COMPARING PULVERIZED COAL REBURNING IN WALL AND TANGENTIAL FIRING CONFIGURATIONS

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ABSTRACT

Pulverized coal reburning was assessed in the CONSOL pilot-scale combustor using high-volatile bituminous coals. NO_x emissions were lower in tangential firing than in wall firing and showed minor differences among coals of different nitrogen content. The loss-on-ignition (LOI) level was coal dependent and showed minor differences between the two burner configurations. Reburning reduced NO_x to 0.25 lb/MM Btu (68% reduction) in wall firing and 0.15 lb/MM Btu (75% reduction) in tangential firing, and increased LOI 2-10 times depending on the coal. A finer grind primary fuel increased NO_x and decreased LOI. A finer grind reburn fuel decreased both NO_x and LOI.

INTRODUCTION

Pulverized coal reburning NO_x control was assessed in the CONSOL 1.5 MM Btu/h pilot-scale combustor equipped with low-NO_x burners in both opposed wall and tangential firing configurations. Several high-volatile (36-40% dry volatile matter) bituminous coals were tested using the same coal as the primary and the reburn fuels. Opposing air jets were used to introduce the reburn fuel and the over fire air. The effects of the three process stoichiometries (primary, reburn and final), the firing rate and the pulverized coal fineness on reburning performance (NO_x emissions and fly ash LOI) were investigated. Final CO emissions were generally below 30 ppm.

REBURN STOICHIOMETRY, FIRING CONFIGURATION AND COAL NITROGEN

Statistically designed tests assessed the impact of four independent variables: 1) the firing configuration (opposed wall-fired and tangentially-fired), 2) the coal nitrogen content (two high-volatile bituminous coals containing 1.3% and 1.8% dry nitrogen), 3) the primary firing rate (volumetric heat release rates of 12,000 and 9,000 Btu/h-ft^3), and 4) the reburn stoichiometry (0.83, 0.88, 0.93, 0.98 and 1.15). Reburning performance (NO_x and LOI) was evaluated by comparing the reburning results to the baseline (no reburn and no over fire air) results corresponding to a stoichiometry of 1.15. The reburn stoichiometry was the dominant operating variable affecting NO_x and LOI.

As the reburn stoichiometry decreased, NO_x emissions dropped and reached an asymptotic level at stoichiometries below 0.84, whereas LOI rapidly increased. With and without reburning, the final NO_x emissions depended on the burner firing configuration and showed minor differences among the test coals, suggesting a minor impact of the coal nitrogen content on NO_x. Tangential firing produced 0.10-0.16 lb/MM Btu lower NO_x emissions than opposed wall firing, with larger differences at higher reburn stoichiometries. At a reburn stoichiometry of 0.84, pulverized coal reburning reduced NO_x emissions from 0.77 to 0.25 lb/MM Btu in wall firing, and from 0.61 to 0.15 lb/MM Btu in tangential firing, corresponding to reductions of 68% and 75%, respectively. With and without reburning, LOI values depended on the coal and showed minor differences between the two burner configurations. At a reburn stoichiometry of 0.84, pulverized coal reburning increased LOI from less than 1% to 2-4% or 10-13%, depending on the coal, possibly due to differences in reactivities and ash contents. Changing the primary firing rate by 25% produced relatively minor changes in NO_x emissions and LOI.

COAL FINENESS, PRIMARY STOICHIOMETRY AND FINAL STOICHIOMETRY

Additional parametric tests assessed the effects of the pulverized coal fineness, the primary stoichiometry and the final stoichiometry. A change from a regular grind (70% passing 200 mesh) primary fuel to a finer grind (95% passing 200 mesh) increased NO_x emissions, which was attributed to a higher primary NO_x level (increase of 65 ppm). A change from a regular grind reburn fuel to a finer grind decreased NO_x emissions, possibly due to enhanced volatile release in the reburn zone. In all cases, using a finer grind coal as either the primary fuel or the reburn fuel decreased LOI. Increasing the primary stoichiometry from 1.05 to 1.10 increased NO_x emissions, attributed to a higher primary NO_x level (increase of 30 ppm) and possibly a greater carryover of oxygen from the primary zone into the reburn zone. Increasing the primary stoichiometry reduced LOI as a result of enhanced primary fuel burnout in the presence of additional oxygen. Changing the final stoichiometry between 1.10 and 1.25 produced relatively minor changes in NO_x emissions and LOI.

ACKNOWLEDGMENTS

This work was supported in part by the Illinois Department of Commerce and Community Affairs through the Illinois Coal Development Board and the Illinois Clean Coal Institute, under project number 96-1/5.1A-2.