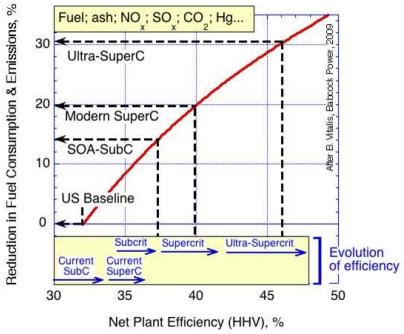
Fossil Energy R&D at Oak Ridge National Laboratory

The Oak Ridge National Laboratory's Fossil Energy Program conducts research and development that contribute to the advancement of fossil energy technologies. The program's efforts are concentrated in two areas; materials for extreme environments and technologies for the sustainable production and use of fossil energy resources. ORNL works with the US Department of Energy (DOE) Office of Fossil Energy (FE) and the DOE's National Energy Technology Laboratory (NETL) to discover, develop and deliver enabling technologies for energy production from fossil fuel resources.

ORNL Fossil Energy Materials Research

As the nation's premiere materials science laboratory ORNL is a leader in addressing the materials barriers for improving the efficiency of fossil energy power plants. ORNL researchers are developing cutting edge materials for use in boilers and turbines for Ultra-Supercritical steam power plants. Through FE's Advanced Research Materials (ARM) program is working to develop a suite of alloys and coatings to enable safer, longer lasting and more efficient power plant operation. ORNL also conducts research into materials for syngas and hydrogen turbines, solid oxide fuel cells, and electrochemical sensors for fossil power plants.

Materials to Enable the Use of Advanced Steam Conditions



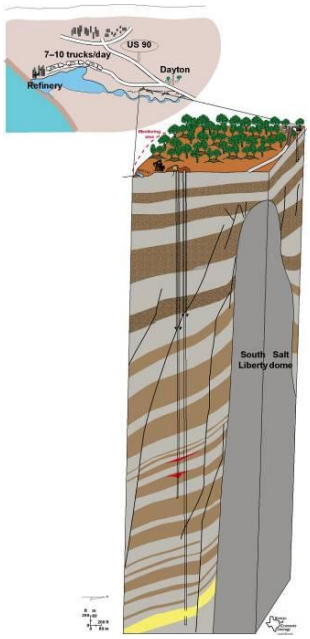
In collaboration with the U.S. Ultra-Supercritical Steam Boiler and Turbine Consortium, ORNL develops mechanical properties and environmental compatibility information to evaluate alloys needed for the operation of a coal-fired power plant using ultra-supercritical (USC) steam conditions and to build confidence in higher-performance alloys and design activities for both boilers and steam turbines. Significant progress in delivering creep data (up to 20,000 h), addressing critical issues with welding, forming, corrosion, and alloy selection has been made. Results were critical in producing data for an ASME boiler code case for alloy 740 and, for steam turbine environments, evaluating the ability to achieve wrought-like properties of cast candidate Ni-based alloys via appropriate heat treatment.

Advanced Research Materials

Through NETL, the ORNL ARM program conducts research into materials critical to the development of clean coal power systems. ORNL is working to improve the performance of creep-strength-enhanced ferritic steels including analysis of the mechanisms for weld failure. ORNL is determining the capabilities new commercially-produced oxide dispersion-strengthened (ODS) alloys for application at temperatures up to 1200°C in environments associated with advanced fossil combustion and conversion processes. ORNL is working to understand corrosion mechanisms in air- and oxy-fired systems by developing an improved mechanistic understanding of (1) the role of H_2O and CO_2 on materials performance and (2) alloy composition and surface modification strategies for improved oxidation resistance, in order to assist in lifetime modeling for current and potentially higher-performance alloys and surface modifications for use in coal-fired power systems.

ORNL Fossil Energy Sustainable Production and Utilization Research

ORNL supports R&D in FE's Clean Coal & Natural Gas Power Systems, Carbon Sequestration, Oil & Natural Gas Supply & Delivery areas. Sustainable Production and Utilization R&D projects also include the development of inorganic membranes for hydrogen separation, novel catalysts for the synthesis of ethanol, economic analysis to support the Strategic Petroleum Reserve and technologies for environmentally friendly drilling.



Monitoring of Geological CO_2 Sequestration Using Isotopes and Perfluorocarbon Tracers

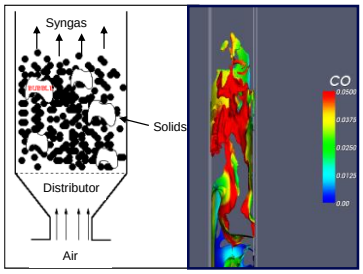
ORNL is a participant on a Southeastern Regional Carbon Sequestration Partnership (SECARB) pilot test to measure, monitor and verify the potential for CO_2 sequestration in a typical large-scale brine formation system. Sampling of the Cranfield April-May 2010 Injection Test has been performed, and perfluorocarbon tracers were successfully injected. Gas and isotopic analyses of samples collected from this and earlier tests are underway.

Hydrate Formation and Dissociation in Simulated and Field Samples

ORNL's long term study of hydrates uses its unique Subsea Process Simulator to model and study the formation of gas hydrates at sea floor conditions. Current research is characterizing kinetics of natural gas hydrate formation and dissociation within natural and simulated sediments. The team successfully used fiber optics technology to track methane hydrate formation and in a production type scenario where heat is being added to decompose the hydrate.

Computational Fluid Dynamics for Industrial Coal Gasification Processes

ORNL, in collaboration with NETL, has developed scalable reacting multiphase flow simulation software – Multiphase Flow with Interphase eXchanges (MFIX) – that can be run on ORNL's Cray XT4 ("Jaguar") supercomputer to simulate coal gasification processes. ORNL is working to enable MFIX to run in an industrial setting.



Points of Contact:

For Materials R&D:
Peter Tortorelli
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6134
865-574-5119
tortorellipf@ornl.gov
www.ms.ornl.gov/fossil

For Sustainable Production and Utilization R&D:
David DePaoli
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6181
865-574-6817
depaolidw@ornl.gov
www.ms.ornl.gov/fossil

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