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PRODUCTION OF BIO-OIL FROM SUGARCANE BAGASSE BY PYROLYSIS PROCESS USING INFRARED HEAT SOURCE

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Abstract- *Sugarcane Bagasse is the most successful alternative solution of renewable energy which is eco-friendly. It's a wonderful hydrocarbon source. It is one type of biomass, and it is cheap, widely accessible and requires no significant extraction effort. An experimental analysis has been held out using pyrolysis (infrared induction cooker) to generate bio-oil from sugarcane bagasse. The tests were conducted at a specific humidity content of about 36.5% for varieties of infrared cooker thermal inputs. In this experiment, a circular type stainless steel reactor was used to finish the pyrolysis cycle. The study results found that the largest amount of 15.68% bio-oil, 71.82% char, and 12.5% gas were produced at 36.5% moisture. Compared to other biomass products, the characteristics of manufactured bio-oil were defined. The calorific value, density, viscosity, flashpoint, and fire point were 11.68 MJ/kg, 902.8 kg/m*^{3}*, 14.07 mm*^{2}*/sec, 61°C and 67°C were obtained respectively when the produced bio-oil was tested. This paper provides clear data on how to generate bio-oil using infrared induction cooker to a higher extent from biomass resources. It is observed that bio-oil manufacturing and uses are one of the origins of minimal-carbon energy production.*

Keywords: Renewable energy, Pyrolysis, Sugarcane bagasse, Bio-oil.

1. INTRODUCTION

Nowadays, the modern world poses serious issues with greater fuel prices. The reserved fossil fuels will be shortly soon very rapidly. This paper has focused on renewable energy sources to overcome this serious issue. Biomass is the largest contributor to renewable energy sources that pyrolysis can convert to bio-oil. Compared to fossil fuels, renewable energy has some advantages. Bangladesh is an agricultural country and it can be used as biomass energy with agricultural residues. Some important features are the heating value of bio-oil. In the absence of an oxidizing agent for converting biomass into bio-oil, gas & char, pyrolysis is the thermal degradation. Bio-oil produces from sugarcane bagasse that has different human applications.

2. LITERATURE REVIEW

Pyrolysis has gained growing attention among the thermochemical conversion procedures for biomass as the process circumstances can be optimized to generate pyrolytic oil with elevated energy density in relation to the derived char and gas. Pyrolysis for the conversion of energy from carbonaceous waste is defined as the thermal degradation of organic matter either in the total absence of air or in the absence of a stoichiometrically necessary quantity of oxygen to the extent that gasification does not occur. Where there is no gasification, Pyrolysis procedures are performed in a reactor where heat is applied either externally to the feedstock or by the feedstock being partially combusted. Pyrolysis always generates gas, vapor that can be gathered as liquid and solid char, each return depending on the circumstances of the method. Sevgi Sensoz et al (2008) pyrolyzed safflower press cake in a fixed-bed reactor to determine the impacts of the temperature of pyrolysis, heating frequency and sweeping gas flow rates of liquid was found which only increased by 4% in the next 20 minutes. So, pyrolysis can be done only for 20 minutes for the optimization of the production process. They also pyrolyzed safflower seed press cake in a fixed-bed reactor to determine the effects of pyrolysis temperature, heating rate and sweep gas flow rates on the yields of the products using pyrolysis temperatures between 400 and 600 °C with a heating rate of 10, 30 and 50°C/min [1]. Ayse E. Putun et al (2002) conducted the slow pyrolysis of soybean cake in a fixed-bed reactor under three different atmospheres: static, for determining the effects of pyrolysis temperature and particle size, nitrogen and steam for determining the product yields. The effect of the process conditions such as heating rate, temperature and particle size on the product distribution, gas composition and char reactivity of olive waste and straw at high temperature (800 -1000°C) in a free-fall reactor at pilot scale was carried by them [2]. The pyrolysis of sawdust of the babul plant using augur reactor shows that the maximum liquid yield was 20.4% at temperature

600°C and loading rate of 5kg/h [3]. Cellulose (polymer glucose), hemicellulose (a polysaccharide that produces wood sugars) and lignin (a multi-ring organic compound) are the main components of wood. There is some variation in the relative abundance of these constituents in separate sugarcane species, but cellulose is taken as a rough guideline by 50% and the other two 25% by dry weight each [4]. The question of whether endothermic or exothermic pyrolysis responses play a significant role in modeling. However, reported values of heat of pyrolysis of sugarcane bagasse range from –613 kJ/kg to 1680 kJ/kg [5]. Carbon molecular sieves that are selective oxygen are usually porous bimodal materials that distinguish oxygen from air on a kinetic basis. These materials are generally prepared by treating a carbonaceous material (e.g. coal, coconut shell char, peat, pitch, carbonated polymers, and the like) with extra carbon-containing species in the separate benefits of pyrolysis of the infrared wave can contribute to the potential for increased manufacturing of desirable pyrolysis products, such as gaseous hydrocarbons and liquid hydrostatic products [6].

3. METHODOLOGY

The purpose of this research is to exploit the method of changing sugarcane bagasse waste into liquid fuel. The Infrared heating method is used for pyrolysis into pyro-oil of the sugarcane bagasse waste. In a fixed bed technology, the thermal treatment of as-received the sugarcane bagasse was performed in an infrared cooker. Argon gas was used in this research to decrease oxygen and remove inert gasses so that no fire happened and inert gas could not respond with other gasses as the argon gas was supplied continually at any time interval. The argon gas also helped to remove the gases which were produced inside the stainless-steel reactor during the pyrolysis process. The recovered pyro-oil was analyzed. The gaseous product was not stored and released in the atmosphere. A bomb calorimeter was used to determine the calorific value of pyro-oil, and a viscometer was used to measure the viscosity of the pyro-oil.

3.1 Working Procedure

At first, the bagasse for infrared pyrolysis is held on the reactor with known bagasse weight. When the microwave heating is beginning, after some temperature assessment, the bagasse starts pyrolysis. Pyrolysis products (vapor & gases) are moved through the copper pipe to the ice water-cooled condenser where condensable materials are mixed at the bottom of the condenser and gaseous goods which are non-condensable pass through the condenser hole. The pyrolysis product temperature is registered in a certain interval of time. In order to obtain desired pyro-oil and bio-char, which has a certain calorific value and viscosity of the liquid oil, the microwave heating is held. The gaseous product is released into the atmosphere in this research. In this research, liquid argon is used to produce an inert atmosphere and carrier gas. Ice cooled water is used to condense the vapor to maximize the oil yield. At the bottom of the condenser, the condensate oil is collected and stored for further study. The purpose of this research is to heat up pyro-oil from sawdust. Figure 1 shows the experimental setup. A 2000-Watt infrared cooker and sawdust heating are kept in the experiment. For this study, the infrared cooker is used which has 20 liters capacity and taken from Model-Prestige-BlackBerry-TCI-202. This infrared cooker has an output capacity of 2000 Watt and a temperature of up to 600 Degrees Celsius. The copper tube's size was 10.8 mm.

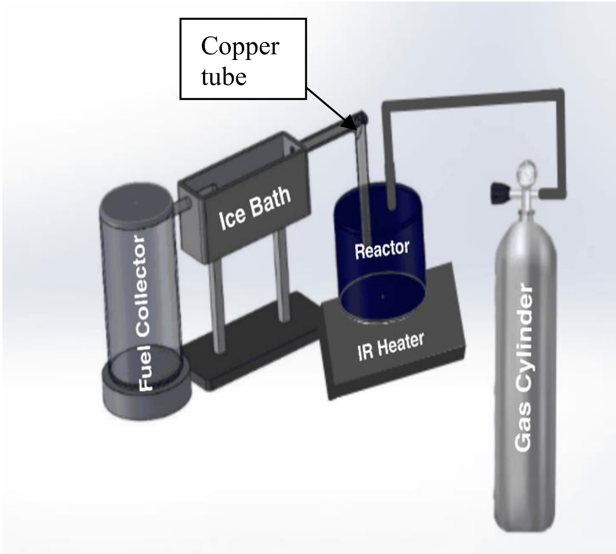

Figure 1: Solid work design of experimental setup.

4. DATA ANALYSIS

The production product yield of 15.68% pyro-oil has been restored in the pyrolysis method, which has a nice calorific significance. In figure 2, the resulting char of 71.82% of the complete weight was achieved using bagasse in the pyrolysis method. The amount of pyro-oil, charcoal and gas for temperature variation. In figure 3, at temperature 540°C, the maximum output was taken during experiment. Due to the instrument leakage, the elevated proportion of gases 12.5% and some losses can be regarded. Compared to other biomass resources, the calorific value of various biomass products, such as sawdust, date seed oil, conventional biodiesel and heavy fuel oil. Because the vapor could not be stored, the low calorific value was not evaluated. The calorific value in terms of the greater calorific value (HCV) was therefore assessed. In figure 4 shows the measured bagasse HCV which is 11.68 MJ/kg but lower the petroleum fuel calorific value. In figure 5 shows the bagasse's dynamic viscosity which is 14.07 mm^2/s lower than the normal value. In figure 6, the measured bagasse density is 902.8 kg/m^3. In figure 7 shows the sugarcane bagasse flashpoint value, which is found at 61°C and the point of fire at 67°C.

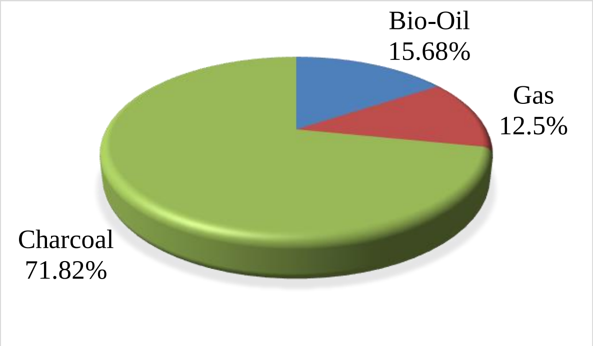

Figure 2: Percentage of product yield

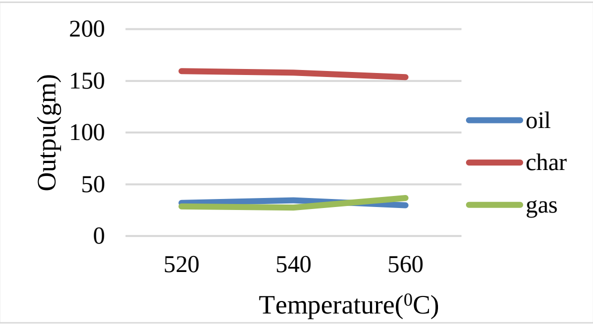

Figure 3: Graphical Representation of the product.

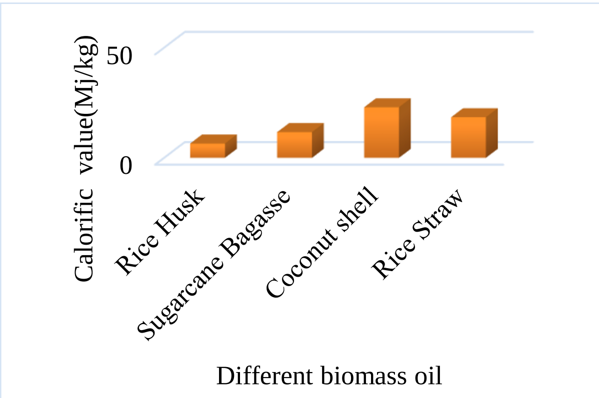

Figure 4: Comparison of calorific value for different biomass resources.

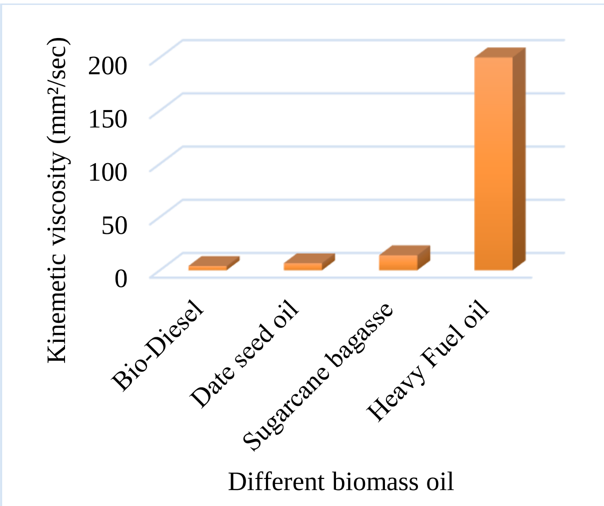

Figure 5: Comparison of Kinematic Viscosity for different biomass resources.

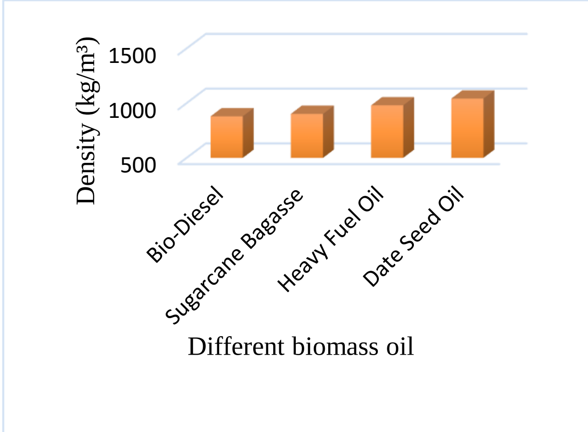

Figure 6: Comparison Density for different biomass resources.

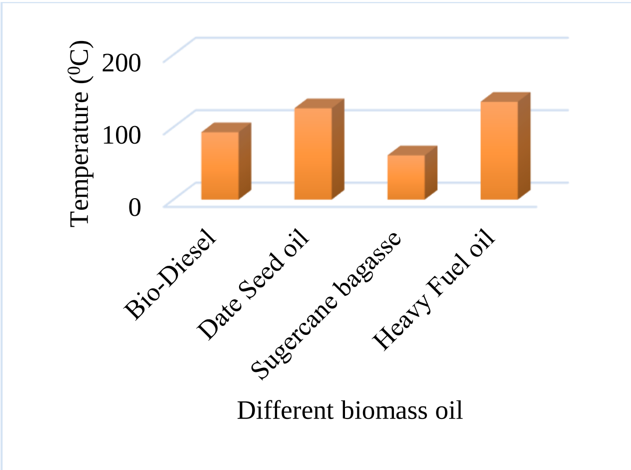

Figure 7: Comparison of Flashpoint for different biomass resources

5. RESULT AND DISCUSSION

The product yield of 15.68% bio-oil, 71.82% charcoal and 12.5% gas were obtained at a specific moisture content of 36.5% during the induction cooking pyrolysis process. The maximum bio-oil was obtained at a heat input of 540°C during pyrolysis process. The heating value, density, viscosity, flashpoint and fire point of 11.68 MJ/kg, 902.8kg/m^3, 14.07 mm^2/sec, 61°C and 67°C were obtained when the produced bio-oil was tested in the experiment.

6. CONCLUSION

The process of pyrolysis in the new era has already demonstrated its effectiveness for various purposes in recycling sugarcane bagasse. The important part of the pyrolysis process is to reduce environmentally friendly sugarcane bagasse waste and make it usable. Pyrolysis is used in the infrared wave to remove bad smell and organic compounds from water. To save energy and recycle many wastes from the environment, many more projects are being proposed daily for pyrolysis. Bio-oil has many positive features such as biodegradability, greenhouse gas reduction, emissions of non-sulfur, pollutants of non-particulate matter, low toxicity. Sugarcane bagasse, which is an important source of renewable energy, is available in Bangladesh. It has also lower production cost in comparison to any conventional process.

7. REFERENCES

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