MICROWAVE ASSISTED CATALYTIC DEPOLYMERIZATION OF BIOMASS AND PRODUCT CHARACTERIZATION

P. Gupta[1], B Behera[1], V. Bhanu Prasad[1], Jagdish Kumar[1], and Y.K.Sharma[1], S.S. Ray[1]

[1]CSIR-Indian institute of Petroleum, Dehradun-248005,India
e-mail: babitab@iip.res.in, +91-135-2525771

Abstract

Microwave assisted Pyrolysis(MAP) of biomass is an important thermo-chemical depolymerisation technology which could produce bio-oil quickly through decomposition. The traditional pyrolysis technology has the disadvantage of high energy consumption and long reaction cycle. Therefore, it is a need to explore or establish a facile route for fast depolymerisation of biomass to value added products for scientific significance. The pyrolysis of Biomass using microwaves is a potential technology for the transformation of waste to high-value bio-energy materials. In literature effect of metal oxides, salts and catalysts were reported for studying product distribution.

In this paper, the influence of microwave heat rate, effect of catalysts and temperature on depolymerisation of lignocellulosic bagasse were studied and profile of product distribution were examined with defferent catalysts. The Data and informations will be useful for designing and optimising a process of pyrolytic depolymerisation of bagasse via microwave heating technology.

Keywords: *microwave pyrolysis, gas, bio-liquid, GC, nmr*

1. Introduction

Decreasing fossil reserves, rising in oil prices, concerns over the energy security, environmental impacts and sustainability have led to a global policy shift back towards the use of biomass as a local, renewable feedstock. Pyrolysis is an efficient thermochemical process for the production of liquid bio fuels in absence of oxygen [1]. Various efforts have been made to understand product pattern and quality of liquid bio fuels. Microwave assited pyrolysis is an important process for pyrolysis of biomassl. Moreover, the bio-fuel contain less amount of harmful polycyclic aromatic hydrocarbons(PAHs) compared to fast pyrolysis oil[2]. As biomass is a poor absober of microwave energy, the yield of bio-liquid from biomass without catalyst is very low. Thus the depolymerisation of biomass needs a suitable catalyst with good microwave absorbing capacity. Metal oxides, salts, catalysts, acids, alkali have been reported in literature for this purpose [3].

In this paper, the objective is to study the product pattern and to screen a catalysts for low temp depolymerisation of biomass.

2. Materials and Methods

Raw bagasse used in this experiment was dried in oven at 105^0 C to remove the moisture content. A Milestone microwave reactor (Milestone srl, Italy) with maximum power input 1200W and frequency of 2.45GHz was used for microwave pyrolysis of bagasse. To determine the influence of different catalysts on the yield of bioliquid, 15gm of bagasse was premixed with 2gm of catalyst in a microwave reactor under N_2 gas purging. Reaction was carried out at 170^0C with 900W microwave power for each run. The volatiles pyrolyzates were condesed after passing through a water cooled condensor (at 5-10^0C) and then collected. The biochar was left in a quartz flask after pyrolysis.

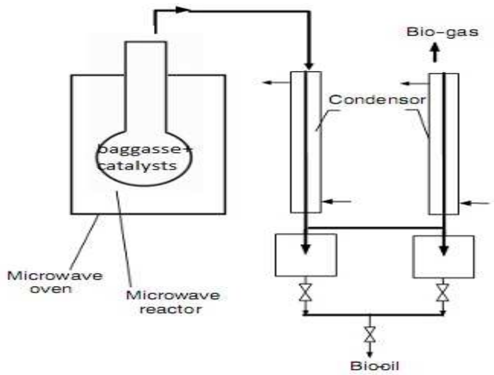

Fig 1: Schemetic diagram of microwave pyrolysis apparatus

The gaseous products were analyzed using Varian-CP-3800-FAST-RGA GC equipped with a TCD detector. Each sample was measured three times to get the average value. The bio-liquid were analyzed using

Avance-III Bruker 500MHz NMR spectrometer equipped with 5mm BBFO Probe.

3. Results and Discussion

The depolymerization of lingo-cellulosic bagasse was investigated in a microwave reactor. The percentage of bio-liquid yield is highest for Cat3. The products are characterized by GC, NMR

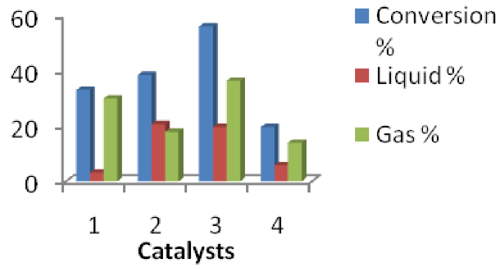

Fig 2: Percentage of conversion and product pattern with four different catalysts.

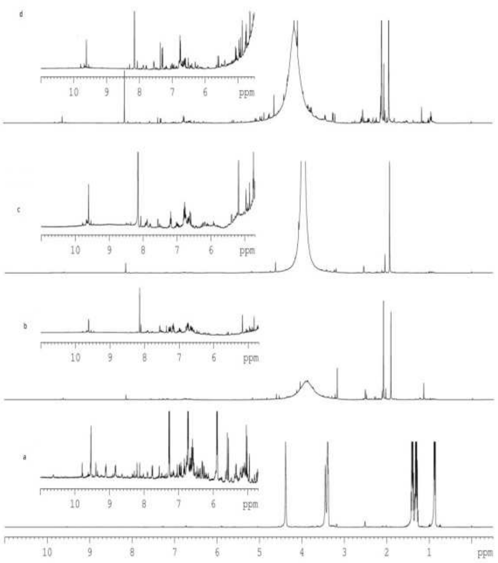

Fig 3: [1]H NMR spectra of bio-liquid of four reactions

The normalized distribution of gases and bio-liquid are calculated from GC and NMR. Cat-3 has highest yield of bio-liquid. The percentage yield of H_2 and methane is found to be more for Cat-3. The bio-liquid contains more oxygenated compounds for Cat 3 followed by Cat-2, Cat-4 and Cat-1. The percentage of aromatics in bi-liquid is highest for Cat-2 with a declining trend for Cat-4, Cat-3 and Cat-1.

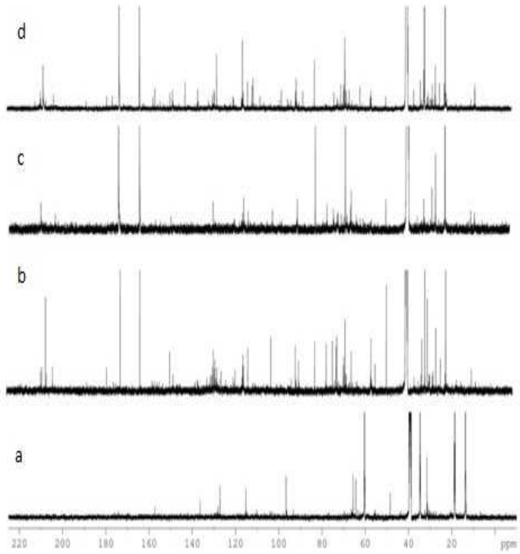

Fig 4:[13]C NMR spectra of Bio-liquid of four reactions.

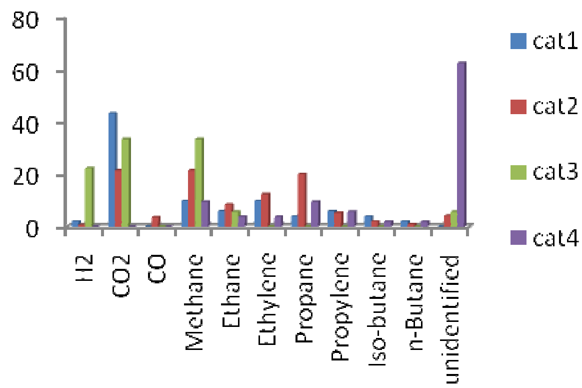

Fig 5: Normalised gaseous distribution with different catalysts

4. Conclusions

Biomass depolymerization occurs at low temperature using microwave conditions. The products were characterized by GC and NMR techniques. The bio-liquid for Cat-3 contains highest percentage of oxygenated hydrocarbon, and while products from Cat-2 contain higher percentage of aromatics.

5. Acknowledgement

CSIR-IIP is acknowledged for providing support for the project CSC-0116/WP-8

References

[1] A. V. Bridgewater, G. V. C. Peacocke. Sustain. Energy Rev. 4(2000)1-73.
[2] A. Dominguez, J. A. Menendez, M. Inguanzo, J. J. Pis. Fuel Process. Tech. 86(2005)1007-1020.
[3] Y. Wan, P. Chen, Bo Zhang, C. Yang, Y. Liu, X. Lin, R. Ruan. J. Anal. Appl. Pyrolysis 86(2009)161-167.