iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 Issue: XI Month of publication: November 2019

DOI: http://doi.org/10.22214/ijraset.2019.11093

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue XI, Nov 2019- Available at www.ijraset.com

Characterization and Utilization of Bio-Oil from Bagasse in CI Engine

Priyanshu Rawat[1], Kshitij Singh[2], Manmeet Singh[3]
[1, 2, 3]Mechanical Department, UPES, Dehradun

Abstract: The growing need of renewable energy sources due to constant exhaustion of fossil fuels have augmented research into the use of more cleaner and renewable energy sources. Biomass is one such cleaner fuel and is a good source of carbon. Sugarcane waste also known as Bagasse is also a biomass and an agricultural waste which can be used as a source of fuel due to its high carbon content. According to various reports it has been assessed that for every tonne of harvested sugarcane about 150kg of Bagasse (sugarcane waste) is obtained. The main aim of this study is to find out if Bagasse can be used as an alternate fuel and also its potential use in CI engine along with diesel.
Keywords: Biomass, Bagasse, Renewable energy, Pyrolysis, Sugarcane

I. INTRODUCTION

In India, approximately 10 million tons raw Bagasse is produced annually. Most large and medium sized mills can use up to 75 % of this Bagasse onsite to generate heat and electricity [1]. Sugarcane Bagasse in some industries although is used as a bio-fuel and as a source of electricity and heat generation but in most industries producing alcohol and sugar, Bagasse is treated as a waste and is not used to its full potential.

The main aim of this study is to find out the potential of Bagasse as a renewable energy source. For which, Bagasse was first dried up under the sunlight for 5-6 days to remove any excess moisture and then converted into powdered form with the help of a grinder. Proximate and ultimate analyses were then performed on the feedstock (powdered Bagasse) to study its composition and the amount of volatile matter and ash content. After which the feedstock with help of Digital Pyrolyser was used to obtain the Bio-oil by the process of Pyrolysis. Pyrolysis is a process of thermo-chemical decomposition of organic waste like Bagasse in the absence of oxygen to obtain the bio-oil for further use [2]. After the Pyrolysis various analysis were performed on the Feedstock and the bio-oil (obtained from Pyrolyser) to check its composition and sustainability as a fuel

II. METHODOLOGY

A. Raw Materials

Bagasse (Sugarcane waste) was taken as a feedstock for the digital Pyrolyser, to undergo the Pyrolysis process. Bagasse was bought from a local sugarcane vendor in Dehradun. It was then dried under the sun for about 5-6 days until it is free of the excess moisture, after which it was processed in a mixer/grinder to convert it into a powdered form. Subsequently, the powder obtained was again dried under the sunlight for about 6 hours and then it was stored in air tight packets. The dried biomass was then fed into the digital Pyrolyser for Pyrolysis.

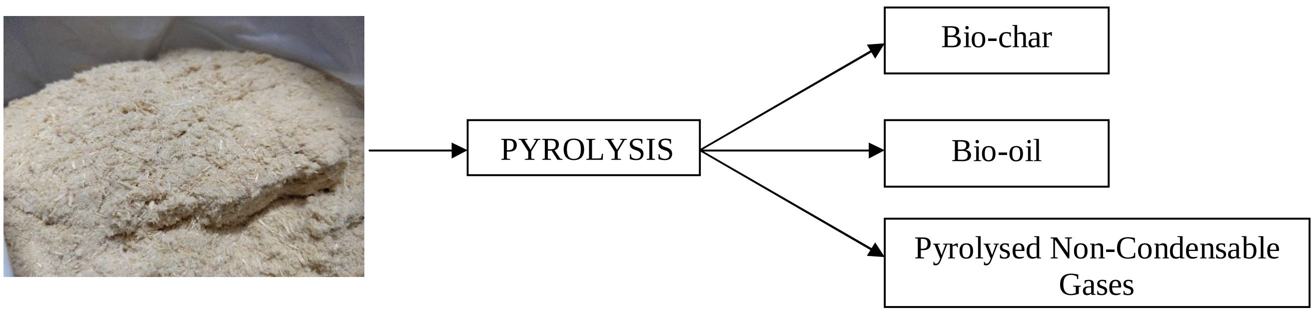
B. Experimental Setup

A Digital Pyrolyser was taken into account for the production of Pyrolysed products namely; (i) bio-oil, (ii) biochar and (iii) bio-gas. Firstly, the powdered biomass of 50g is collected and transferred into a fixed bed reactor. The maximum temperature attained was around 400^{o}C. With the increase in the temperature, heat energy was absorbed by the biomass and correspondingly the biomass temperature increased drastically.

After temperature reached to around 200^{o}C, fuel vapours were formed due to its thermal decomposition. Subsequently, these vapours were collected, condensed and stored in a borosilicate bottle. The non-condensed gases (pyrolytic gaseous products) were collected in a separate dispenser (gas collection unit). This process took around 2-3 hours to fully utilize the powdered Bagasse in a unit batch.

The biochar, which was formed during Pyrolysis (settled down by-products left in the reactor), was collected from bottom outlet of the reactor after completion of each process. The whole operation was carefully performed for the consistency of the results at equilibrium conditions.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue XI, Nov 2019- Available at www.ijraset.com



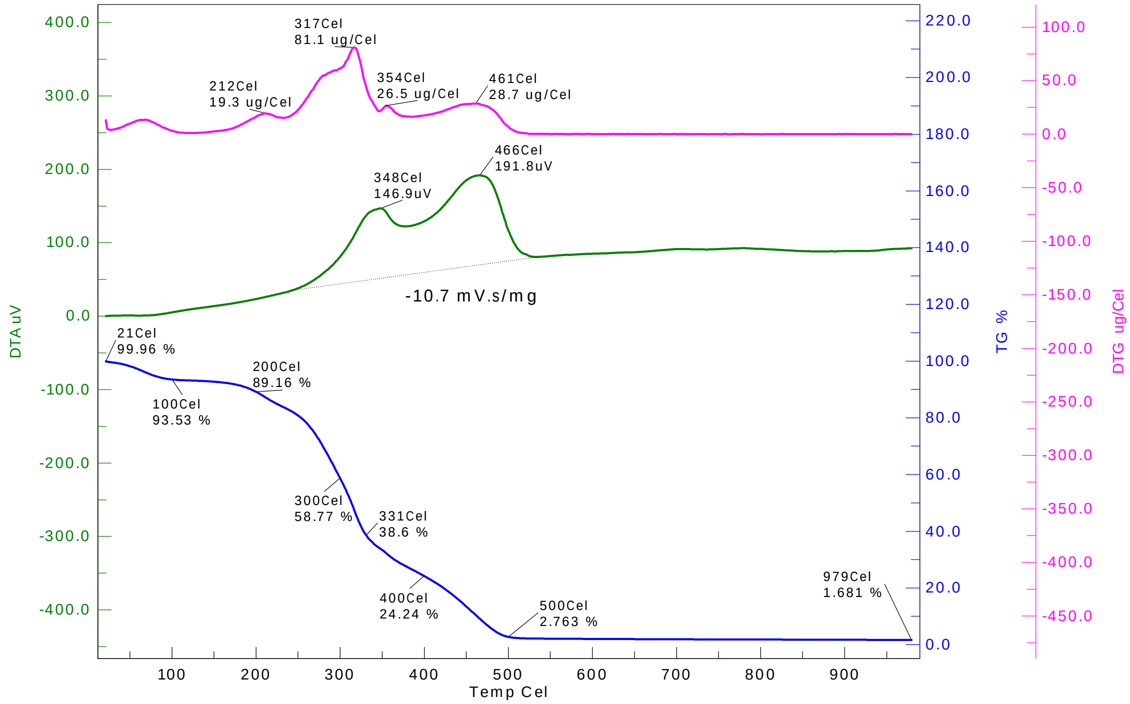
(Dried Bagasse in Powdered form)

C. Analysis Performed

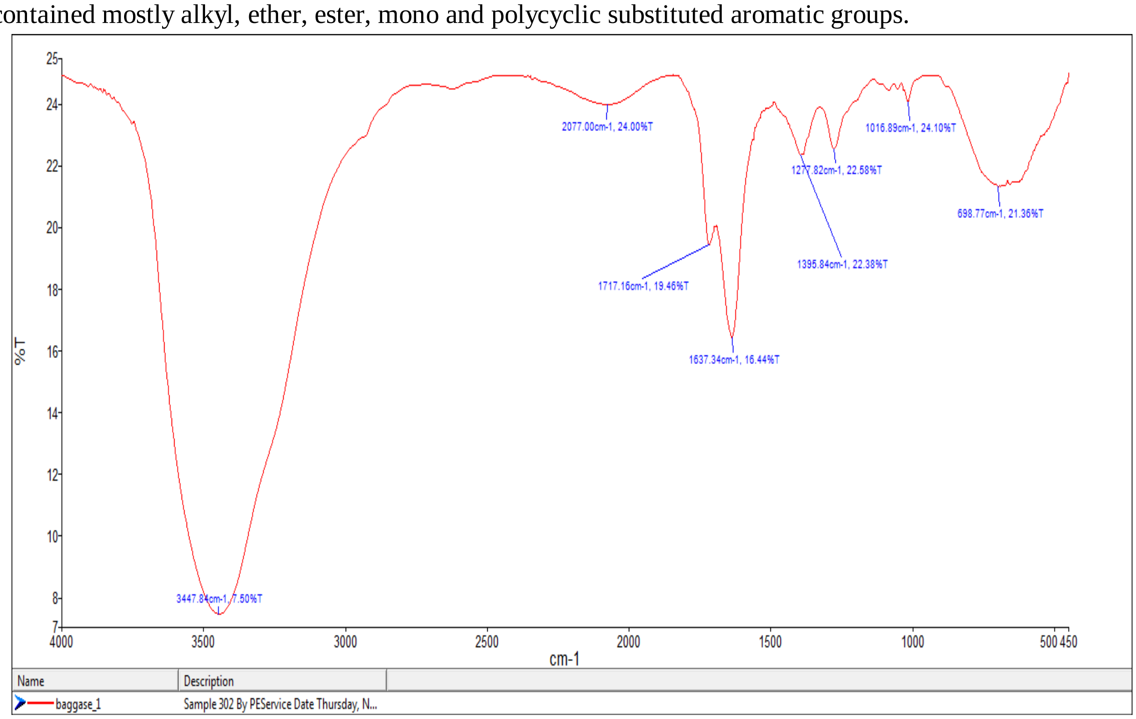
1) *Proximate and Ultimate Analysis:* Before feeding the feedstock (Powdered Bagasse) into the Pyrolyser, Proximate and Ultimate analysis were performed to check its sustainability during the Pyrolysis process. Proximate Analysis of the feedstock gave the Moisture, Volatile Matter, Fixed Carbon, Ash and Carbon content in the feedstock. The Moisture content was found to be 8.4% (which is less than 10%) that leads to improved heat transfer during Pyrolysis process. Also presence of high volatile matter refers to its suitability for Pyrolysis process at high temperatures. The biomass has lower ash content and lower fixed carbon which qualifies the biomass as good raw material for production of bio-fuels. Also, the Ultimate analysis was performed on a different sample of the same feed stock to check the Hydrogen (H), Nitrogen (N), Sulfur (S) and Oxygen (O) content in the feedstock which showed that Sugarcane Bagasse biomass is a suitable feedstock for producing biofuels through Pyrolysis process.

Characteristics		**Bagasse Biochar**
Proximate Analysis (wt.%)	*Moisture Content*	8.4
	Volatile Matter	69.5
	Fixed Carbon	9.3
	Ash Content	12.8
Ultimate Analysis (wt.%) using CHNS analyser	*Carbon (C)*	43.65
	Hydrogen (H)	5.73
	Nitrogen (N)	2.05
	Sulfur (S)	3.17
	Oxygen (O) (by difference)	45.4

2) *TGA Analysis:* Thermo-gravimetric analysis was performed on the feedstock to measure the change in weight with temperature. Mass loss is observed if the feedstock contains volatile compounds. Thermo-gravimetric analysis of Bagasse samples were carried in the presence of Nitrogen with a flow rate of 200ml/min. The experiment was carried out with 10.55 mg of the powder in an Alumina crucible from room temperature to 1000^{O}C with 10^{O}C/min. heating rate.

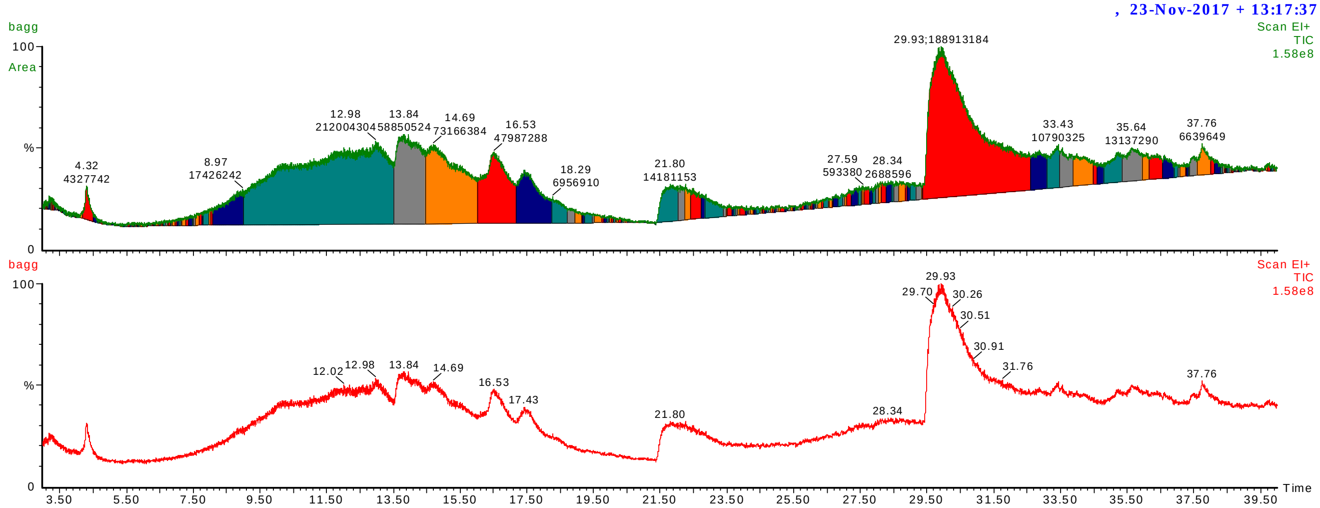


3) *FTIR Analysis:* Fourier Transform Infrared (FTIR) Spectroscopy was performed on the feedstock to identify the presence of organic, polymeric compound in the sample from the feedstock [3]. The results obtained from the test clearly represents that the biomass contained mostly alkyl, ether, ester, mono and polycyclic substituted aromatic groups.



International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue XI, Nov 2019- Available at www.ijraset.com

4) GC-MS Analysis: Gas chromatography–mass spectrometry (GC-MS) is an analytical method that combines the features of gas-chromatography and mass spectrometry to identify different substances within a test sample [4].



III. RESULTS

Electrical thermo-chemical Pyrolysis of Sugarcane Bagasse biomass was carried out in a Pyrolysis reactor and produced three Pyrolysed products; (i) bio-oil, (ii) biochar, and (iii) pyrolytic gas. The yield of bio-oil was about 20% along with 55% biochar and 25% pyrolytic gas. However, the avg. yield of bio-oil was around 15% due to significant heat transfer losses from the reactor, and the absence of catalysts. Characterizations of these Pyrolysed products were carried out as per the standards.

The following results were obtained from the study:

From Proximate analysis it could be concluded that the presence of higher volatile matter content in Bagasse biomass promotes its suitability for Pyrolysis process.

A. FTIR Analysis

It confirmed the presence of alkanes, esters and fatty acids in the bio-oil. It could be concluded that the bio-oil has good potential as a fuel candidate for CI engines

B. GC-MS Analysis

It confirmed the presence of combustible gases such as H_2, CO_2, CO, CH_4, and C_2H_4 which enables its use as a fuel candidate for CI engines.

IV. CONCLUSIONS

From the study on Bio-oil and results of different analysis performed on bio-oil and Bagasse it can be inferred that bio oil is a potential fuel alternative for CI engines. And in future, it can be used alongside diesel in small proportions to compensate for the growing fossil depletion. Although Bio-oil was extracted from sugarcane waste it can be used as fuel alternative in various sectors. In future, with the growing need of renewable energy sources its scope of usage can be augmented with more extensive research.

V. ACKNOWLEDGMENT

We would like to thank the faculty members of Mechanical Department as well as Electrical and Electronics Department, of our University, for their intellectual support and guidance throughout the course of this work.

REFERENCES

[1] https://en.wikipedia.org/wiki/Biochar http://events.saip.org.za/getFile.py/access?confId=14&contribId=117&materialId=paper&resId=0&sessionId=30
[2] https://en.wikipedia.org/wiki/Biochar
[3] https://www.labtesting.com/services/materials-testing/chemical-analysis/ftir-analysis/
[4] https://en.wikipedia.org/wiki/Gas_chromatography–mass_spectrometry
[5] https://manualzz.com/doc/30544370/energy-conversion