Task 2: 
Materials for Oxy-Combustion Systems (U.S.)

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Task 2: Overview of Oxy-Combustion

- **US** – Task Leader: Gordon Holcomb, NETL
  - NETL – National Energy Technology Laboratory
    Gordon Holcomb, Cathy Summers, Joe Tylczak
  - ANL – Argonne National Laboratory
    Ken Natesan
  - REI – Reaction Engineering International
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  - U Pitt - University of Pittsburgh
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- **UK** – Task Leader: Nigel Simms, Cranfield
  - Cranfield University
  - Doosan Babcock
  - E. ON
  - NPL
  - RWE
Task 2: Overview of Oxy-Combustion

- **NETL**
  - Model
  - Characterize
  - Corrosion/Retro
  - Wear-corrosion

- **ANL**
  - Model
  - Corrosion/New

- **REI**
  - Corrosion/Retro

- **U Pitt**
  - Corrosion/Basic

- **Cranfield**
  - Characterize oxy / biomass
  - Corrosion
  - Coatings
  - Model

- **Doosan Babcock**
  - Characterize oxy / biomass
  - Corrosion
  - Coatings

- **NPL**
  - Corrosion oxy / biomass
  - Coatings
  - Model

- **RWE**
  - Characterise oxy / biomass
  - Corrosion
  - Coatings

- **E.ON**
  - Characterise oxy / biomass
  - Corrosion
  - Coatings
Refit Options and NETL Materials Research

Oxy-Combustion of Fossil Fuels with Carbon Capture
Oxy-Combustion Ash

Materials Performance in Oxyfuel Combustion Environments
Fireside Corrosion

CO₂ Pipeline

Materials Performance Issues in CO₂ Transport

Materials Performance in Oxyfuel Combustion Environments
Wear-Corrosion

A Cold Recirculation with Cleanup and Reheat
B Cold Recirculation with Cleanup, Reheat and Coal Motivation
C Hot Recirculation
D Hot Recirculation with Coal Motivation

Increasing Efficiency
Increasing Corrosion Risk
Increasing Heat Changes
NETL Proposed Task 2 Sub-Tasks

- **Modeling of oxy-combustion environments based on different strategies**
  - For example, with or without SO₂ cleanup
- **Analysis of oxy-combustion ash**
  - Ash from oxy-combustion rigs (E. ON and others)
  - Synthesis of oxy-combustion ash
- **Corrosion study of commercial and previously-corroded commercial alloys**
  - Effect of [SO₂], [HCl], and [H₂O]
- **Hot corrosion related studies**
  - Solubility of oxides in molten components of ash
- **Wear-corrosion of coal pulverizers in CO₂ recirculation**
ANL Proposed Task 2 Sub-Tasks

- Computer modeling of combustion environments in oxy-combustion systems as compared to conventional air-blown combustion systems
- Assessment of the implications of oxy-combustion environments on materials selection and long-term performance
- Experimentally-developed corrosion data for candidate materials in oxy-combustion systems
  - Superheater environments with and without ash
REI Proposed Task 2 Sub-Tasks

- REI will share information/results from their US DOE oxy-firing program, where they will study fire-side corrosion tendencies to elucidate one of the impacts of retrofitting pulverized coal-fired utility boilers for oxy-combustion.

IEP – Oxy-Combustion CO₂ Emissions Control
Characterization and Prediction of Oxy-Combustion Impacts in Existing Coal-fired Boilers

Reaction Engineering International will conduct multi-scale experiments, coupled with mechanism development and computational fluid dynamics modeling, to evaluate the impacts of retrofitting existing coal-fired boilers for oxy-combustion. Test data will be obtained from oxy-combustion experiments at the 0.1-kilowatt (kW), 100-kW, and 1.2-megawatt scale.
U Pitt Proposed Task 2 Sub-Tasks

• Corrosion of simple and commercial alloys in CO₂ and CO₂-H₂O mixtures
  – Simple alloys – Fe-10Cr, Fe-12Ni-18Cr and Ni-22Cr as compared to T91, T92, and INC 617

• Effect of surface deposits on the corrosion of simple alloys
  – Simple synthetic ashes with [S] and [C] as variables
Highlights of US Task 2 Program

- Model oxy-combustion environments based on different firing strategies
- Compare oxy-ash to air-ash & develop a synthetic oxy-ash
- Conduct a basic study of oxy-combustion corrosion with simple environments and simple alloys
- Conduct corrosion studies using modeled environments, synthetic ashes, and both new and previously-corroded commercial alloys
- Conduct cutting edge wear-corrosion studies
- Shared information and results from REI’s multi-scale program to evaluate the impacts of retrofitting existing coal-fired boilers for oxy-combustion.
  - 0.1-kilowatt (kW), 100-kW, and 1.2-megawatt scales