# Reduction of harmful emissions, including greenhouse gases, during oxy-fuel combustion of solid fuel in a circulating fluidized bed.

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## Abstract

Fossil fuel combustion is one of the major means to meet the mounting global energy demand. However, the $CO_2$ emissions arising from fossil fuel combustion process have hazardous effects to global warming problem. Thus, mitigating these gases is vital to attain a sustainable environment. The challenge of using complex technology such as oxy-fuel combustion in fluidized bed boiler for carbon capture and minimized (NOx, $SO_2$) emissions is strongly sustainable compare to other approaches. Specifically, the tasks include modeling the processes of formation and suppression of harmful emissions during combustion of fuels in an oxygen environment with $CO_2$ recirculation, the ANSYS-CHEMKIN-PRO software package was mainly used. Computational studies of the effect of biomass properties on nitrogen oxide emissions, study of the effect of hydrodynamic parameters on reducing sulfur oxide emissions by supplying limestone to a furnace with a circulating fluidized bed. The analysis results show that the use of fluidized bed technology under conditions of combustion in an oxygen atmosphere with $CO_2$ recirculation can be one of the optimal solutions. In spite of the high cost of obtaining oxygen. In additions co-combustion of biomass (wood chips) with coal gives less NOx emissions than separate combustion. The combination of elements present in biomass with oxygen combustion results in lower NOx .This reduction is more noticeable if flue gas circulation is used. Nevertheless, adding biomass as co-fired, has purely balance effects (there is little sulfur and ash in biomass, as a rule, less nitrogen). Therefore even simple mixing can lead to reduced emissions of

pollutants, especially dust and sulfur oxides. In this case, both positive and negative synergistic effects can be deducted. The positive effects are primarily associated with a decrease in emissions of nitrogen and sulfur oxides. However, the negative effects of co-firing such as corrosion of heating surfaces and agglomeration…etc. The ratio of 80% coal and 20% biomass is close to optimal in terms of nitrogen oxide emissions. The calculation of SO2 formation and suppression during the combustion of coal and biomass in different atmospheres were carried out according to the developed one-dimensional model .The addition of limestone (at a rate of about 0.40 g/s at a Ca/S molar ratio of 2.7) significantly reduces the SO2 concentration under various conditions. The optimal SO2 capture been fixed at 925°C with higher oxygen concentration (29% vol), that could be explained most likely by this condition capture can be occurs by both mechanisms direct and indirect sulfation. In this mode, the SO2 emission concentration decreases closely to 200 mg / Nm3. Therefore, by adding limestone another important quantity that should be taken into account when operating a CFB boiler is the feed particle size, which effects on the hydrodynamics process. The correct particle size must be used to avoid unnecessary entrainment and to obtain an adequate solids circulation rate in the system. The optimal particle sizes been fixed in range of 0.2 to 0.3mm.Thus, recycling ash and limestone significantly increases the efficiency of sulfur capture. Calculations both models were compared with the available experimental data to validate the models, and good agreements were obtained. Errors around 15% in the calculation of NOx emissions using the ANSYS CHEMKIN-pro program are explained by its sensitivity to the input data. Errors can also arise from imbalances in oxygen content and biomass volatility (or in volatile biomass).Finally Oxy-fuel combustion can play an important role in suppressing all types of emissions, especially $CO_2$ capture. A dual combustion concept that allows the power plant to operate with or without a $CO_2$ separation and removal system. Seems to be the most relevant. The combination of this concept and the co-combustion of coal and biomass provide additional synergistic effects.