



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Carbon capture and sequestration (CCS) is gaining popularity to mitigate the CO₂ emission and greenhouse gases. The oxy-fuel circulating fluidized bed (CFB) combustion is one of the most promised techniques of CCS, where CFB has advantages over the pulverized coal power combustors namely, in situ SO_x and NO_x capture as well as fuel flexibility. However, significant drop in thermal efficiency with oxy-fuel CFB combustion is reported in literature. The research and developments are continuing to overcome the high cost of implementation of oxy-fuel CFB combustion technology. There is hardly any research regarding the hydrodynamic behaviour of CFB under oxy-fuel combustion.

In the present work, two CFB units (cold and hot) of identical geometry are designed and fabricated to investigate the bed hydrodynamic and combustion under oxy-fuel combustion conditions. The core of this work is to develop a novel technique for oxy-fuel CFB combustion to enhance the efficiency and eliminate the recirculation of the flue gases. The proposed method suggests controlling the combustion temperature by adjusting the stoichiometric ratio with multi-reaction stages rather than controlling the temperature by CO₂ recirculation. Moreover, the hydrodynamic behaviour of CFB is studied under different operating conditions viz. pressure, velocity, aeration flow rate, particle size, bed inventory and primary flow rate, etc. The results obtained from the present investigation show a similarity in hydrodynamic behaviour between the oxy-fuel combustion and conventional combustion with air. Experiments with oxy-fuel combustion of coal and biomass shows promising results with working gas as pure oxygen with successful control of the temperature of the bed by maintaining suitable stoichiometric ratio as per the hypothesis suggested.

Finally, a thermodynamic analysis involving energy and exergy is performed considering the chemical reactions. It was observed that both the first and second law of thermodynamics efficiencies are improved with application of pure oxygen reaction in comparison to the mixtures of CO₂-O₂. Thus the novel method, i.e., 3rd generation of the oxy-fuel CFB combustion, can help in the development of CFB for combustion of coal and biomass with improved CO₂ capture.