INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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| Programme of Study | : | Ph.D. |

Thesis Title: **Studies on direct chemical looping combustion of coal with rice straw using electronic waste based oxygen carriers for clean energy production**

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## SHORT ABSTRACT

Chemical looping combustion (CLC) is one of the promising technology, which inherent captures $CO_2$. In this context, experimental studies were conducted using a blend of high ash coal (HAC), low ash coal (LAC) with rice straw (RS) in a fixed bed reactor under $CO_2$ based in-situ gasification mode of operation. To commercialize the CLC based carbon capture technology, low-cost oxygen carriers need to be employed for economical operation. Thus, mixed oxygen carrier particles obtained from a printed circuit board (PCB) based electronic wastes were used in the present study. The XRF analysis showed that the obtained oxidized PCB contains 21% $Fe_2O_3$, 22.8% CuO and 3% NiO, 9.6% CaO and 33.6% inert supports ($Al_2O_3$, $SiO_2$, $TiO_2$). The experimental results highlighted that by using OPCB as oxygen carriers, the $CO_2$ yield has increased by 4.6% for LAC, 3.9% for HAC, and 4.2% for RS, compared to the commercial $Fe_2O_3$ metal oxides. This is due to the chemical looping oxygen uncoupling nature (CLOU) of CuO, which releases oxygen molecules directly for combustion. Further, the blend of coal (LAC, HAC) and RS displayed higher gas conversion by 3-5% when compared to coals alone, irrespective of the oxygen carrier ($Fe_2O_3$, OPCB). Aspen Plus simulations were also performed by integrating the CLC system with a combined cycle power plant having a net capacity of 150 MW for electricity generation. It is found that the use of electronic waste-based oxygen carriers achieved almost an equivalent net thermal efficiency of 42.4%, compared to the commercial $Fe_2O_3$ based power plants. The economic analysis showed that the levelized cost of electricity (LCOE) of the CLC integrated combined cycle power system employed with OPCB is 85.9 $/MWh, which is the lowest among other cases. Thus, the electronic-based oxygen carriers and the co-processing of Indian coals with RS in the CLC process can be considered as an alternative way to make the process more economical and feasible for large-scale applications.