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Catalytic pyrolysis of green algae for hydrocarbon production using H$^+$ZSM-5 catalyst

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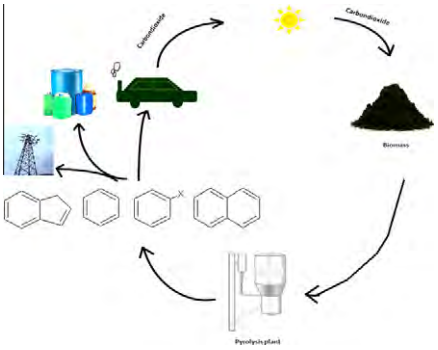
HIGHLIGHTS

- Fixed bed pyrolysis of *Chlorella vulgaris* produced 52.7 wt.% of bio-oil.
- Bio-oil from algae contained alkane compounds and aromatic hydrocarbons.
- A high yield of aromatics was obtained from catalytic pyrolysis of algae.
- About 25 wt.% of the carbon in algae was converted into aromatics.

GRAPHICAL ABSTRACT



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ABSTRACT

Microalgae are considered as an intriguing candidate for biofuel production due to their high biomass yield. Studies on bio-oil production through fast pyrolysis and upgrading to hydrocarbon fuels using algal biomass are limited as compared to other terrestrial biomass. Therefore, in this study, a fresh water green alga, *Chlorella vulgaris,* was taken for pyrolysis study. The average activation energy for pyrolysis zone was found to be 109.1 kJ/mol. Fixed-bed pyrolysis of algae gave a bio-oil yield of 52.7 wt.%, which accounts for 60.7 wt.% carbon yield. In addition, analytical pyrolysis of *C. vulgaris* was carried out in a Py/GC–MS to identify major compounds present in bio-oil with and without catalyst (H$^+$ZSM-5). The study found that in catalytic-pyrolysis, as the catalyst loading increased from zero to nine times of the biomass, the carbon yield of aromatic hydrocarbons increased from 0.9 to 25.8 wt.%.

1. Introduction

Biomass, a renewable source for carbon based liquid fuels, has a potential to alleviate the dependency on fossil fuels, and related environmental problems. Therefore, biofuels are considered as an important candidate for the national energy security and energy sustainability. In addition, biofuels can be a major factor for the nation's economy in creating more job opportunities in rural areas. Biochemical and thermochemical techniques have been developed to convert biomass into electricity and liquid fuels. Fast pyrolysis, a thermochemical conversion, gives high liquid yield (*i.e.,* bio-oil) up to 70 wt.% (dry weight) from biomass. The liquid can be utilized as an energy carrier, source for many commodity chemicals, or can be upgraded as a transportation fuel. However, bio-oil has some negative properties such as high density, acidity, water content, and, oxygen content together with low heating value.

Catalytic pyrolysis is one of the methods to produce hydrocarbon fuels from bio-oil where C–C bonds in bio-oil compounds are ruptured in presence of some shape selective catalysts. Cracking reactions involve dehydration, decarboxylation, and

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