Reducing NOx Emissions and Flyash UBC with Combustion Control

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SUMMARY

INTRODUCTION

In a low NOx combustion environment, unburned carbon (UBC) in flyash generally increases. Increased flyash UBC reduces boiler efficiency and may cause deterioration in the performance of backend pollution control equipment such as electrostatic precipitators. This may then lead to issues with controlling stack opacity. Additionally, the degraded flyash quality may not be appropriate for industry sectors such as using flyash as an aggregate for manufacturing concrete. Therefore, methods are needed for reducing flyash UBC without significantly affecting NOx emissions. Such methods include comprehensive burner tuning and improvements in burner-to-burner coal distribution. Recent experiences by RPI with these methods and the results achieved are briefly discussed below.

FIELD RESULTS AND EXPERIENCES

A few years ago, RPI retrofitted three (3) 115 MW utility boilers with low NOx burners. The boilers are located in the Southeast and fire eastern bituminous coal. NOx emissions on these units were reduced from about 1.0 to 0.36 lb/mmBtu using burners only and no OFA. Acceptance testing was performed and RPI met all performance guarantees. Recently, the utility began experiencing increased levels of stack opacity resulting from poor precipitator performance. Further investigation revealed that the deterioration in precipitator performance resulted from increased levels of flyash UBC as a result of reducing NOx emissions over 65%. Several efforts were made to tune the pulverizers but performance was considered to be the best possible from these machines. Therefore, efforts to reduce flyash UBC focused on additional burner tuning.

RPI's low NOx CCV burner is equipped with a damper for controlling the flow split between secondary and tertiary air flow in the dual air zone burner. This damper was adjusted to increase secondary air flow and subsequent mixing and localized stoichiometry at the coal nozzle discharge. UBC was reduced from 22 to 14% while NOx increased from 0.36 to 0.41 lb/mmBtu. Precipitator performance and stack opacity improved to acceptable levels.

A similar experience involved a 190 MW utility boiler equipped last spring with RPI's low NOx CCV DAZ burners. In this unit, additional burner tuning using the same SA flow control damper was implemented to reduce UBC. UBC was reduced for 7.6 to 6.6% while NOx increased from 0.30 to 0.34 lb/mmBtu for only a 1" adjustment in SA flow damper.

In addition to comprehensive burner tuning for optimizing flyash UBC, when possible, efforts can be made to improve burner to burner coal distribution to have a positive influence on flyash UBC. RPI and Lehigh University were involved last spring in such a project involving an 80 MW utility boiler that fires a blend of bituminous coal and petroleum coke. A specially designed coal flow adjustor was installed immediately upstream of the mill coal riffles to better equalize the burner-to-burner coal distribution. At optimum settings, flyash LOI was reduced on average about 19% without a significant increase in NOx.

CONCLUSION

The amount of UBC can be reduced or further optimized using burner tuning, provided low NOx burners are designed with the proper hardware for this level of adjustability. By utilizing the SA flow control damper, unique to the RPI low NOx burner designs, RPI was successful at reducing UBC by over 30% at one plant with a small increase in NOx emissions. Another plant experienced a 13% reduction in flyash UBC also with only a small increase in NOx. Burner to burner coal distribution is another important parameter to consider when tuning for reduced UBC. By optimizing the coal distribution as much as possible on one utility boiler, UBC was reduced 19% on average which greatly improved combustion conditions and stack opacity. NOx was virtually unaffected by this UBC improvement.