the ENERGY lab

R&D FACTS

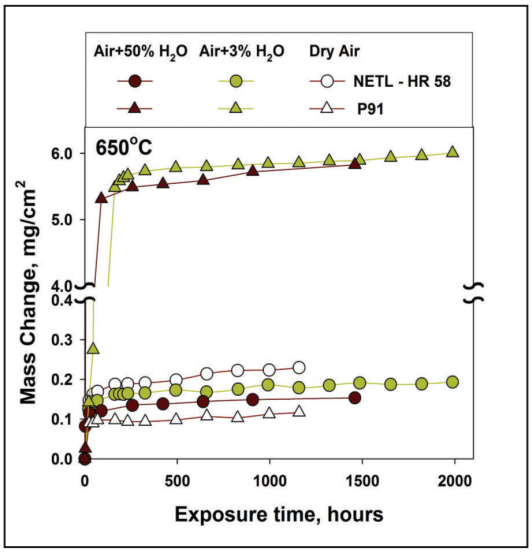
Materials Science

Materials Performance In Severe Environments

Emerging energy-production technologies such as gasification, solid oxide fuel cells, and ultra supercritical, fluidized bed, and other advanced combustion processes offer the nation the opportunity to convert domestically abundant coal and other carbon-based fuels to energy more efficiently and with significantly less environmental impact than current industry standards. However, in many cases simultaneous advances in materials technology are required to meet the performance demands of these new power systems and to ensure the new power plants are both economical and reliable. NETL researchers have extensive experience in the design, construction and conduct of experiments to evaluate materials performance in real world service environments. The aim of NETL research ranges from defining and understanding basic mechanisms of wear and corrosion of materials to providing input on materials performance and specifications for specific operating environments. Experts at NETL continue to work with industrial partners to identify materials performance shortfalls and to engineer improved materials and protection strategies that can meet stringent performance criteria at an affordable cost.

Improved Alloys for High Temperature Oxidation Resistance

The DOE goal of coal power generation at 60 percent efficiency would require combustion steam temperatures approaching 760 °C. In support of this goal, NETL researchers are investigating the influence of moisture on the oxidation characteristics of high temperature alloys. Combining the results of these studies with fundamental alloy design concepts is leading to the development of new alloys with improved performance characteristics. In 2007, an Ultra Supercritical (USC) steam test loop will come online which will allow for the exposure of alloys to steam at temperatures and pressures up to 760 °C and 37.9 MPa (1400 °F and 5500 psi).



Improvement in alloy performance of 9Cr steels. P91 is a commercial steel. Alloy HR58 was developed at NETL.

CONTACT

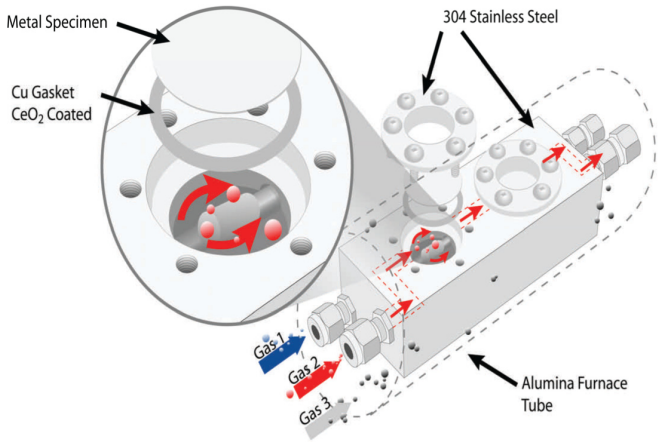
Cindy Powell
Focus Area Lead
Materials Science
Office of Research and Development
National Energy Technology Laboratory
1450 Queen Avenue SW
Albany, OR 97321-2198
541-967-5803
cynthia.powell@netl.doe.gov

Corrosion of Alloys in Mixed Gaseous Environments

Utilizing the Severe Environment Corrosion and Erosion Facility (SECERF), NETL researchers are determining the performance of boiler tube alloys in conventional air blown and oxyfuel coal combustion environments. The SECERF is a unique, computer-controlled laboratory that allows materials to be exposed at elevated temperatures (up to 1600 °C) to mixed gaseous environments. Current exposure gases include: O_2, N_2, CO, CO_2, CH_4, H_2, H_2S, SO_2, HCl, Ar, dry air, and water vapor.

A SECERF module for evaluating the performance of materials in mixed gases.

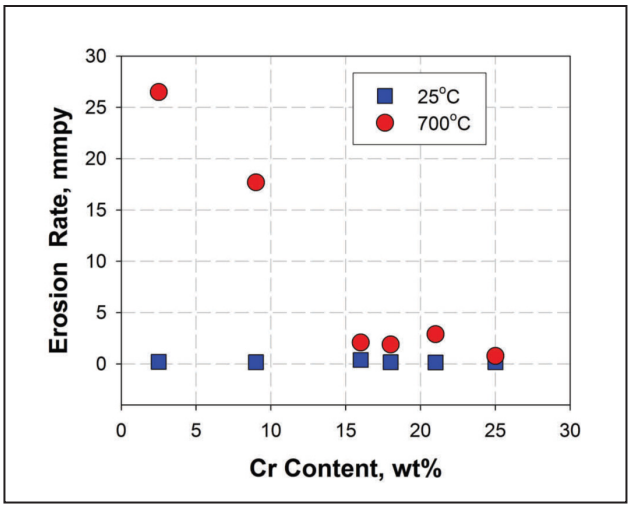
NETL researchers have designed a dual environment fixture that allows each side of a sheet material to be simultaneously exposed to different gaseous environments at elevated temperatures. Many applications subject components to different environments on opposite sides, such as fuel cell interconnects (simultaneous exposure to anode (reducing) and cathode (oxidizing) gases). Such exposure to dual environments can cause anomalous and accelerated corrosion that can lead to performance issues.



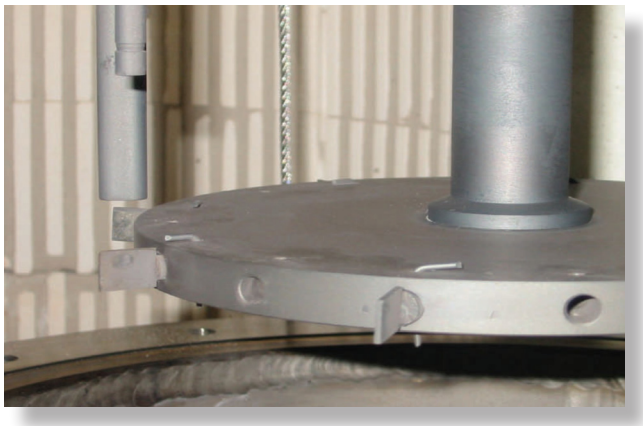
Dual Environment Apparatus.

Wear of Materials in Hostile Environments

Materials loss by abrasion and erosion is a common, and sometimes significant, issue in the operation of fossil energy plants. Abrasion is a problem in the production of fuel, including the pulverization of coal. Erosion is a problem during the operation of boilers and turbines. Borrowing on over 40 years of NETL experience in wear of materials, unique abrasion and erosion test beds have been designed to evaluate the performance of materials in hostile wear environments, including a SECERF module that allows for erosion at high temperatures to be evaluated in mixed gas environments.



Erosion of ferrous alloys in a combustion atmosphere.



The Hostile Atmosphere Erosion Test apparatus for evaluating erosion in mixed gas environments.