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CoalFleet for Tomorrow® Oxy-Combustion Activities

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March 31, 2009

EPRI's CoalFleet for Tomorrow® Program

- Build an industry-led program to accelerate the deployment of advanced coal-based power plants; members now span five continents
- Employ "learning by doing" approach; generalize actual deployment projects (50 & 60 Hz) to create design guides
- Augment ongoing RD&D to speed market introduction of improved designs and materials
- Deliver benefits of standardization to IGCC (integration gasification combined cycle), USC PC (ultra-supercritical pulverized-coal), and SC CFBC (supercritical circulating fluidized-bed combustion)
  - Lower costs, especially with CO_2 capture
  - High reliability
  - Near-zero SO_X, NO_X, and PM emissions
  - Shorter project schedule
  - Easier financing and insuring

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Overall EPRI Approach to Oxy-Combustion for Power Generation

CO_2 emissions control by Oxy-Coal process technology is being pursued as part of EPRI's CoalFleet RD&D program, including:

- Oxy-pulverized coal combustion development.
- Oxy-coal flow sheet assessment – Pulverized Coal and Circulating Fluidized Bed.
- Assessing options for thermal integration of ASU, CO_2 Purification, and CO_2 Compression
- Assisting in Development of Demonstration Projects
- Supporting demonstration of low-cost oxygen separation
- Supporting ultrasupercritical boiler /turbine materials for air or oxy – joint with manufacturers, DOE and State of Ohio

Oxy-pulverized Coal Combustion development

- Babcock & Wilcox completed a 12-month 30-MWt oxy-coal burner test program in late 2008.
  - Bituminous and sub-bituminous coal, and lignite were successfully tested.
- NO_x emissions 60% lower than for air but SO_2 control not affected
- Most effective way of combining oxygen with recycle flue gas (RFG) determined
  - RFG used with and without moisture control
- Controlled startup and shutdown achieved with transitions to and from oxygen firing
  - Controls safely managed trips at high and low load

Oxy-coal Flow Sheet Assessment

Internal EPRI resources used to assess:

- "Inside the loop" and polishing requirements for SO_2, NO_x, halogens, mercury. How will control of these pollutants differ from conventional air-fired pulverized coal plants?
- BOP requirements for "dual oxidant" (air and O_2/CO_2) operations
- Prospects for reducing CO_2 recycle (increased O_2 content) to reduce 2nd generation oxy-fired steam generator costs.

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Thermal integration of ASU, CO_2 Purification, and CO_2 Compression

- Useful low-temperature heat recovery: Flue gas temperature must be minimized prior to CO_2 purification. How can this be reliably accomplished while mitigating the need for additional cooling tower capacity?
- Optimizing air and CO_2 compression; identifying opportunities to reduce compressor and cooling costs by employing high pressure-ratio compression with heat recovery to the power production process.
- Employing available ASU and CO_2 purifier cold box “cooling” resources in the host power cycle.

Generic Advanced Coal Activities Applicable to Oxy-combustion Power Plants

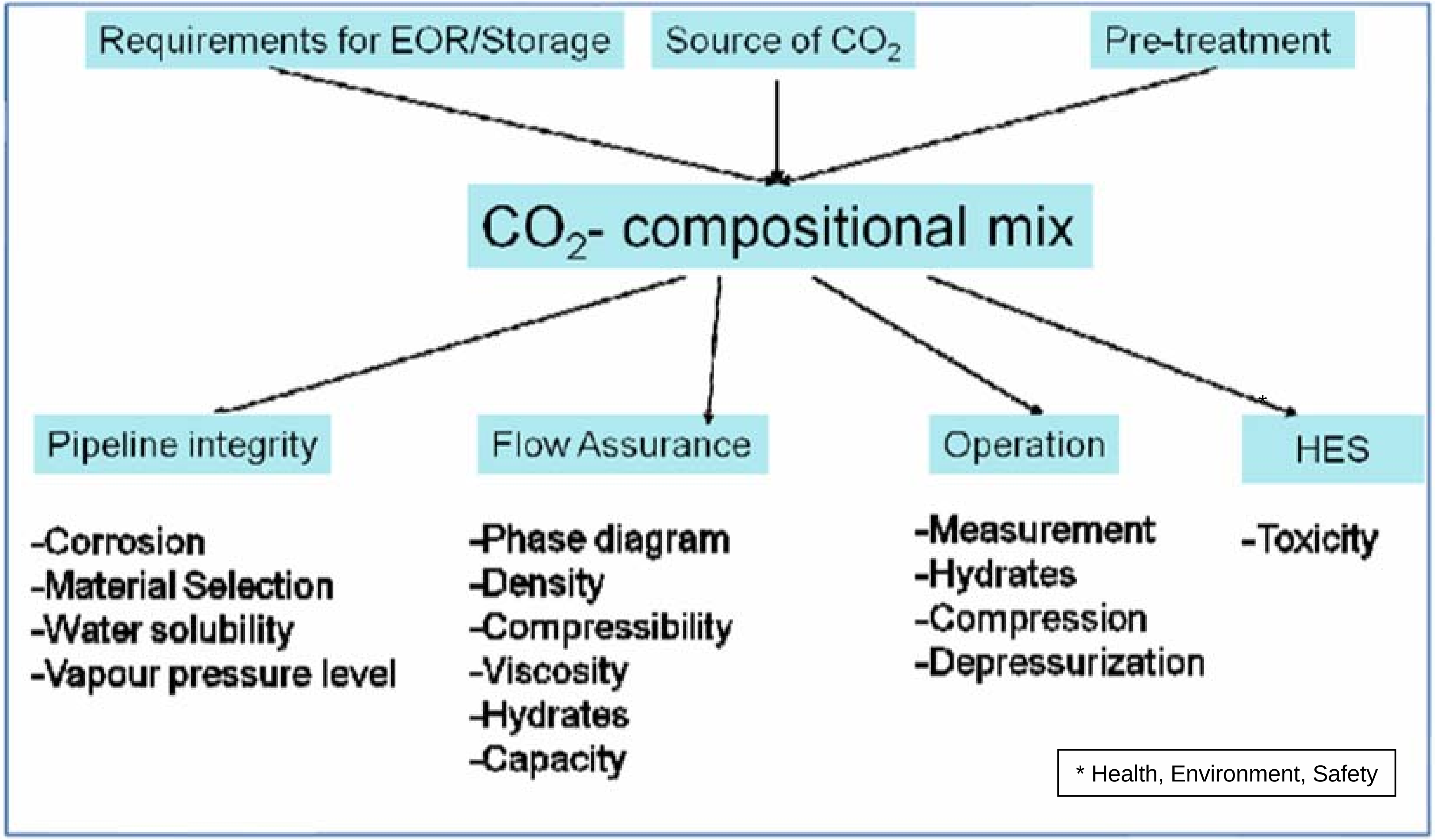
- Heat rate improvement (reducing CO_2 produced)
  - Steam cycle temperatures to 1400°F (760°C).
  - Low-temperature heat recovery
  - Fuel drying (lignite and sub-bituminous coals)
  - Other design-level measures
- CO_2 transportation/storage
  - Acceptable purity specifications for CO_2 to be transported and stored in geological formations.
  - Legal/regulatory/permitting development
  - Long term storage performance monitoring and verification.
- Water acquisition/recovery/use/disposal

Oxyfuel Issues for Transport

- Oxygen, Residual moisture, and SO_2 may be issues for transport/storage
- Purity may be relatively low < 90% and of more important is that oxygen will be well beyond current pipeline specifications without treatment
- Off gas may require cryogenic (freezing) treatment of CO_2 to purify for pipeline use, requiring capital , operating costs for purification
- Meeting similar pipeline specifications to gasses from IGCC or PC with post combustion may be problematic
- Pressure is typically atmospheric and significant compression is required

Impurities Affect Design of Compressor and Pipeline

Source: DNV



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North American CO_2 Pipeline Purity Specifications

	Dakota Gasification	FutureGen	K. Morgan	Hydrogen Energy CA
CO_2	>95%	95%	>95%	>97%
H_2S	<20,000 ppmv	100 ppmv	20 ppmv	
Total S			35 ppmw	<30 ppmv
N_2	<2%	<0.5%	<4 mole %	
O_2	25–50 ppm		<10 ppmw	<10 ppmv
HCs	<2%		<5 mole %	
Water	<15 lb/MMSCF (<0.26 g/Nm^3)	100 ppmv max	<30 lb/MMSCF (<0.52 g/Nm^3)	0.61 lb/MMSCF (13 ppmv)
Pressure	2700 psi (186 bar)	2200 psi (152 bar)		
Temp.		95°F (35°C)	<120°F (50°C)	<120°F (50°C)

Potential Roles - Assist in Development of Demonstration Projects

- Jamestown BPU 50 MWe (gross) CFB project
  - Risk Assessment report prepared
  - Preliminary Front End Engineering Design project underway
  - Negotiating for participation in Detailed Front End Engineering Design project
  - Negotiating for Monitoring and Reporting Scope (pending project approval)
- Babcock and Wilcox 150 MWe (gross) PC project
  - Negotiating for Monitoring and Reporting Scope (pending project approval)

Additional Information on Oxyfuel and EPRI

Together…Shaping the Future of Electricity

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