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INVESTIGATION OF WOOD BIO FUEL POTENTIAL AS FEED STOCK FOR HYDROGEN FUEL

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ABSTRACT

Sawdust from sawmill was paralyzed under a temperature of 450^oC and with a particle size of 1mm to produce bio-fuel. The bio-fuel as analyzed to get some elemental components. Proximate analysis of sawdust was also done. Hydrogen-carbon ration and oxygen-carbon ration were also determined. From the result obtained, moisture content and carbon content were 28.16% and 48.44% respectively which showed that sawdust has large potential benefits in terms of reduced emissions of CO_2, greenhouse gases and energy supply. The hydrogen to carbon and oxygen of carbon ration of 30 and 0.049 indicates low emissions associated with hydrogen production and can also be suitable for thermos-chemical steam reforming process. Wood bio-fuel analysis revealed its suitability for hydrogen

Introduction:

Wood is an excellent source of energy. It can be used to create bio-fuels. Burned directly, tuned into synthetic gas or paralyzed turned into a liquid to create electricity. Wood fired power plants can have a positive impact on the economy of some rural areas. At present, Texans has no operating wood-to-electricity facilities, but two are being developed. Nacogdoches power is building a large wood-burning facility in Sacul, Texas expected to be operational in Late 2009. Mesquite fuels and agriculture in Hamlin, Texas expected to be operational in late 2009. Mosquito fuels and agriculture

production through steam reforming process.

Keywords: *Wood, Bio fuel, Hydrogen, Sawdust, Energy*

In Hamlin, Texas plans to establish a smaller-scale wood gasification facility expected to be operational in spring or summer 2008 (Biomass Engineering, 2008). These facilities are projected to add about 500 jobs to all sectors of the economy once completed.

Biomas is the oldest human energy source. Mankind has burned wood to create heat for tens of thousands of years. But 1890, commercial, residential and transportation sectors counted on wood as the primary fuel supply (Biomass Engineering, 2008). Biomas (including organic waste fuels derived from plants and wood) recently surpassed hydroelectric power to become the largest source of renewable energy is the U.S industrial consumers use the majority of the energy generated from biomass to determine its chemical compositions

The technology to generate energy from wood has entered a new millennium in most of the developed countries, with virtually limitless possibilities, sawdust from Agriculture and wood industry are abundant in Nigeria as such can be pyrolsed and changed into liquid fuel for used production of hydrogen which can used as a fuel. The depletion of fossil fuel reserves and the pollution caused by continuously increasing energy demands make hydrogen an alternative energy source with zero CO_2 emission. Liquid fuel (Biofuel) from wood serves as feed stock for hydrogen production. Most of this energy is generated at mills or paper plants that burns their own wood waste for power and heat (Kassenga, 1997). The principle economic advantage of wood biomass energy is that wood is significantly less expensive the competing fossil fuels. Public institutions, such as schools hospitals, prisons, and municipality owned district heating projects, and prime targets for using wood biomass for energy, potential user should evaluate the local market fir the available supply of wood. Biomass can be used to create electricity through a variety of methods, including direct firing. Gasification and pyrolysis (the liquefaction of biomass to form oil, which is our focus in this project), among others. Direct firing is the most common of these methods (Larson, 2008). The objectives of the study are to carry out pyrolysis of wood sawdust at a selected temperature and particle size reduction and characterize the biofuel produce

METHODS

Sample Collection

Sawdust being the raw material was collected from a saw mill in a very large quantity for use. The sawdust was then dried by exposure to sunlight in order to remove on the surface of its particles. Next the sawdust was selected from other dirt particles in the sawdust, then the sawdust was separated using a sieve of 1 mm.

Experimental Procedure

600 g of the sawdust was weighed using a weighing balance of the 1 mm particle size sawdust. The measured sawdust was then put into the oven in order to remove the moisture content in the sawdust to obtain maximum yield of oil on extraction. The oven was operated on a temperature of 110^{0}C at time intervals of 1 hr until the mass of the sawdust became constant which indicated there was no moisture contained in the sawdust anymore. The experimental setup was fixed which was made of a heating furnace of up 1200^{0}C, a condenser an cyclones. The function of the heating furnace was to heat the sawdust in the absence of oxygen under a high temperature of 450^{0}C. while the sawdust was put in reactor and into the heating furnace, the cyclone in connection to the condenser was connected directly to the furnace and well-fixed in such a way as to avoid the escape of any gas out of the pipe that was connected to the heating furnace.

A water source was connected to the condenser to condense the gas that passes through the cyclone to the condenser for the condensation process. The gas that was gotten from sawdust under pyrolysis process was condensed into liquid form and the bio-fuel was collected using a beaker, in the collection of the products of the pyrolysis, water was also collected in large quantity compared to the oil that was collected in large quantity that was collected in each run. 100 g of the saw dust of particle size of 2 mm was fed into the reactor and the liquid obtained was measured, same was done for saw dust for particle size 1 mm at a temperature of 450^{0}C the bio-fuel that was produced for the particle size of 1 mm was taken to the laboratory for elemental analysis.

Determination of the Physio-Properties of Sample

The procedure for the determination of physio-chemical properties of the sample is as listed below;

Moisture content

500g sawdust sample was measured in weighing pan using a digital weighing balance. It was subjected to heating in the electric oven at a temperature of 110^{0}C for 10 hours. 1 hour at intervals subsequently, the sample was then cooled and re-weighed at every 1 hour interval. The process of drying and weighing continued until a constant weight was obtained. The loss in weight in the sawdust represents the total moisture content of the sawdust.

Volatile Solid (Vs)

Volatile solid content of the samples was determined by heating 150 g of the sample at 650^{0}C in the muffle furnace for an interval of 30 minutes. Then the volatile solids content in percentage was determined by using the formula;

$$Vs = \frac{\text{mass(g)before heating} - \text{mass(g after heating}}{\text{mass before heating}} \text{ X } 100 \qquad 1$$

Where: VS = Volatile solid of the sample.

Carbon Content

The carbon content of the sawdust was measured by considering the volatile content that is expressed as percentage and the total carbon content was obtained from volatile solids using empirical equation as reported by (Onchieku, 2011)

$$\%\text{ Carbon } = \frac{\%(Volatile\ Solid)}{1.8} \qquad 2$$

Ash Content

This analysis was carried out in a muffle furnace and ignited at a high temperature of about 650^{0}C for an interval of 30 minutes before reweighing. This was repeated until a constant weight was obtained. The mass left was weighed and this represents the ash content of the samples.

$$\%\text{ Ash content} = \frac{\text{weight of sawdust after ignition}}{\text{weight of sawdust before ignition}} \text{ X } 100 \qquad 3$$

RESULTS AND DISCUSSION

Results

Table 1: Proximate Analysis of Sawdust of 1mm Particle size

Properties	Sawdust (1mm)
Moisture content (%)	28.16
Volatile Solids (%)	87.19
Ash content (%)	12.81
Carbon content (%)	48.44

(Source: Author's field work)

Tables 3: Ratio of Hydrogen and Oxygen to Carbon

H-C	30
O-C	0.049

(Source: Author's field work)

Tables 4: Moisture Content for Proximate Analysis of Sawdust

Time (hours)	Initial weight(g)	Final Weight(g)	Weight loss(g)
1	500	491.11	8.89
2	491.11	491.51	9.96
3	481.51	478.52	2.99
4	478.52	460.23	18.29

5	460.23	400.41	59.82
6	400.41	380.40	20.01
7	380.40	360.11	20.29
8	360.11	359.20	0.91
9	359.20	359.20	0
10	359.20	359.20	0

(Source: Author's field work)

Table 5: Ash and Volitile content for Proximate of Sawdust

Time (m)	Initial weight(g)	Final Weight(g)	Weight loss(g)
30	150	43.5	106.5
60	43.5	39.41	4.09
90	39.41	28.30	11.11
120	28.30	21.11	7.19
150	21.11	19.21	1.9
180	19.21	19.21	0

(Source: Author's field work)

Discussion of Result

From the proximate analysis result carried indicated in table 1, it can be seen that the percentage of moisture content in sawdust is high which is not usually good for the yield of bio-fuel because moisture content bin sawdust to absorb and retain moisture. Therefore, this aided information helped in the drying the sawdust until there was no moisture. This, in turn yielded more quantity of oil that moisture. The volatile solid which was 87.19% indicated that sawdust was volatile and this is owing the fact that saw dust is a highly combustible material. The carbon content of the content of the sawdust which was 48.44% indicated that sawdust contained a high carbon content which under pyrolysis conditions can be minimized to avoid air pollution. From the result obtained in Table 2 of the ultimate analysis, potential for production of hydrogen from bio-fuel using sawdust was determined. This was determined using hydrogen carbon ration oxygen carbon ratio as given by Lv *et al.,* (2003) Hydrogen to carbon ratio which gave 30 indicates low emissions associated with hydrogen production which is a generally acceptable level by the Environmental Agency. Oxygen to carbon ratio which gave 0.049 indicates fuel tends to reform than Oxidize and increases the hydrogen yield of steam reforming reaction as given by Lv *et al.,* (2003). From the quantity of oil obtained from sawdust. it is seen that the smaller particle size yields smaller quantity and vice versa in comparison with the particle size 1mm of the report of this work to another's of 2 mm particle size under same temperature.

CONCLUSION

Based on these result obtained, the following conclusion were made:

i. Sawdust has the potential to produce bio-fuel when pyrolised with a particle size of not less than 1mm and a temperature of 450°C.
ii. The elemental composition revealed wood bio-fuel contain hydrogen, Carbon Oxygen, and Nitrogen.
iii. High value of Hydrogen , H to Carbon, C ratio 30 clearly indicates, when wood oil is used in the production of hydrogen , it will be associated with low CO2 (greenhouse gases) emission which will not cause global warming .
iv. Low value of Oxygen, O to carbon, C ratio 0.049 also indicates when used in the hydrogen production, it can undergo reforming rather than oxidizing CO2 and CO respectively.
v. The wood Bio-fuel has every potential as feedstock for hydrogen production which can serve with zero CO2 emission.

RECOMMENDATIONS

i. It is recommended that ultimate and proximate analysis of bio-fuel produced from sawdust be carried out in order to determine properly of wood fuel for the production of hydrogen.
ii. It is recommended that different types of wood should be analysis in order to get the one that will produce maximum yield of bio-fuel.
iii. Equipment for Elemental and analytical are needed in the to aid the research process of this work.

REFERENCES

Biomass Engineering, 2008. The Clean and Renewable Energy Resource. Website (accessed 6 Aug 2011): http://www.biomass.uk.com

Larson, E., 2008. Biofuel Production Technologies, Status, Prospects and Implications for Trade and Development. New York and Geneva: UNCTAD.

Kassenga, G.R. 1997. Promotion of Renewable Energy Technologies in Tanzania. Resources, Conservation and Recycling. Vol. 19 No. 4; pp. 257 - 263.

LV, P.M, Chang J, Xiong ZH, Huang HT, Wu CZ, Chen Y, et al. Biomass air-streamgasification in afluidized bed to produced hydrogen-rich gas. Energy & Fuels 2003;17:677e82

Onchieku, J.M., Odongo, F., Ondieki, M.M.C., Gladys, K.M., Mayaka, A., Wanjiku, J. and Chiteva, R. (Eds.), 2011. Biomass gasification and technology utilization: Proceedings of biomass gasification workshop, Wida Highway Motel, Kenya, 24th – 27th May 2011.