



Numerical investigation on ammonia co-firing in a pulverized coal combustion facility: effect of ammonia co-firing ratio

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A new computational Fluid Dynamics (CFD) simulation approach was built for ammonia (NH₃) co-firing in pulverized coal fired furnace. This simulation approach was used to investigate the effect of ammonia (NH₃) co-firing in a pulverized coal combustion facility with a single swirling burner (heat input: about 8.5 MWth). At first, in one case of coal firing and one of NH₃ co-firing with NH₃ co-firing ratio of 20 cal.%, the prediction accuracy of simulation approach was evaluated by comparing with the experimental data. The differences between coal firing and NH₃ co-firing in the gas temperature, concentrations of NO and CO₂, and unburnt carbon in fly ash at furnace exit can be well reproduced in simulation. In addition, as for the heat flux distributions on walls, in both cases of coal firing and NH₃ co-firing, there is a large difference between simulation and measurement near the over-fire air (OFA) port, but the prediction accuracy is very satisfying near the burner. Therefore, this simulation approach used in this study is reliable at least in the qualitative discussion.

Then, the effects of NH₃ co-firing ratio (0, 10 cal.%, 20 cal.%, 40 cal.%, 60 cal.% and 80 cal.%) were investigated on the flame shape, distributions of NO and NH₃ in furnace, the heat absorption amount, concentrations of NO and NH₃, and unburnt carbon in fly ash at furnace exit. The simulation results show the flame shape is significantly affected by NH₃ co-firing ratio, due to the changes of injection velocity of NH₃ from center of burner. When the NH₃ co-firing ratio exceeds 40 cal.%, the recirculation zone is completely penetrated by high velocity NH₃ flow, which leads to much unburnt NH₃ in furnace. These changes significantly affect distributions of NO and NH₃ through the DeNO_x reaction of unburnt NH₃.

As the increase of NH₃ co-firing ratio, the total heat absorption is decreased a little and unburnt carbon in fly ash is increased, due to the decrease of flame temperature. In addition, in the case of NH₃ co-firing ratio of 10 cal.%, the NO concentration at furnace exit is increased due to the increase of fuel-NO_x from NH₃, compared with the case of coal-firing. When the NH₃ co-firing ratio exceeds 10 cal.%, the NO concentration at furnace exit was obviously decreased, due to the DeNO_x effect of unburnt NH₃ in furnace. However, once the NH₃ co-firing ratio exceeds 40 cal.%, it should be noticed that the residual NH₃ concentration can reach hundreds of ppm at furnace exit.

