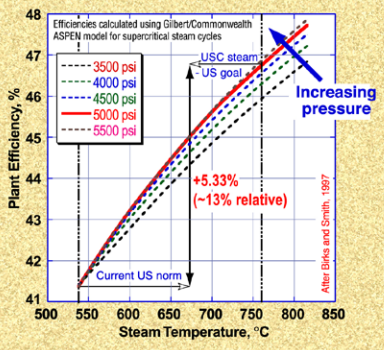
Materials for Ultra-Supercritical Steam Power Plants

Increased cycle efficiency is the key to the cleaner use of coal for generating electricity. As efficiency increases, less coal is burned, and thus, less CO_2 is produced per megawatt of electricity. Improving efficiency will require increasing the maximum steam temperature and thus will require improved materials and components

In the Rankine cycle, efficiency is related to the difference between the steam temperature at the condenser and at the high-pressure turbine inlet.

- **Steam conditions of state-of-the-art European and Japanese plants:**
  - **600°C/600°C/600°C/300 bar**
- **EU Goal:**
  - **700°C/720°C/720°C/375 bar**
- **US Goal:**
  - **732°C/760°C/345 bar (current US norm : 540°C/566°C/241 bar)**
  - **Efficiency gain of >5 percentage points (~13% relative efficiency increase)**



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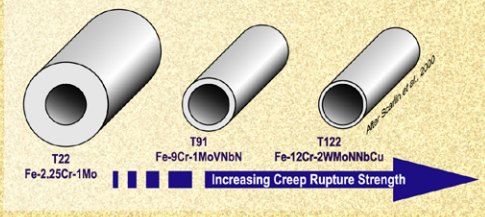
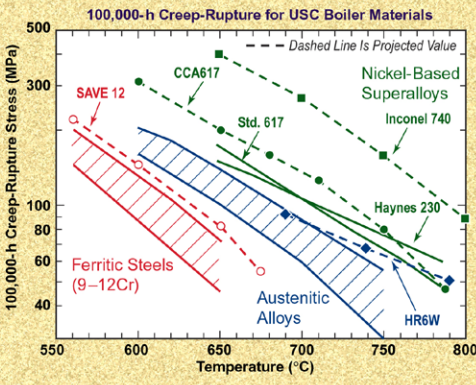
Materials Issues

- **In an integrated power supply system, all fossil-fueled power plants will be required to load-cycle**
  - **need alloys with adequate strength to allow the use of tube wall thicknesses thin enough to minimize the thermal fatigue problem**
  - **criterion of creep strength of 100 MPa for 10^5 h at service temperature**

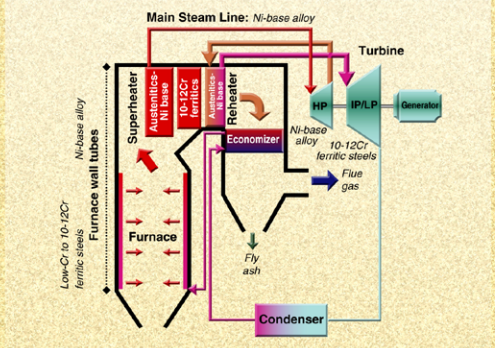


- **Resistance to fireside corrosion from sulfur and alkalis in the coal (rapid tube thinning)**
- **Resistance to steamside corrosion (rapid tube thinning, scale exfoliation, tube blocking, turbine erosion)**

Alloy Classes



Schematic of a Steam Power Plant

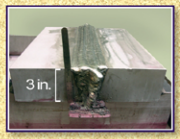


Simplified layout of an advanced coal-fired steam generator

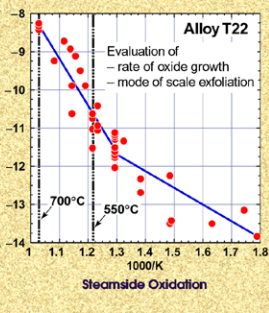
Project Tasks

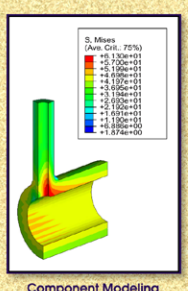
- **Code design approaches**
- **Mechanical properties of advanced alloys**
- **Fabricability**
- **Welding development**
- **Fireside corrosion resistance**
- **Steamside oxidation resistance**
- **Coatings**

Fabrication



Haynes 230 Welded Plate





Component Modeling

Funding Agencies

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NETL

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ALSTOM · EPRI · FOSTER WHEELER · BABCOCK & WILCOX · BabcockPower · Energy Industries of Ohio

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