INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title : **Pyrolysis of Biomass of Different Nature in Various Reaction Environment: Fuel, Physicochemical and Qualitative Analysis of Their Products**

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SHORT ABSTRACT

The fossil-fuels are heading towards extinction, and their extensive use is deteriorating environmental synchronization. In addition to this, there is also a massive need for energy in the form of heat, electricity and fuels. To overcome these burning issues, it is time to make up a setback for cleaner fuels generation. In this regard, 'Waste to Wealth' is one such renewable resource which can withstand the responsibility as new generation energy giant. Considering waste, biomass has tremendous energy stored within it. Scientific community already focused on this area lately with different approaches of treatment methods such as thermochemical conversion and biochemical conversion of biomass waste to biofuels. However, these methods did not make it out to the full-fledged functioning industry and stuck in laboratory or at pilot scale only due to inherent drawbacks in their liquid products. Overcoming the drawbacks of biochemical conversion technologies of long reaction time, thermochemical processes are very fast and produce biofuels in significantly small amount of time. Among the thermochemical processes, pyrolysis technology got much upper hand due to its reliability and simpler methodology to produce biofuels from waste biomass. Furthermore, pyrolysis is also found to be more effective when the biomass is co-fed with other waste materials such as tube waste, tyre waste and other types of plastic wastes.

In this thesis, the focus of the study is on promising technology of pyrolysis for bio-oil production from scarcely researched lignocellulosic waste biomass (of different nature such as woody biomass, leaves waste and algal biomass) and industrial waste such as butyl rubber waste material for production of biofuels and valuable hydrocarbons. Further different modes of pyrolysis are conducted on above-mentioned materials that are single feed non-catalytic pyrolysis, catalytic pyrolysis, hydropyrolysis, and co-feed pyrolysis. This study particularly reports the actual results obtained from the experimental interventions performed on rarely researched biomass and materials which are contributing to the solid waste. In the first study, pyrolysis of lignocellulosic biomass Delonix Regia (DR) is conducted at variable temperatures of 500 °C, 600 °C and 700 °C and at 1 bar pressure in inert medium that resulted in bio-oil of 20.88 MJ/kg to 25.77 MJ/kg based on elemental analysis. In the second study, DR biomass is pyrolysed under different pyrolysis atmospheres such as non-catalytic pyrolysis, catalytic pyrolysis and catalytic hydropyrolysis at 600 °C and 1 bar pressure. The catalyst used for catalytic pyrolysis and catalytic hydropyrolysis in this study is zeolite Y, sodium, whilst hydropyrolysis is conducted completely under hydrogen atmosphere without nitrogen inert gas. The results showed increasing trend in calorific value of bio-oil as 16.5 MJ/kg by non-catalytic pyrolysis, 18.14 MJ/kg by catalytic pyrolysis and 20.65 MJ/kg by hydropyrolysis as obtained by bomb calorimeter. Similar pyrolysis approaches are applied for another biomass of algal species, but at 550 °C and 1 bar as part of third study of this thesis. The green algae of *Oscillatoria* resulted in bio-oil of 16.664 MJ/kg calorific value from hydropyrolysis along with popular hydrocarbons such as BTX, phenols, styrene, caprolactam etc. In the fourth study, another research gap is fulfilled by conducting co-feed pyrolysis of two lignocellulosic materials where DR biomass is co-fed in various ratios with pinewood sawdust (PW) at 625 °C and 1 bar. The results are compared with individual biomass pyrolysis results where the best results are obtained from co-feed ratio of 50:50 with calorific value of 20.3 MJ/kg bio-oil and improved quality of bio-oil in terms of pH, density and moisture content. Finally, as part of fifth study, other co-feed pyrolysis is conducted between DR biomass and butyl rubber tube waste (TW) at 600 °C temperature and 1 bar pressure. It resulted in 32.61 MJ/kg bio-oil from 50:50 co-feed ratio, where increasing TW ratio increases bio-oil yield as well as its calorific value. The bio-oil also consists higher fraction of C_{10} cut D-limonene with BTXS and other hydrocarbons. In addition, advanced characterization techniques are applied for the qualitative determination of produced bio-oil and bio-char along with physico-chemical characteristics for all above studies. The bio-oil samples analysed by Fourier Transform Infrared Radiation (FT-IR) Spectroscopy, Gas Chromatography and Mass Spectrometry (GC-MS) and Proton Nuclear Magnetic Resonance (^{1}H-NMR). On the other hand, the bio-char characterized by Field Emission Scanning Electron Microscope (FESEM), X-Ray Diffraction (XRD) and Brunauer-Emmett-Teller (BET) surface area analyser.