The Fossil Report

Oak Ridge National Laboratory Fossil Energy Program — Summer 2001

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

ORNL Proposal Winner in National Laboratory Competition

An Oak Ridge National Laboratory proposal was one of the winners in the recent DOE Laboratory solicitation for applied research for the Natural Gas Infrastructure Reliability Program.

The proposed work, New Acoustic Wave Pipe Inspection System, was submitted by Venu Varma of ORNL's Robotics and Process Systems Division.

The work has the objective to demonstrate a new waveguide pipe flaw detection technique.

It is envisioned that the new technique will enable the detection of flaws in a single pass, something not achievable with current methodologies, Varma says.

The need for this work results from our aging pipeline transportation system. Aging pipelines develop weak spots, which can lead to leakages and failures.

Events within the past year, particularly the tragedy in Carlsbad, New Mexico, where 12 people lost their lives and a recent death in Knoxville, Tennessee, illustrate the urgency of having a reliable pipeline inspection system.

In each case, internal corrosion of an underground pipeline distribution system is suspected to have been the cause of the leakage and rupture.

The currently-used method of detecting corrosion damage through the application of a magnetic field to the interior of a pipe can not be utilized to detect flaws or cracks.

An efficient and reliable inspection system is needed to prevent failures.

The new technology will enable pipeline operators to detect defects, which are not detectable by other means.

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

For more information on this work, contact ***Venu Varma****, Oak Ridge National Laboratory.*

Venugopal (Venu) K. Varma received his B.Tech from I.I.T. Kharagpur, India in 1983, his M.S. in 1986 from Colorado State University, Fort Collins, and his M.S. and Ph.D in 1989 and 1993 from University of Maryland, College Park.

Since 1993, he has been a researcher at Oak Ridge National Laboratory, where he has been involved in projects related to manipulator kinematics, dynamics and control. He has numerous papers in the area of robot grasping, robot vision and other related areas.

His current area of interest is micro-actuation using smart materials. Under a DARPA-funded program he is building an SMA actuator with higher efficiency of operation.

He is also working on other types of actuators using piezoelectric materials.

IN THIS ISSUE

ORNL Proposal Winner in National Laboratory Competition
Welcome to the Program
Inorganic Membranes to Benefit Petroleum Refining
Legislation Introduced on Deep-Sea Natural Gas and Petroleum Exploration
COMING SOON
Aging Pipelines Call for More Intensive Testing

"The whole of science is nothing more than a refinement of everyday thinking."

Albert Einstein

The Fossil Report **is published quarterly by the Oak Ridge National Laboratory Fossil Energy Program.**

Send comments to:

Paul T. Carlson
Editor and Publisher

Welcome to the Program

David DePaoli

David DePaoli

David DePaoli is Leader of the Separations and Materials Processing Research Group in the Chemical Technology Division at ORNL.

He is trained in chemical engineering (B.S., University of Michigan; Ph.D., University of Tennessee), and is also an adjunct professor of chemical engineering at the University of Tennessee.

David conducts and manages fundamental and applied research, aimed at making advances in topics of national interest, including energy-efficient chemical processing, carbon management, and nanotechnology. His current work focuses on transport processes in separations and materials synthesis.

Topics include novel separations employing electric fields, ionic liquids, and mesoporous sorbents; inorganic membranes for separations and reaction; formation and growth of inorganic materials in waste-treatment systems; and assembly of surfactants at interfaces and the impact on aqueous cleaning.

David's current work on the Fossil Energy Program is the study of **Efficient Clean-Fuel Processing Using Designer Solvents**

Jeff Muhs

Jeff Muhs has over 10 years of experience in fiber optics, photonics, and transportation measurement systems. Jeff, who hold a B.S. in Electro-Optical Sciences, is the author of ten patents and 30 publications and was named Oak Ridge National Laboratory's "1997 Engineer of the Year."

Jeff Muhs

Jeff's major responsibilities are to generate new project ideas, develop those ideas into funded programs, manage selected projects, and perform research and development.

Jeff's primary research interests include fiber optic sensors and hybrid solar lighting systems that use large-core optical fibers to improve the energy efficiency of lighting in buildings and photosynthetic-based bioenergy systems.

Jeff currently is working on two projects on the ORNL Fossil Energy Program—**Enhanced Practical Photosynthesis Carbon Dioxide Mitigation** and, jointly with Bart Smith, Life Performance Monitoring Using Fiber Optic Strain Sensors.

Lee Trowbridge

Lee Trowbridge received a B.S. in Chemical Physics from Michigan State University (1970), an M.A. in Physics from Harvard University (1971) and (after a few years in the US Army), a Ph.D. in Chemical Physics from Harvard University (1978).

Lee Trowbridge

His 22 years of professional experience in chemistry has been largely in the areas of uranium and fluorine chemistry, particularly as applied to isotope separation applications and the uranium fuel cycle.

Lee transferred from the Oak Ridge Gaseous Diffusion Plant to the Chemical Technology Division in August 1997, working primarily on the remediation of the ORNL Molten Salt Reactor Experiment.

His various activities have utilized physical and chemical process modeling, chemical kinetics and thermodynamics, and related transport phenomena in research, development, technical support to ongoing or future operations.

Lee's work for the Fossil Energy Program, **Application of Oak Ridge Inorganic Membrane Technology to Cat-Cracker Recycle Gas Hydrogen Separation,** involves investigating the application of Oak Ridge inorganic membrane technology to hydrogen/hydrocarbon separation applications in the petroleum industry.

These membranes, developed by the Inorganic Membrane Technology Laboratory at ETTP and redesigned for light gas separation, are the technological descendants of the membranes used for decades in gaseous diffusion plants.

"However beautiful the strategy, you should occasionally look at the results."
—Winston Churchill

Inorganic Membranes to Benefit Petroleum Refining

A new project, led by **Lee Trowbridge** of ORNL's **Chemical Technology Division**, is intended to improve the economics of petroleum and heavy oil upgrading and, as a consequence, contribute to clean fuel development.

Refineries use high-pressure hydrogenation to remove sulfur and reduce aromatic content in process streams. Typically, the excess hydrogen is burned. Rather than burning, recycling, purification, and reuse of the excess hydrogen will not only conserve hydrogen, but will also contribute significantly to improving the economics of the refining process.

Whereas organic membranes are attractive as a means to separate and recover hydrogen from refinery gases, there are temperature, pressure and permeation rate limitations to these materials.

Delivery of purified hydrogen at temperatures and pressures, which are closer to process conditions, offers considerable energy and economic savings in refinery operations.

The key to this work is the development and application of inorganic membranes for the separation of the hydrogen from the high-pressure hydrogen and hydrocarbon gas mixtures.

The inorganic membranes envisioned for this specific application are those being designed by the **Inorganic Membrane Testing Laboratory, Bechtel-Jacobs, LLC**.

This inorganic membrane technology is capable of customization for a variety of separations. The membranes can be constructed of corrosion-resistant and high-temperature-tolerant materials, such as ceramics or metals, to meet the needs of a wide variety of refinery applications.

Recently, for example, inorganic membranes have been designed to address the problem of separation of hydrogen from volatile organic compounds.

The objective of this work is to determine the effectiveness of specialized custom inorganic membranes designed for the separation of hydrogen from similar to those present in refinery gas streams.

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

This article was excerpted from a document authored by Lee Trowbridge. For more information on this work, please contact ***Lee Trowbridge.***

COMING SOON

The Proceedings of the 15th Annual Conference on Fossil Energy Materials is in preparation and will be posted to the Fossil Energy Program Web site in near future.

Legislation Introduced on Deep-Sea Natural Gas and Petroleum Exploration

Legislation introduced in the House on August 2 proposes to establish funding for research, development, and demonstration activities related to ultra-deepwater and unconventional natural gas and petroleum exploration and production technologies.

The National Energy Technology Laboratory and the United States Geological Survey have been designated as the lead organizations to pursue the research, should the bill be signed into law.

Specifically, the activities which would be funded would be long-term research into new gas and petroleum exploration and production technologies, in areas currently available for Outer Continental Shelf leasing.

The work would also include the development of environmental mitigation technologies, associated with production from ultra-deepwater resources.

Methane hydrates formations were specifically designated as the type of ultra-deepwater resource toward which the bill is directed.

The legislation would also fund the development and demonstration of new technologies for the reduction of greenhouse gases from ultra-deepwater natural gas or petroleum resources.

Included in the language was the specific mention of sub-seafloor carbon sequestration technologies.

The legislation was referred to the House Subcommittee on Energy and Mineral Resources on August 20.

Aging Pipelines Call for More Intensive Testing

Early on the morning of August 21, 2000, the tranquil silence near a favorite camping site in Carlsbad, New Mexico, along the Pecos River was shattered by a deafening report, when a natural gas pipeline ruptured.

The explosion and ensuing fireball killed 12 campers—men, women, and children—as they slept under a bridge spanning the Pecos River, within 600 feet of the explosion.

The explosion resulted in a crater 86 feet long, 46 feet wide, and 20 feet deep. The heat of the explosion was sufficiently intense to melt sand into glass and concrete into powder. The fire burned for up to an hour and was visible to residents of Carlsbad, 20 miles to the north.

Federal regulators, after finding corrosion and thinning of the walls on pipe fragments, issued one of the strongest orders in the history of gas pipelines. They stated that extensive testing and repairs were mandatory before any of the affected lines could be placed back in service.

The line which ruptured, a 30-inch, underground pipeline, owned by El Paso Energy Company, was 50 years old. And, according to the National Transportation Safety Board chairman, it had not been properly tested in 48 years.

Preliminary investigations by the NTSB indicated that significant internal corrosion was visible and determined that internal corrosion was potentially the cause of the fatal explosion.

The NTSB further surmised that there was valid concern that other portions of the 10,000-mile pipeline could have similar problems.

The Department of Transportation Office of Pipeline Safety mandated that El Paso Energy develop a plan to assess the entire 10,000-mile pipeline system for potential problems.

Crater formed by the explosion

It was estimated that the accident investigation and subsequent pipeline testing would not be completed for as long as up to a year.

The ruptured pipeline segment was constructed in 1952 and had not been internally inspected or hydrostatically tested in 48 years.

The NTSB has stressed the need for mandatory testing, as well as pressure testing, since 1987.

Federal regulations did not at the time of its installation require such testing.

A similar tragedy occurred in July of this year in Knoxville, Tennessee, when gas, seeping from a leak in a natural gas pipeline, was ignited by a 16-year-old boy who had unwittingly ignited a lighter.

The boy died from third-degree burns when he was engulfed by the resulting fireball.

One week after the fatal eruption, another leak was discovered in East Knoxville, but this occurrence did not lead to injuries.

In both cases, it was determined that the leaks were due to corrosion.

Congress has responded with the introduction of legislation by Senator John McCain on January 22, 2001—the Pipeline Safety Improvement Act of 2001.

The bill, in part, "requires the Secretary, as part of the DOT research and development program, to direct research attention to the development of alternative technologies: (1) to expand the defect detection capabilities of internal inspection devices; (2) to inspect pipelines that cannot accommodate internal inspection devices available on the date of enactment; and (3) to develop innovative techniques measuring the structural integrity of pipelines."

With much-deserved attention on this problem, new work at Oak Ridge National Laboratory has taken on a special significance. [**see story on Page 1**].

It is hoped that this new work—to develop a new pipe inspection system—will provide pipeline operators with the capability to detect defects, which are not detectable by other means.