Project Title:

Oxy-Combustion Boiler Development for Tangential Firing

Technology Area:	**Technology Maturity:**
Oxy-Combustion	Pilot, Actual Flue Gas, 120 tonnes CO_2/day

Primary Project Goal:

Alstom Power is designing and developing a tangentially fired (T-fired) oxy-fuel technology for retrofitting existing boilers.

Technical Goals:

- Design and develop an innovative oxy-fuel firing system for existing T-fired boilers that minimizes overall capital investment and operating costs.
- Evaluate the performance of oxy-fuel T-fired boilers in pilot-scale tests at Alstom's 15-MWth boiler simulation facility (BSF).
- Determine the boiler design and performance impacts for oxy-combustion.
- Evaluate and improve engineering and CFD tools for oxy-combustion.

Technical Content:

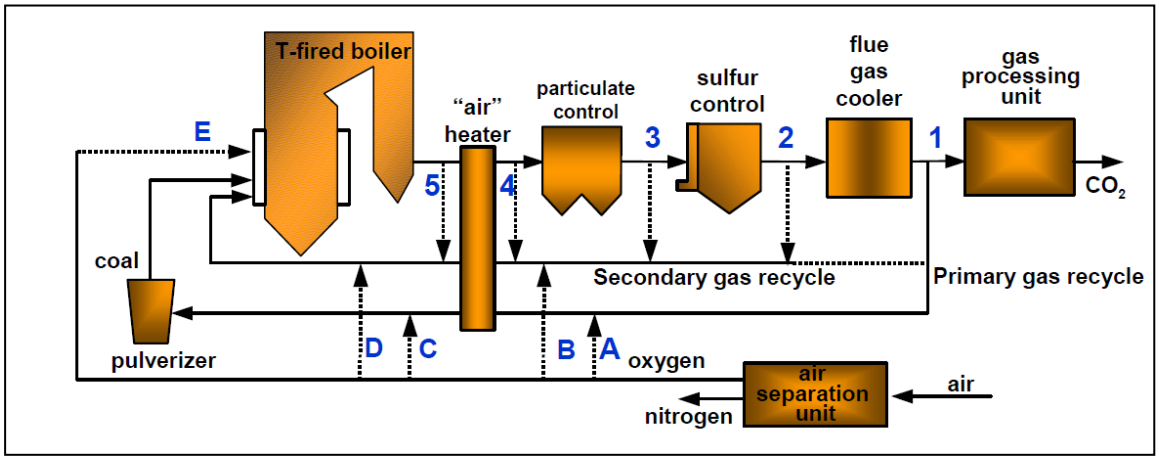

Figure 1: Simplified Oxy-Combustion Process Diagram

Figure 1 is a schematic representation of an oxy-combustion process showing the location of a T-fired boiler and several possible take-off locations for flue gas for recirculation (numbers) and locations for oxygen injection (letters). The different take-off locations will affect variables in the recirculation stream such as water, particulate, and sulfur content for the pilot tests.

The pilot-scale tests include the following variables:

- Gas Recycle Take-off Location
- Gas Recycle Flow Rates
- Oxygen Injection Flow Rates and Locations
- Windbox Design
- Over-Fire Air Compartment Design

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Additional detailed evaluation of oxy-firing system design variables and their impacts on boiler performance is being conducted using CFD analyses. These models of the BSF were developed and are being used to allow for evaluation of various oxy-fired design options. Key variables evaluated include: gas recycle ratio, gas recycle composition, oxygen injection method and distribution, windbox design, and separate over-fire air design. The models are updated using boundary conditions and data from the BSF test runs to be compared with test measurements and validate predictions.

Figure 2: Photo of BSF with Oxy Modifications

CFD simulations are also being conducted using an 850-MWe supercritical T-fired boiler model to evaluate various oxy-configurations as part of a techno-economic analysis. The economic impacts of these runs are being assessed.

Alstom Power is utilizing its 15 MWth BSF facility, shown in Figure 2, for the pilot tests. The BSF will act as an experimental tool to replicate T-firing conditions in utility boilers and isolate variables to study behavior.

Tangential firing is different from other boiler configurations in that it utilizes air/fuel admission assemblies located at the corners of the boiler furnace, which generate a rotating fireball that fills most of the furnace cross section, as seen in Figure 3. In T-firing, air/fuel mixing is limited until streams are joined together in the furnace cavity, while in wall-firing most of the mixing and flame stabilization occurs at the exit of the burner. Detailed data is being collected during the 15 MWth tests on combustion performance, heat transfer distribution, and pollutant formation. Boiler operating and performance differences, as well as changes in design requirements between air- and oxy-firing modes, are being evaluated.

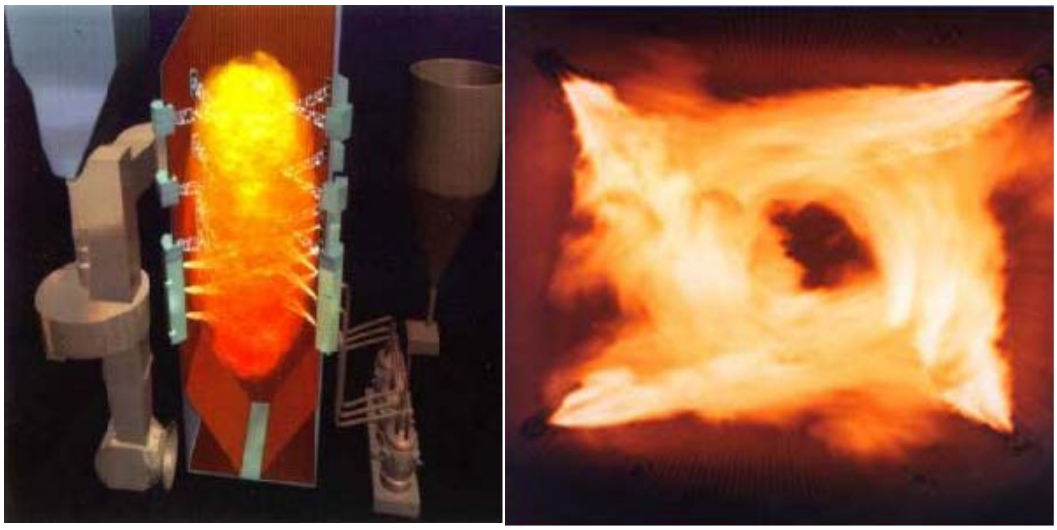

Figure 3: Model of Tangential Firing System Furnace Cavity (left); Top View of Tangential Firing (right)

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Technology Advantages:

This project will develop a better understanding of the impacts of oxy-combustion on pollutant formation, ash deposition, fireside corrosion, and heat transfer in a boiler in order to optimize this carbon mitigation technology.

R&D Challenges:

Understanding difference from air firing in pollutant formation, ash deposition, fireside corrosion, and heat transfer rates in an oxy-fired boiler, as well as control of air in-leakage and developing cost-effective designs to address these issues.

Results To Date/Accomplishments:

- Completed the design for BSF modifications.
- Completed CFD screening evaluations.
- Completed modifications to the BSF for oxy-fired operation to permit the firing under both air and oxygen, as well as with several FGR configurations and oxygen injection methods.
- Completed the two of three large, T-fired, pilot-scale test series over a range of combustion conditions.

Next Steps:

- Conduct an additional large, T-fired, pilot-scale test series over a range of combustion conditions.
- Test a different type of U.S. coal for each test, because coal properties impact the combustion process. Likely candidates include a sub-bituminous coal, a low-sulfur Eastern bituminous coal, and a high-sulfur bituminous coal.
- Examine a matrix of combustion conditions on each of the coals, including the oxygen to re-circulated flue gas ratio, effect of injecting pure oxygen and premixed oxygen and re-circulated flue gas in various configurations, total excess oxygen, furnace staging, various air in-leakage rates, reduced loads, and comparison tests with air firing.
- Test several proposed coal nozzle/windbox designs and compare for flame attachment, uniform heat release, emissions, etc.
- Perform bench-scale ash deposition and corrosion evaluation in order to provide supplemental data to support the evaluation of candidate oxy design options and assist in the analysis of BSF test results.
- Final test results will not be available until the September 30, 2010, project completion date.

Available Reports/Technical Papers/Presentations:

"Oxy-Combustion Boiler Development for Tangential Firing Fact Sheet." http://www.netl.doe.gov/publications/factsheets/project/Proj609.pdf (Accessed 9/17/2009).

"Alstom's Oxy-Firing Technology Development and Demonstration-Near Term CO_2 Solutions." 34th International Technical Conference on Coal Utilization and Fuel Systems. June 2009.

"Oxy-Combustion Boiler Development for Tangential Firing." Presented at the annual NETL CO_2 capture

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technology for existing plants R&D meeting. "Oxyfuel PC and CFB Solutions - A Promising Option for CO_2 Capture." Presented at 8th Annual Conference Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 5, 2009. "Oxy-Firing Technology – Pilot Testing Leading to Large-Scale Demonstration." 11th Annual Electric Power Conference, Chicago, Illinois, 14 May 2009.	
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