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Project Summary

Field Evaluation of a Low NO_x Firing System for Tangentially Coal-Fired Utility Boilers

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This report presents the findings of a full-scale utility demonstration of Combustion Engineering's Low-NO_x Concentric Firing System (LNCFS) conducted at Utah Power and Light's 400 MWe Hunter No. 2 boiler. This program was implemented to investigate and evaluate the effectiveness of employing concentric (offset) firing to reduce NO_x emission levels from tangentially coal-fired utility boilers.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Emphasis on improved quality of the environment has led to the design of new and unique methods of reducing NO_x emissions from coal-firing steam generators. This study gives results of a full-scale utility demonstration of one of these methods. This program was conducted at Utah Power and Light Company's 400 MWe Hunter No. 2 Generating Station. The method demonstrated was Combustion Engineering's Low-NO_x Concentric Firing System (LNCFS). The LNCFS was designed for application to tangentially fired boilers. The principle behind the LNCFS is aerodynamic control of the mixing of the fuel and the combustion air to stage the burning process. Using this design, control is achieved by directing a portion of the combustion air away from the fuel's ignition and devolatilization zone such that this zone is fuel-rich and conducive to the in-flame NO_x reduction phenomenon.

Results

Baseline Boiler Characterization

Normal baseline operating conditions (full load, no overfire air (OFA), and 4.5 to 5.0% excess oxygen) produced NO_x emissions of 450 to 460 ppmv (adjusted to 3% oxygen). Changing the excess oxygen (or excess air) by 1% changed NO_x emissions by about 45 or 55 ppmv without or with OFA, respectively. OFA reduced NO_x by between 75 and 100 ppmv. Minor but definite NO_x effects were shown for changes in burner tilts, OFA tilts, fuel-air flow, and fuel elevations in service. No effect in NO_x was shown to be directly applicable to load changes. As such, the lowest NO_x emissions achievable without degrading boiler performance were about 300 ppmv (adjusted to 3% oxygen). The conditions set to achieve this value were full load, 3.0% excess oxygen, and full OFA.

Post-Modification Characterization

During post-modification characterization, NO_x emission levels of 200 to 220 ppmv were achieved at full load, full OFA, and the OFA uptilted. These levels were also achieved repeatedly for boiler loads between 370 and 380 MWe, which appear to be the optimum boiler loads for achieving low-NO_x emissions. With horizontal OFA tilts, which is recommended for long-term operation, NO_x emission levels of 250 ppmv are more typical. The

parametric examination revealed that with the modifications a 1% change in excess oxygen now changed NO_x by about 65 ppmv. OFA reduced NO_x by about 80 ppmv. Closer ignition front stabilization with flame holders reduces NO_x by about 50 ppmv. Finally, utilization of the offset firing system in conjunction with OFA appears to have a synergistic NO_x reduction effect of an additional 50 ppmv beyond the OFA levels.

With respect to boiler performance, there appear to be no significant changes between baseline and post-modification operation. Reduced excess air levels have slightly improved boiler efficiency, and the flame holders appear to have improved low load ignition stabilization. But steam temperature control and carbon-in-flyash levels have been unchanged for normal operating conditions.

Thirty-Day Continuous Emissions Monitoring Tests

The 30-day continuous emissions monitoring (CEM) system was employed four times during the low-NO_x test program. Flue gas emissions of NO_x, O_2, CO, and CO_2 were monitored continuously and logged at 15-minute intervals throughout the tests. The principal goal of these tests was to provide an overall determination of flue gas emissions during normal boiler load cycling over an extended period. NO_x emissions for the four tests at this unit averaged 0.41 lb*/10^6 Btu* fired for the 30-day rolling averages when firing under normal low-NO_x operations. The mean boiler load for this result is about 70% of the unit design rating. This result also exhibits the difference between short-term controlled characterization tests (NO_x levels down to below 0.3 lb/10^6 Btu) and long-term normal operation.

Corrosion Tests

Low-NO_x boiler operation with the concentric firing system (LNCFS) and OFA does not detrimentally affect furnace waterwall material wastage rates. This was shown with over 1000 ultrasonic wall thickness measurements. In all cases the loss rate was less than 2 mils* per year (MPY); for the whole boiler average, the loss rate was 0.75 MPY. The use of corrosion probes yielded only qualitative trends even after 1000 hours of testing. The wastage rate results from the probe tests were conservative (higher) when compared to the actual UT results.

Therefore, because each tube has a nominal wall thickness of about 1/4-in.*, the wastage rates measured under this program, about 3/4-mils per year (0.00075 in.), would not be expected to affect the boiler's design life of 30 years.

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The complete report, entitled "Field Evaluation of a Low-NO_x Firing System for Tangentially Coal-Fired Utility Boilers," (Order No. PB 85-201 093/AS; Cost: $26.50, subject to change) will be available only from:

National Technical Information Service
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*For readers more familiar with the metric system:
1 lb = 0.454 kg and 1 Btu = 1.055 kJ.
1 mil = 0 0254 mm and 1 in. = 25.4 mm.

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