



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **DESIGN AND OPERATION OF A FIXED BED PYROLIZER FOR THERMOCHEMICAL CONVERSION OF MUNICIPAL SOLID WASTE AND ITS PRODUCT APPLICATIONS**

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SHORT ABSTRACT

Pyrolysis offers a sustainable solution for municipal solid waste (MSW) management by enabling energy recovery and resource utilization. This study evaluated the pyrolysis of MSW and legacy waste, revealing high heating values (37,737.89 and 40,432.84 kJ/kg, respectively) and significant lignin content, supporting char production. Thermal degradation led to mass losses of 68% (MSW) and 82% (legacy waste), with MSW exhibiting lower activation energy (5.72 kJ/mol), indicating faster reactions. A fixed-bed reactor optimized using Central Composite Design yielded 72.62% char at 250°C, 10°C/min heating rate, 50 mm particle size, and 180 min residence time. ANOVA results ($p < 0.05$) confirmed all process variables as significant, with temperature being the most influential. Char produced at 250°C retained the highest fuel potential. Activated carbon derived from this char achieved over 90% Pb(II) removal from water (Langmuir isotherm, $R^2 = 0.99$), with reusability up to two cycles. Composting trials with 5% MSW char improved compost quality, enhancing nitrogen (+2.35%), phosphorus (+23.48 mg/kg), and reducing the C/N ratio (10). Soil amendment studies over 120 days showed improved soil health with lower bulk density (-12%), increased organic matter, and higher cation exchange capacity. While compost alone increased heavy metal bioavailability, MSW char mitigated it. In mine tailing soil, 10% MSW char raised pH (+45.44%), while a 5% char and 30% vermicompost mix improved nutrient retention and reduced Ni (-30%) and Pb (-61%) leachability. Thus, MSW pyrolysis supports circular economy goals through effective waste valorization and environmental sustainability.