INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Transient Hydrodynamics and Heat Transfer Behavior along with Heat Recovery in a Pressurized Circulating Fluidized bed unit**

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SHORT ABSTRACT

The consumption of energy has always been on the rising trend. In the year 2017, the world consumed 153,595 terawatt-hours (TWh) of primary energy which is above 2500 % more than in the year 1800. Majority of our current power systems are dominated by the three basic sources of fossil fuel viz. coal, oil and gas. The combustion of these fuels produces carbon dioxide (CO_2) and other greenhouse gases responsible for global climate change. Biomass-based energy has several distinct advantages such as wide availability and uniform distribution that puts it ahead among the renewable and clean energy options for India. The estimated potential of power generation through renewable sources in India is 85 GW with biomass power contributing approximately 20 GW. Circulating fluidized bed technology is one such technology that can be utilised to harness the vast resources of biomass that is abundantly available in our country with a very amiable impact on the environment. Pressurized circulating fluidized bed (PCFB) which is an extension of ACFB technology is another such technology that can be utilized even further due to its fuel flexibility, compact furnace size, low emission of pollutant, high combustion efficiency and adaptability to load change. However due to its vast diversity in designs and the complex hydrodynamics and heat transfer phenomenon involved coupled with different bed

geometry and fuels, extensive research is needed for proper and optimized design of PCFB. Furthermore PCFBs are mostly subjected to load variations or transients during startup and shutdown and also due to variations in load demands when used as a combined heat and power generation unit. This makes understanding the complexities of its hydrodynamics and heat transfer behavior even more challenging. Therefore investigation of these complex transient hydrodynamics and heat transfer phenomenon of a PCFB is very crucial for the better understanding of this system.

Additionally, an enormous amount of heat energy is present in the cyclone and downcomer of a CFB. Very few investigations have reported regarding the recovery of heat in these components. Hence there is a scope for investigating on prospects of recovering heat along the downcomer.

In the present work, the transient hydrodynamics and heat transfer characteristics are investigated in a PCFB unit with a riser of 2.0 mm height and 54 mm inner diameter. The unit is used alternatively for studying the transient heat transfer in the upper splash region and the whole riser. During the studies on the upper splash region, the heat is supplied to the wall surface of this section through a heater coil, while for the studies on the riser; heat is supplied directly to the bed by heating the air before entering the bed with a tubular furnace fitted below the distributor plate. The heat recovery experiments are performed on the PCFB under the steady state as well as transient conditions. Bed voidage with fluctuations as high as 48% are observed during the transient periods. Heat transfer coefficient is observed to fluctuate by 5 to 50 % for various transient conditions. Heat recovered is around 290 W which is observed to fluctuate by 50% at various transient conditions.