

PREFACE

Fossil fuel-based energy is exhaustible and accompanied by adverse impacts at local, regional, and global levels for environment, ecology, human beings and flora and fauna. Climatic conditions of the planet are being burdened due to population. Generating energy from waste biomass is a sustainable, novel and renewable green-energy generation approach for addressing energy-linked environmental impacts focusing on generation of wealth-from-waste. Lignocellulosic biomass is the most abundant, renewable, sustainable, and carbon neutral feedstock for the production of bio-energy, bio-fuels and high value bio-products. Pyrolysis is a thermochemical route for transforming biomass into biofuels (pyrolysis liquid called as bio-oil, solid bio-char and gases) at high temperature and inert atmospheric conditions. Often, bio-oil is the main targeted product of pyrolysis, but it has several drawbacks like high oxygen content and water content, high acidity and viscosity. Catalytic pyrolysis is used to enhance product quality. Bio-oil has potential for generating bio-energy and chemical feedstocks. Bio-char can be used as a substrate for activated carbon and other applications.

In view of the above stated issues, the objectives of this study were decided, to carry out pyrolysis of *Melia azedarach* sawdust for evaluation of its bio-energy generation potential and also to further carry out catalytic pyrolysis for attaining improved pyrolytic yields. The complete research work of thesis entitled “**Study of kinetics, thermodynamics, process parameter variation and comparison of non-catalytic and catalytic pyrolysis of *Melia azedarach* sawdust**” can be summarized as follows:

Chapter 1 explains the present energy scenario, emissions and other issues arising due to it and how this demand and emission is projected to rise in near future. Importance of biomass as a renewable energy source, its characteristics, various pathways for

conversion of biomass into bio-energy, etc. have also been discussed in this chapter. Utilization of waste biomass for energy generation can fulfil the aspiration of creating wealth from waste. It will serve the dual purpose of energy generation and waste management simultaneously.

Chapter 2 is dedicated to the review of biomass pyrolysis in the available literature. A holistic review related to various aspects of biomass pyrolysis including physicochemical properties, its thermal degradation kinetics, effect of variation in operating parameters on biomass pyrolysis and catalytic pyrolysis have been summarized in this chapter.

Chapter 3 is related to the evaluation of physicochemical properties of *Melia azedarach* sawdust, its thermal degradation characteristics, thermo-kinetic analysis, thermodynamic parameters and reaction mechanism associated with the thermal decomposition of *Melia azedarach* sawdust. Thermogravimetric analysis of *Melia azedarach* sawdust was performed at three distinct heating rates of 10, 20 and 30 °C/min under inert atmosphere of N₂ gas. TG/DTG curves, Iso-conversional models and z-master plot were employed for the study of this section.

Chapter 4 explains effect of operating process parameters on pyrolysis products yield distribution of *Melia azedarach* sawdust. Influence was analysed for various parameters including temperature, sweeping gas flow rate, bed height, particle size, heating rate and pyrolysis time. Pyrolytic products yield varied significantly with variation in pyrolysis temperature as compared to other parameters. Further, characterization of bio-oil and bio-char was carried out by employing different characterization techniques.

Chapter 5 deals with comparative study for non-catalytic and catalytic pyrolysis of *Melia azedarach* sawdust using copper (Cu) metal as a catalyst. Thermal degradation performance of catalytic and non-catalytic *Melia azedarach* sawdust was examined by thermogravimetric analysis. Effect of variation in temperature and biomass to catalyst

ratio on catalytic pyrolysis was explored. Study on characterization of resultant bio-oil and bio-char has also been discussed in this chapter.

Chapter 6 summarizes conclusions of this thesis entitled “**Study of kinetics, thermodynamics, process parameter variation and comparison of non-catalytic and catalytic pyrolysis of *Melia azedarach* sawdust**”. Also, recommendations for future studies have been provided. Based on this study it was concluded that *Melia azedarach* sawdust has significant potential for generation of bio-energy via pyrolysis. Using catalyst can impart improvements in pyrolytic products and can enhance production of targeted products.