7.12 Development and Evaluation of an Advanced NO_x Control Technology for Cyclone-Fired Boilers and Other Retrofit Applications

Objective: To further develop and evaluate the performance of a newly identified NO_x control technique which is suited for cyclone-fired boilers.

Approach: Tests of a new NO_x control combustion modification, which requires the primary zone of a staged combustor to be operated at extremely high temperatures, yielded initial results indicating that NO_x levels as low as 80 ppm (at 0% O_2) can be achieved with reasonable residence times (less than 400 msec) in the primary zone. The high temperatures cause the coal ash to form molten slag, making this technology ideally suited to cyclone boiler applications. A series of bench- and pilot-scale studies will determine why the technology works and how furnace input and design parameters impact emission and steam generation performance. The sulfur capture potential of the molten ash system will be studied to learn the effect of using additives (such as iron or limestone) when burning coal. The majority of the work will be performed at a scale of about 1×10^6 Btu/hr, providing necessary input to design and test a larger prototype system.

Rationale: Cyclone boilers, popular from the 1950's through the early 70's, offered a way to burn problem coals having low ash fusion temperatures and bad slagging characteristics. The coal ash is purposely melted and removed as a molten slag. Unfortunately, the cyclone-fired boiler has typical NO_x emissions greater than 1,000 ppm (some as high as 2,000 ppm). Of the approximately 150 cyclone boilers in the U.S. today, about 90 percent are utility boilers. Although they account for only 9 percent of the steam generation capacity, they contribute about 20 percent of NO_x generated in the utility sector. Unavailability of NO_x control technology, coupled with the utility boiler NSPS, has led to no cyclone boilers being sold since the early 1970's.

This new control technology for cyclone-fired boilers represents about a 90 percent NO_x reduction from uncontrolled levels and should be applicable for both retrofit and for new unit design. By maximizing ash removal, the technology may be used to convert oil-fired boilers to coal firing and to facilitate the use of coal-oil mixtures. If sulfur capture can be effectively incorporated with this NO_x control technique by use of additives, the combined NO_x and SO_x emission reduction offers a strong potential for acid rain control.