the ENERGY lab

PROGRAM FACTS

Strategic Center for Coal

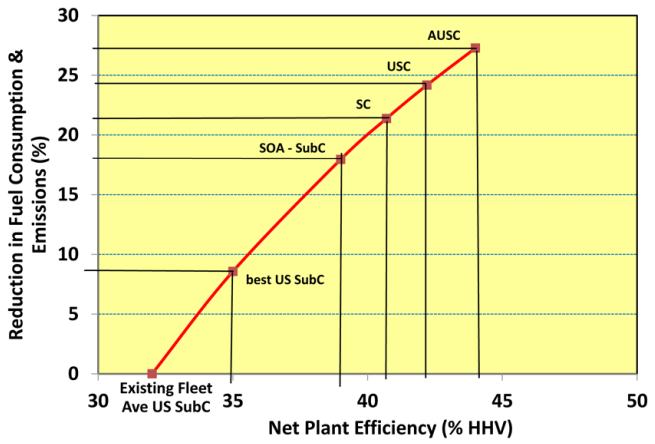
Crosscutting Technology Research Program High Performance Materials: Advanced Ultra-Supercritical (AUSC) Consortium

High-Performance Materials focuses on materials R&D that will lower the cost and improve the performance of fossil-based power-generation systems. New materials are essential for advanced power generation systems with carbon capture and storage capability to achieve performance, efficiency, and cost goals. Materials of interest are those that enable components and equipment to perform in the harsh environments of an advanced power system. A significant focus for this program has been development of materials that enable improvement in the efficiency of fossil power generation. NETL is working with industry to develop the new materials needed to meet these goals. The Advanced-Ultra-Supercritical (AUSC) Consortium, was formed to achieve a step increase in the operating efficiency of coal fired Rankin cycle power plants by the use of advanced structural materials.

AUSC Consortium Members

Increasing Steam Temperature & Pressure Increases Thermal Efficiency and Decreases Emissions

(Illinois #6 Bituminous Coal used for SC, USC, AUSC calculations)



Advanced Ultra-Supercritical Power-Steam Cycle Goals

Temperature:
760 ˚C (1400 ˚F)

Pressure:
35 MPa (5000 psi)

CONTACTS

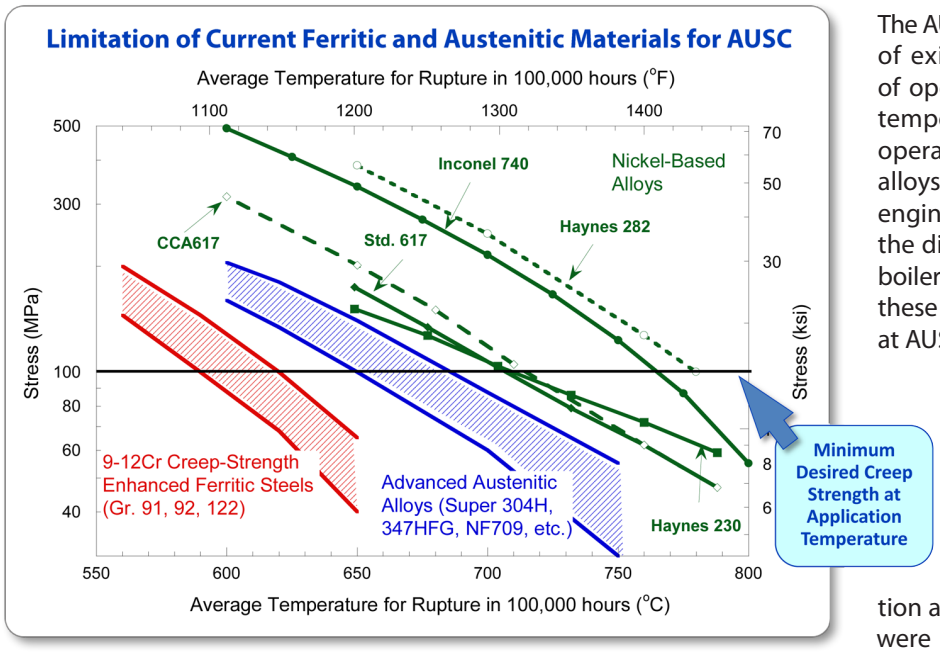
Robert Romanosky
Deputy Director,
Office of Coal and Power R&D
Acting–Technology Manager,
Crosscutting Technology Research Program
304-285-4721
robert.romanosky@netl.doe.gov

Robie Lewis
Program Manager,
Crosscutting Technology Research
301-903-6166
robie.lewis@hq.doe.gov

Regis Conrad
Director,
Division of Advanced Energy Systems
301-903-2827
regis.conrad@hq.doe.gov

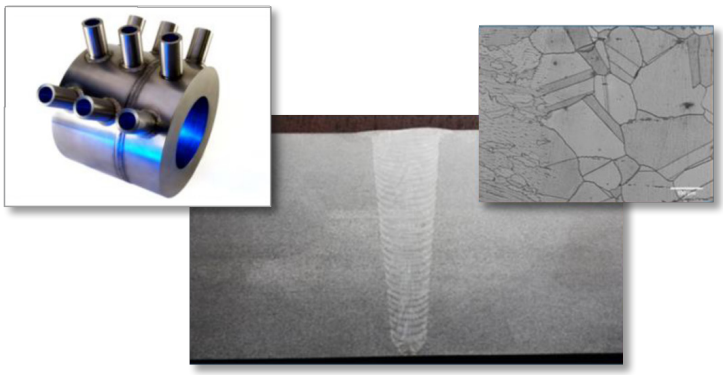
John Wimer
Director,
Office of Coal and Power R&D
304-285-4124
john.wimer@netl.doe.gov

Sean Plasynski
Director,
Strategic Center for Coal
412-386-4867
sean.plasynski@netl.doe.gov



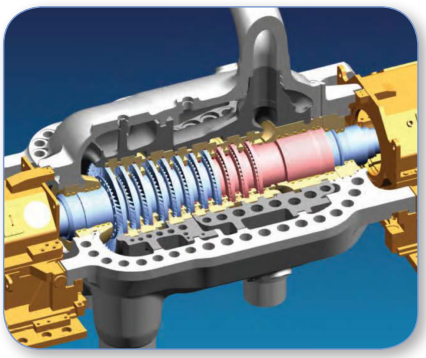
The AUSC program is focused on performance testing of existing nickel super-alloys that are capable of operating in the harsh environments (e.g. high temperature and pressure) associated with AUSC operating conditions. Most of these nickel super-alloys were developed for use in gas turbines or jet engines. Testing of these materials was needed in the different and harsh environment of a coal fired boiler. The Consortium is investigating the viability of these alloys for boiler and steam turbine applications at AUSC temperatures and pressures.

After a review of existing data on mechanical properties and resistance to oxidation at AUSC temperatures, laboratory scale tests were performed on the most promising alloys to determine relevant mechanical properties, resistance to steam-side oxidation and resistance to fire-side corrosion. The alloys were also tested for their fabricability, weldability, and castability in the forms needed for Rankine cycle power plants. A key milestone of the boiler materials evaluation work was recently completed in a long term combined fireside/steam corrosion test loop installed at Southern Company's Plant Barry. Analyses of the exposed alloys indicate very good resistance to fireside corrosion during the test period with the type of coal used in the plant's boiler.



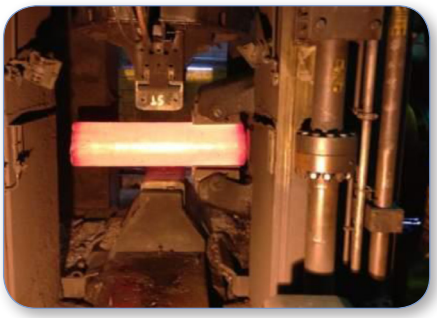
76mm (3") Wall Thickness Full Circumferential Pipe Weld in Inconel 740H

Corrosion Test Loop: World's First Steam Loop Operating at 760 °C (1400 °F)



HP Steam Turbine Design for Operation 760 °C (1400 °F)

The AUSC program also conducted research on materials for an AUSC steam turbine. A steam turbine capable of operating at the same temperature as the high-temperature steam delivered from an AUSC boiler is also needed. The steam turbine materials project focused on a few selected nickel super alloys for casting or forging into components. Work focused on developing the specific methods for casting these materials and determining the weldability, mechanical properties and repairability of the candidate alloys for turbine rotors, casings and valves. Studies were performed to establish a design basis for commercial scale components. Two (2) significant accomplishments of this project were the first triple melt Haynes 282 forging ingot and the world's largest Haynes 282 valve body casting.



World's First Haynes 282 Triple Melt Ingot

The goal of the AUSC Program is to reduce the identified risk barriers to full-scale demonstration and ultimately commercial deployment of a coal fired power plant operating at ASUC temperatures and pressures. The AUSC Consortium has started developing the plan for a test program "ComTest" that will define the performance requirements of key components of an AUSC power plant: design; tests for suitably sized components; and finally design, fabricate and test these components at AUSC conditions at a facility where operation of scalable components can be tested for sufficient amount of hours to gather data needed for the design of an a commercial scale AUSC demonstration power plant.