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Technical upscaling of ClO_2 based multipollutant emission control technology

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ABSTRACT

Combustion of fossil fuels causes emissions which have adverse effect on both human health and the environment. Emissions of major concern are oxides of nitrogen and sulfur (NO_x and SO_x). A novel concept based on oxidation of NO to NO_2, via an oxidizing agent prior to wet scrubbing has shown promising results in bench scale. In the present work, the concept of using chlorine dioxide (ClO_2) as oxidizing agent will be demonstrated on a 100 kW boiler to confirm the findings of the bench scale investigations.

The experiments will be conducted on a 100 kW gas-fired atmospheric oxy-fuel boiler at Chalmers University of Technology where a ClO_2 generator as well as a two stage spray tower will be installed. ClO_2 will be injected into the flue gas downstream the boiler at a temperature below 200°C. After the oxidation of NO to NO_2, the flue gas will be treated in a subsequent two-stage scrubber. The flue gas composition – NO, NO_2, SO_2 and combustibles (CO, CH and soot) – will be varied. Furthermore, the influence of the scrubber solution, in terms of pH and additives, will also be investigated for its impact of absorption of nitrogen and sulfur species. The flue gas composition will be analyzed using FTIR (MKS MultiGas 2030) after the combustion, injection of oxidizing agent, and wet scrubbing. The liquid composition in the tower bottom holdup and the bulk container will be analyzed with a spectro-photometer to determine the amount of N(III), N(V), S(IV) and S(VI).

In bench scale experiments it has been shown that ClO_2 oxidizes NO to the more soluble NO_2 with very high selectivity. Removal efficiencies of NO_x in subsequent wet scrubbing using water (pH 10) is in the order of 60% and as high as 94% with addition of Na_2SO_3 to the scrubber solution. The removal of SO_2 is 99% independently of scrubber solution. By technical upscaling of the concept, crucial information will be gained both regarding the oxidation step and the liquid chemistry in a commercial application. The results from the upscale experiments presented in this work will thus indicate the conversion of NO to NO_2 with ClO_2 as well as the absorption efficiency of NO_x and SO_x in a wet scrubber in commercial applications.

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