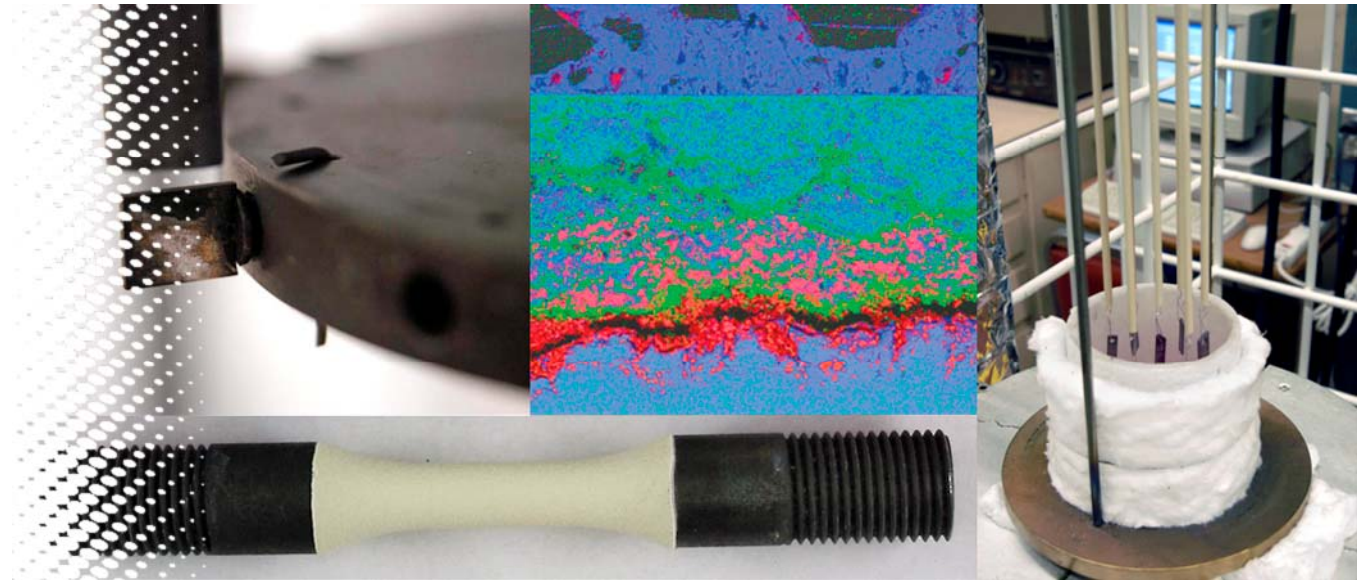




NATIONAL ENERGY TECHNOLOGY LABORATORY



Task 2—Materials for Advanced Boiler and Oxy-combustion Systems (NETL-US)

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NETL Proposed Task 2 Sub-Tasks

Fireside Exposure Tests

- Determine fireside corrosion ramifications in boilers refitted for oxyfuel combustion.
- Alloys of interest represent 4 currently used boiler alloys:
 - T22 (for waterwalls)
 - T91 (for waterwalls and superheater/reheater tubes)
 - 347 (for superheater/reheater tubes)
 - 617 (for superheater/reheater tubes and weld overlays)

Tasks

- Exposure tests for 1000 hours with ash refreshment every 250 hours.
- Characterize exposed coupons in terms of corrosion kinetics (primarily by section loss) and corrosion microstructures (by light microscopy, SEM, XRD, and elemental analysis).
- Expose US/UK round robin alloys under round robin conditions. Focus is on validation of experimental methods and procedures in terms of repeatability across laboratories.

NETL Proposed Task 2 Sub-Tasks

Oxide Solubility Studies

- Determine the fireside corrosion ramifications in boilers refitted for oxyfuel combustion.
- Important hot corrosion parameters are the melting point of the sulfate phase, the solubility of the oxide in the molten sulfate, and the solubility gradient of the oxide away from the scale into the molten sulfate.

Tasks

- Develop a method for determining the solubility of protective oxides (Fe_2O_3 , Cr_2O_3 and NiO) in an ash exposed at a particular temperature and gas composition. Metal oxide powder (Cr_2O_3 and NiO) will be mixed with a synthetic ash, milled for complete mixing, exposed at a variety of exposure times, and removed for analysis.
- A decision will be made based on the results on to going further with the next tasks.
- Perform the solubility tests on synthetic ashes and ashes collected from various oxyfuel burner rigs.
- Correlate the solubility with long term corrosion tests and variables from the burner rig tests.

Fireside Corrosion Exposures—Waterwalls

Oxidative Conditions

450 °C

Gas Phase (2.5 O₂)

- Air-fired
- Oxy-fired with CO₂ recycle after FGD
- Oxy-fired with CO₂ recycle before FGD

Ash Phase

- Base Case: 5Na₂SO₄, 5K₂SO₄, 30Fe₂O₃, 30SiO₂, 30Al₂O₃
- Base case with 10FeS (for 10Fe₂O₃)
- Base case with 5C (for 2.5SiO₂, 2.5Al₂O₃)

Reducing Conditions

450 °C

Gas Phase (5 CO)

- Air-fired
- Oxy-fired with CO₂ recycle after FGD
- Oxy-fired with CO₂ recycle before FGD

Ash Phase

- Base Case: 5Na₂SO₄, 5K₂SO₄, 30Fe₂O₃, 30SiO₂, 30Al₂O₃
- Base case with 1NaCl (for 0.33Fe₂O₃, 0.33SiO₂, 0.33Al₂O₃)

Gas Phase Details

Gas	Prior Air	Prior Oxy	SH/RH Air	SH/RH Oxy (FGD)	SH/RH Oxy (wo FGD)	WW Air	WW Oxy (FGD)	WW Oxy (wo FGD)	WW Air	WW Oxy (FGD)	WW Oxy (wo FGD)
	Oxidative Conditions		Oxidative Conditions			Oxidative Conditions			Reducing Conditions		
N ₂	74.1	0	Bal	8	8	Bal	8	8	Bal	8	8
CO ₂	14.6	60.1	14	Bal	Bal	14	Bal	Bal	14	Bal	Bal
CO									5	5	5
H ₂ S									0.1	0.1	0.3
H ₂ O	5	32.6	9	20	20	9	20	20	9	20	20
O ₂	6	2.5	2.5	2.5	2.5	2.5	2.5	2.5			
SO ₂	0.3	0.9	0.3	0.3	0.9	0.3	0.3	0.9	0.2	0.2	0.6

Fireside Corrosion Exposures—SH/RH

Oxidative Conditions

700 °C

Gas Phase (2.5 O₂)

- Air-fired
- Oxy-fired with CO₂ recycle after FGD
- Oxy-fired with CO₂ recycle before FGD

Ash Phase

- Base Case 5Na₂SO₄, 5K₂SO₄, 30Fe₂O₃, 30SiO₂, 30Al₂O₃

Fundamental Conditions

650 °C



Gas Phase

- Air
- 70CO₂+30H₂O
- 70CO₂+30H₂O+SO₂

Ash Phase

- A: 50SiO₂-25Al₂O₃-12.5CaO-12.5Fe₂O₃
- B: 49SiO₂-25Al₂O₃-12.5CaO-12.5Fe₂O₃-1K₂SO₄
- C: A mixture of 67% Deposit A and 33% Carbon
- D: 49SiO₂-25Al₂O₃-12.5CaO-12.5Fe₂O₃-1MgSO₄ (liquid at 650 °C)

Oxide Solubility

Overview

- Determine oxide solubility of protective scales as a possible ash corrosivity measurement
- Oxides of interest: Fe_2O_3 , Cr_2O_3 , and NiO

Tasks

- Expose oxides of interest in ash mixtures with oxyfuel gases as a function of time.
- Post test examination of ash mixture looking for Fe, Cr or Ni containing sulfates or Cr or Ni incorporated into the ash.