate at higher temperatures to achieve adequate ionic conductivity. The higher temperatures, although contributing to higher efficiencies, also result in higher rates of material degradation.

Edgar Lara-Curzio of Oak Ridge National Laboratory's Metals & Ceramics Division is identifying the mechanisms responsible for the failure of solid oxide fuel cell components. The particular components of interest are multilayer anode/electrolyte/cathode assemblies, which constitute the building blocks of these systems.

Although fuel cells have been used successfully in short-term duration applications, their future viability in distributed power applications will demand reliable operation for times measured in tens of thousands of hours.

Predictions of service life and reliability of solid oxide fuel cells require a fundamental understanding of how and why damage occurs and how that damage proceeds to a failure of the component.

To understand and prevent long-term failures in solid oxide fuel cell components, Lara-Curzio is investigating the effects of processing and fabrication parameters, and the resultant residual stresses, on the initiation of material damage and the progression of the damage in materials which are candidates for solid oxide fuel cell components.

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

*For more information on this work, contact **Edgar Lara-Curzio**, Oak Ridge National Laboratory.*

Carbon Sequestration Technology Roadmap Posted

The **Carbon Sequestration Technology Roadmap**, issued by the DOE National Energy Technology Laboratory, has been posted to the DOE-NETL Web site.

The roadmap covers the major research and development pathways, which are most promising for achieving the goals of carbon sequestration.

Clean Coal Power Initiative Solicitation to be Issued

The DOE National Energy Technology Laboratory plans to issue a solicitation in mid-February for "projects that demonstrate advanced coal-based technologies and accelerate their deployment to commercial

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Mark Your Calendar...

The Sixteenth Annual Conference on Fossil Energy Materials will be held at the Wyndham Baltimore Inner Harbor Hotel in Baltimore, Maryland, from April 22-24, 2002.

The format for the conference will be the same as in years past, with poster and oral presentations of materials-related activities on the DOE Fossil Energy Program.

The conference will be sponsored jointly by DOE Office of Fossil Energy's National Energy Technology Laboratory, and Oak Ridge National Laboratory.

Conference reservation and travel information will be available in the near future on the **ORNL Fossil Energy Program Web site**.

New Work Seeks to Extend Life of Critical Gas Turbine Components

The performance goals and expectations for metallic components of large, land-based gas turbines call for the use of single crystal airfoils.

The complexity of the manufacture of single crystal components for land-based turbine systems is significant, owing to the considerably larger size of these systems, as compared to aircraft turbines.

This increased complexity, of course, results in increased costs.

Due to the size of the components, remanufacturing a failed part is a very expensive proposition.

For improved and more cost-effective use of single crystal turbine components, it is essential that components can be repaired and refurbished, extending their lives for at least one additional duty cycle.

Stan David and **John Vitek** of Oak Ridge National Laboratory's Metals & Ceramics Division are leading an effort to address the repair of single crystal components, such as blades and vanes, of turbine systems through the use of welding technology.

Stan David

John Vitek

Welding is tool for repairing rejected as-cast components, as well as for repairing and refurbishing used components.

The work will focus on welding behavior and weldability of single crystal nickel-base superalloys.

Nickel-base superalloys are used extensively for the components of large, land-based turbines.

Three major problems will be addressed—stray grain formation, weld cracking, and irregular as-welded microstructure formation.

David and Vitek plan to concentrate on these three problems and to determine the processes, process conditions, and alloy compositions necessary to make possible the cost-effective repair welding of critical superalloy components in gas turbine systems

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

*For more information on this work, contact **Stan David** or **John Vitek**, Oak Ridge National Laboratory.*

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use."

The **Clean Coal Power Initiative** is open to "technology advancement related to coal-based power generation that results in efficiency, environmental and economic improvement."

DOE national laboratories are permitted to respond to this solicitation, but only as team members on CCPI projects.

National laboratories are not eligible to receive an award as the prime recipient.

The solicitation addresses technologies capable of producing any combination of heat, fuels, chemicals or other useful by-products, in conjunction with power generation.

Proposed projects must show that coal will be used for at least 75% of the fuel energy input, to maintain the focus of the solicitation on coal-based power generation.

Prospective projects must also show the potential for rapid market penetration upon successful demonstration of the technology or concept.