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Research Article

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Biofuel Production From Wood Shavings

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Abstract

In this study, wood shavings were sourced from a sawmill in Ibadan, Nigeria and treated to a 12% moisture content for size reduction using a hammer mill. A measuring balance was used to weigh the samples in increments of 1kg, and the wood shavings were processed with the assistance of the hammer mill for size reduction. The particles were then passed on to a pre-treatment chamber where water and tetraoxosulphate VI acid were added to the blend. The mixture was then pumped into a fermentation chamber where heat was introduced by a heater up to 100C. The experiment was conducted for various masses of wood shavings, and the amount of biofuel produced was measured in liters. The efficiency of the hammer mill was 84.6%, with a throughput capacity of 13.63 kg/hr. The mean efficiency of the pre-treatment chamber was calculated to be 82.29% with throughput capacity of 38.4 kg/hr. The final product, ethanol, was assessed for its physical and chemical properties in a laboratory setting, and it was found to be combustible and supported ignition. The amount of ethanol produced increased with the amount of feedstock used.

Keywords: Wood Shavings, Biofuel, Moisture Content, Production Plant

Introduction

It is important for engineers and scientist not to rest on the search for alternative energy source across the globe as fossil fuel continues to deplete every day, this is making the price of gasoline to rise almost everyday world over. This research work majorly focuses on extraction of biofuel from wood shavings with the help of biofuel production plant.

Nwakaire et al (2013) investigated on the age of cellulosic ethanol from wood sawdust in an examination office scale. This work as such was finished utilizing an area available biomass misuse as an elective wellspring of ethanol, which is correct currently used as a piece of begin engines as a supportable power source fuel. It furthermore chose the yield of ethanol from the sawdust used. The sawdust test was assembled from the Nsukka Sawmill (Timber shade). Materials used incorporate 18 m (78% center) of sulfuric destructive, 6 m of sodium hydroxide for hydrolysis, and maturing strategy. The hydrolysis incorporate the extraction of fermentable sugar from a cellulosic biomass. The sawdust of the sulfuric destructive mix was allowed to sit for 48 hours, by then the refined water was used to debilitate with a particular ultimate objective to bring its pH between 5.0 - 6.0. 10 kg of sawdust gave 500 cm3 of ethanol using the Beer-Lambert plot of ethanol water mix. The accomplishment of the extraction of ethanol shows up there with potential results for advancement.

The examination of ethanol yield conveyed from dissimilar crops exhibits that cassava has the most amazing biofuel yield of 6,000 kg per hectares year and most critical change rate of 150 Liters per ton of all the essential crops [1]. Regardless of the way that sugar stick and carrot have higher gather yield of 70 and 45 tons/ha/yr independently appeared differently in relation to 20 tons/ha/yr for cassava, the enormous measures of water, which they require in the midst of their formative periods is a strong control when stood out from cassava which can truly create under extensively drier conditions. Agboola and Agboola (2011) saw that an immense measure of new cassava tubers yields around 150 liters of ethanol. Adelekan and

Review of Literature

Bamgboye (2009) investigated ethanol gainfulness of cassava trim in an exploration focus preliminary by relating volumes and masses of ethanol made to most of tests used. Cassava tubers (collection TMS 30555) were stripped, cut and washed. 5, 15, 25 and 35 kg trial of the tubers were said something three repeats, ingested water for a period of multi day, after which every precedent was dried, squashed and the pound mixed with 500, 650, 800, and 950 ml of N-hexane (C_6H_{14}) exclusively. This pummeled pound was then allowed to develop for a period of 8 days and a while later pushed on a 0.6 mm hole size and sieved to yield the alcohol contained in it. The alcohol was warmed at 79°C for 10 h at between times of 2 h took after by a cooling. Ethanol yield was at ordinary volumes of 0.31, 0.96, 1.61 and 2.21 liters, separately, for the picked masses of cassava tests. This examination found that a total of 6.77 million tons or 1338.77 million gallons of ethanol are available from signifying cassava creation from tropical countries. The creation and usage of ethanol from cassava alter in the cassava-creating tropical countries of the world decidedly holds much certification for essentialness security and is thusly endorsed.

Kadam and McMillan, (2003), Scholtes (2009) alluded to by Barta et al (2010) valued that 200 million dry tons per year of over the ground corn Stover is open, while almost 60 % may be monetarily gathered[2, 3]. Wyman et al., (2005) stated that about 58% of the corn stover can be procured on a practical reason. Regardless, with current hardware and no-till developing, 76 – 82% could be gathered, though 70% is the most extreme for business balers. In light of these doubts, Blanco-Canqui and Lal, (2007); Schell, (2004) assessed the corn stove openness to be 153 million on dry ton per year [4]. Kaparaju et al., (2009) foreseen corn stover and wheat straw costs by contemplating the expense of the social occasion developments, the amount paid to farmers, and charges of moving stores from farm area to customer workplaces [5].

Bioethanol Production

Preparing of lignocelluloses or cellulosic materials to bioethanol comprises of four noteworthy unit tasks: pre-treatment, hydrolysis, fermentation and item division/refining [6].

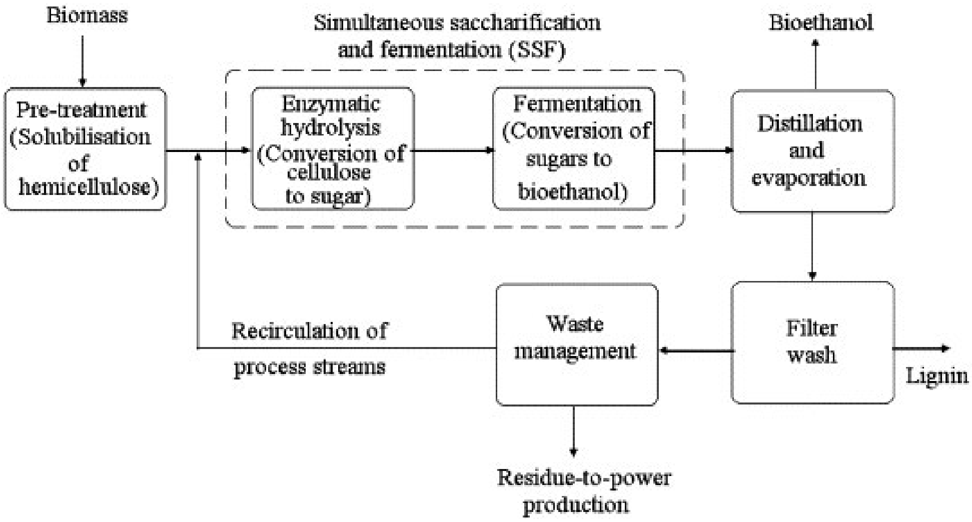

Figure 1: Process for Bioethanol Production from Biomass (Source: Basso et al, 2011)

Pretreatment of Feedstock

The underlying stage in bio-conversion of lignocellulosic or cellulosic materials to biofuel is assessed diminishing and pre-treatment. The target of any pretreatment development is to change or oust helper and compositional deterrents to hydrolysis in order to upgrade the rate of impetus hydrolysis and augmentation yields of disintegrated glucose from cellulose or hemicellulose.

There are diverse sort of pre-treatment headways

Pre-treatment Technology (Mechanical Method)

Target of this method is to disintegrate the lignocellulosic biomass into small units. Mechanical pretreatment is habitually used as a piece of mix with various advancements. The high imperativeness essential of this pre-treatment is a vital drawback and it is likely not going to be fiscally reasonable at commercial level.

Physico-Chemical Pretreatment Technology

Vapor Eruption

Biomass is treated with high weight splashed steam and the load is in a brief moment decreased, which causes a temperamental rot of biomass. Normal temperatures for this method are 1600C to 2600C which looks at to 0.69 to 4.83 MPa weight. Acidic destructive is made from the acetyl bundles in hemi-cellulose. Concentrated acid and other weak acids added in the midst of pretreatment may moreover catalyze hydrolysis and sugar degradation. Some learning is emptied by this pretreatment, in any case, it is redistributed on the fiber surfaces as a result of the condensing and depolymerization/repolymerization reactions [7]. Cellulose is generally secured in the solid segment.

Fiber Expansion Using Ammonia

Fiber expansion using ammonia is in a general sense equivalent to steam impact. It is commonly coordinated at temperatures of 60 oC to 110 oC within 30 minutes with fluid smelling salts portion of about 2Kg/Kg dry biomass, trailed by an insecure weight release. In the midst of pre-treatment, certain percentage of lignin and hemicelluloses are cleared while disintegrating the cellulose. The materials structure will be altered, achieving rising in the liquid holding limit and higher edibility [8]. Stood out from destructive pretreatment, AFEX has no gigantic effect on solubilization of hemicellulose [8].

Supercritical Fluids

It suggests a fluid that is in a vaporous casing, nonetheless, it is compacted at temperatures over its essential point to a liquid like thickness, yet underneath the load required to combine it into a solid [9]. Carbon dioxide (CO2), water and propane are the most focused supercritical fluids. The high weight empowers the speedier passageway of CO2 particles into the lignocellulosic structure. Under these conditions, carbon dioxide shapes carbonic destructive when in water, realizing the hydrolysis of cellulose and hemicellulose parts. The hydrolyzed monomers can be moreover changed over to furfurals, HMF, and different perilous reactions under growing temperatures and reaction times. The risky entry of the carbon dioxide weight, redesigns substrate hydrolysis by exasperating the cellulosic structure.

Hot Water

In this methodology water is used under strain and at bringing temperatures to remain up in the liquid state [11]. This pretreatment occurs at temperatures in the extent of 140°C to 300°C with a 15 min living plan time, which achieves the removal of 4 to 22 % cellulose, 35 % to 60 % lignin and most of the hemicelluloses. Liquid high temp water separates the acetyl and uronic destructive social affairs in hemicelluloses making acidic and other regular acids. The entry of these acids catalyzes the improvement and clearing of oligosaccharides [14].

Irradiation

Light by γ shafts, electron column and microwave are some other physical ways to deal with decrease the crystallinity of lignocellulosic material. Regardless, these advances remain exorbitant at full scale [1].

Chemical Pretreatment Technology

Alkaline Hydrolysis

Alkaline settling agent pre-treatment systems can be parceled into two essential get together depending upon the stimulus applied, metal based like sodium, potassium, etc with smelling salts centered forces. Not in the slightest degree like destructive methodology, essential pretreatments are convincing in ousting lignin showing negligible cellulose with fairly higher hemicellulose solubilization [12, 13]. Using this method, lignocellulosic bio-mass can be breakdown into dissolvable lignin, hemicellulose and solid development (generally cellulose). Before long, the sufficiency of this strategy depends upon the lignin substance of the biomass.

Ozonolysis

Ozone is used to spoil lignin and hemicellulose. Debasement happens even more effectively to lignin and, less enough to hemicellulose and cellulose. This pretreatment is extraordinarily expensive as it requires a ton of ozone, which adds to the getting ready expense.

Acid Hydrolysis

The purpose behind destructive pretreatment is to dissolve the hemi-cellulose part and to redesign cellulose edibility in the rest of the solids. This sort of pre-treatment can be achieved with strong or debilitated acids and it has been endeavored on a broad assortment of feedstock running from hardwood to grasses to cultivating developments. Sulfuric destructive is the most thought destructive. Others join hydrochloric destructive, nitric destructive, phosphoric destructive, peracetic destructive and normal acids such as fumaric and maleic. Debilitated destructive pretreatment bolsters the solubilization of hemicellulose, xylem in particular, yet it similarly isolates the solubilized hemicellulose to fermentable sugars [3].

Oxidative Pre-treatment

An oxidative pre-treatment uses the extension of an oxidizing pro, for instance, hydrogen peroxide. The focus is to oust lignin and hemicelluloses with unimportant sugar corruption together with an unsafe compound course of action. When in doubt the oxidant used is non-specific.

Ionic Liquids

Ionic liquids (ILs) are thermally enduring, non-unsafe characteristic salts with potential application as "green solvents". ILs can diminish the crystallinity of cellulose and generally empty hemicellulose. Pretreatment with ILs are less imperativeness asking for, more straightforward to manage and more environmentally very much arranged than other pretreatment methods, for instance, mechanical preparing, steam impact, destructive, base, or regular dissolvable techniques. ILs used in the midst of pretreatment contain anion of chloride, format, acidic corrosive determination or alkyl phosphonate which outline, strong hydrogen-securities with cellulose and diverse sugars

Biological Pretreatment Technology

In normal pretreatment shapes, microorganisms, for instance, white, darker and sensitive rot parasites are used as a piece of the breaking down of lignocellulosic biomass. Dull hued rots disturb starch, however white and sensitive rots ambush, both cellulose and lignin. White-rot life forms breakdown lignin through the movement of peroxidases and laccases.

Hydrolysis

In a split second the pre-treatment point of view is done, the cellulose is set up for hydrolysis, which implies the piece of an iota by including a water molecule as introduced by [14].

Enzymatic Hydrolysis of Cellulose

Enzymatic hydrolysis of cellulose are finished by cellulase mixes which are exceedingly specific. Utility expense of enzymatic hydrolysis is low diverged from destructive or dissolvable hydrolysis since protein hydrolysis are typically driven at smooth conditions and does not have a breaking down issue [6]. The two minute living beings and developments can convey cellulases for the hydrolysis of lignocellulosic materials.

These micro-organisms could be energetic, mesophilic or thermophilic. Micro-organisms having a spot with Clostridium, Cellulomonas, Bacillus, Thermomonospora, Ruminococcin, Bacteroides, Erwinia, Acetamiprid, Microspore, and Streptomyces can convey cellulases [1]. Cellulomonas fame and Thermomonospora fusca have been generally analyzed for cellulose age. Yet various cellulolytic microorganisms did not convey high protein titter.

Living beings that have been represented to make cellulases consolidate Sclerotium Rolfson, P. chrysophobia and sorts of Trichoderma, Aspergillus, Schizophyllum and Penicillium [3].

Fermentation

As the feedstock will be hydrolyzed by destructive treatment; the hydrolysate procure will be utilized for bio-ethanol maturing by micro-organisms, for instance, yeast. Since such lignocellulose hydrolysate contains glucose, just as various monosaccharides, microorganisms should be required to profitably age these sugars for the viable mechanical age of biofuel as considered by Bertilsson, 2007. Simultaneous saccharification (glucose) and maturing (SSF) will be used in light of the fact that the structure will make use of a mix of debilitating destructive with high-temperature bubbling water pre-treatment for victories. Around 80% of the ethanol conveyed on the planet is as yet getting from developments; whatever remains of by and large by blend from the oil based item, ethylene.

The alcohol conveyed in the US is on a very basic level used as a piece of blended refreshments, be that as it may, this isn't commonly the situation elsewhere on the planet. Brazil has set out on a significant program to convey ethanol for fuel and in like manner decline oil imports.

Regardless of wide research on fuel ethanol age from biomass, until 1995, not a singular plant fit for changing over cellulosic raw materials to biofuel, through natural planning on the cutting edge scale, has been put into movement wherever on the planet, though some model or trial plants have been selected.

Distillation

This is to confine course of action obtained which will contain water and diverse synthetic concoctions from the real ethanol [15]. Adeleke et al (2012) has inquired about the effect of the overall unusualness of mix obtained from the maturing of cassava squash on the layout of refining fragment using made a Java based proliferation programming. The entertainment was done by varying the relative unsteadiness as a data parameter to the made programming and changes in the amount of plate in the segment and the section stature were considered. Contrasting the relative unusualness in the region of 1.3 and 2.2 at a between time of 0.1, the amount of plate lessens from 10 to 4 (generally) and the segment stature reduces from 5.375 to 2.411m. The result exhibited that decrease in the estimation of area stature and number of plates with augmentation in relative unconventionality shows the effect of relative shakiness on the similar number of plates and the section height of refining fragment that would give the most shocking faultlessness of ethanol.

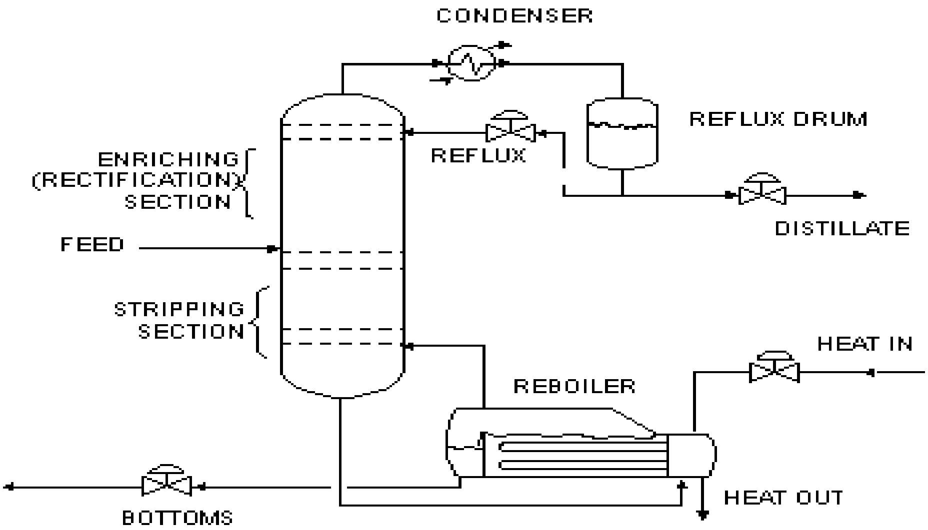

Figure 2: Bioethanol Distillation Unit (Source: Adeleke et al, 2012)

Size Reduction

It is a methodology of reducing broad compacted component masses vegetables or engineered substances into small unit masses, rough particles or fine particles. Measure diminishment is ordinarily used in pharmaceutical ventures. It is the methodology of diminishing of far reaching solid units into little units. Gauge diminishment process is in like manner implied as Comminution and Grinding.

There are various sorts of size-diminishment gear, which are as often as possible developed observationally to manage specific materials and after that are associated in various conditions.
Diverse segments like hardness, quality, stickiness, trickiness, clamminess substance, melting or relaxing point, abrasiveness and others (material structure, gauge, shape, stream, and mass thickness of the thing) extent of supporting size to thing measure, impact the size diminishment.

Various experts, especially in the zone of the building have tackled the layout and improvement of size reducing machines. Adekomaya and Samuel (2014) reported plans and enhancement of oil controlled sledge process for provincial agriculturists in Nigeria. The sledge procedure was sketched out and created from nearby open ingredients for pulverizing grain particles, for instance, maize, millet, guinea corn and other coarse materials of cassava tuber, yam tuber, beans, etc into little adequately size to experience the holes of the round and empty sifter arranged underneath the hammer get together. The beating method is practiced by the usage of a mallet in beating the material reinforced into fine particles; the fineness pointed depends upon the detachable screen with opening sizes stretching out from 87µm to 2 mm. In light of the power assessments and yield shaft speed of the flow pulverizing machines in ventures like flour process, it was found that the essential shaft speed of 700 RPM transmitted by a belt drive from a one-pull electric motor is sensible to process suitably. The machine was proposed to be control worked and reduced with general estimations of 900 x 500 x 400 mm.

Ajaka and Adesina (2014) in like manner explored to plan, production and testing of an examination focus estimate sledge process. The examination office gauges pound process was fabricated from nearby open materials for pummeling of minerals, for instance, calcite, dolomite, limestone, stone and distinctive materials of medium hardness. The staggering technique is cultivated by the use of a game plan of sledges in an overwhelming chamber which beats the mineral supports into littler particles adequately less to experience the hole of the replaceable sifter arranged underneath the staggering chamber. The size pointed depends upon the opening of the replaceable screen. In perspective on the theoretical layout, it was found that the major shaft speed of 913.5 RPM transmitted by a belt drive from a three torque electric motor is sensible to crush reasonably. A relationship of the consequences of the as of late fabricated machine with those of a standard Denver inquire about focus jaw smasher shows that the overwhelming rate of the new machine is higher, anyway the standard machine produces coarse things. The results, anyway shown that the new machine can perform better similar to things with upgraded diagram.

Bioethanol Reactor

Different sorts of bioreactors have been used as a piece of solid state maturing, which uses measures of dry solid medium from several grams up to two or three kilograms. A couple bioreactors like plate reactor, squeezed bed reactor were used for the age of ethanol using biomass as feedstock.

Sindhu et al (2012) layout and fabricated a novel bioreactor for the formation of ethanol from straightforwardness pretreated rice straw by Saccharomyces cerevisiae. The bioreactor was working at 38°C using rice straw as carbon source, at 70% sogginess content. A lot of cellulolytic and hemicellulolytic practices were gained. The general execution of the bioreactor was promising for development examination .The yield of ethanol gained in the sketched out reactor is 1.5 occasions more conspicuous than customary one. SEM examination was done to insist the essential change happening in the midst of the maturing system. The GC/MS examination was finished for the estimation of ethanol content. His examination effort was revolved around the arrangement of Rotating Biological Reactor (RBR) with perfect essential speed. Besides, the arrangement was furthermore revolved around the riddles, and jacketed vessel.

Methodology

Materials

The study make use of the following materials; 100 kg of wood shavings, weighing balance, biofuel production plant, concentrated tetraoxosulphate vi acid (H2SO4), 30 liters of water, and stop watch.

Methods

Wood shavings were sourced for at the New Garage sawmill, Ibadan Oyo State, Nigeria. The wood shavings utilized was gathered and treated to 12% moisture content keeping in mind the end goal to permit simple exchange from the hammer mill to the conveyor. A measuring balance was utilized to weigh the feedstock in 1kg, 2kg, 3kg, 4kg and 5kg respectively. Each of the samples was processed with the assistance of the hammer mill for size reduction.

The wood shavings was weighed with measuring balance and it will be stacked into the hammer mill, in which the 5 HP electric engine will be exchanged on for the size decrease of the feedstock. The particles was passed on to the pre-treatment chamber while the water and tetraoxosulphate VI acid was added to the blend. The blend will be altogether mixed and pumped into the fermentation chamber where warmth will be acquainted with the framework by the assistance of the heater up to 100 C. While the copper gathering channel (condenser) will be going through the buildup chamber for cooling and after that to the ethanol collection chamber.

The experiment was continued for various masses of wood shavings, which was recorded with the retention time with the assistance of the stopwatch and the amount of biofuel from the feedstock was estimated in liters.

Nasir (2005) technique for effectiveness efficiency for hammer mill machine was embraced for evaluation of the milling machine.

$$\text{Milling Efficiency} = \frac{\text{Mass of the output feedstock x 100}}{\text{Mass of input feedstock}} \quad (1)$$

To determine the losses that occurs during the milling operation

$$\text{Losses} = \frac{M_b - M_a}{M_b} \quad (2)$$

Where Mb = Mass of feedstock before milling

Ma = Mass of feedstock after milling

To calculate ethanol content by % volume = volume of the product x mass x density (3.26)

Volume = Mass/Density (3)

Milling or crushing capacity is defined as the mass of material ground in kg/hr (Mott 1980).

Table 1: Bill of Engineering Materials and Evaluation for the Production

S/No	Description	Specification	Quantity	Cost (N)	Total Cost (N)
1	Wood Shavings	100 kg	100 kg	10	1,000
2	Sulphuric Acid	Conc.	5 liters	1000	5000
3	Fuel for Generating set	Diesel	10	750	7500
4	Transport and Labour			10000	10000
25	Miscellaneous			10000	10000
	Total Cost				**N33,500**

Results and Discussion

Table 2: Result for the Milling of the Feedstock (Wood Shavings)

Trial	Mass of feedstock before milling (kg)	Mass of feedstock after milling (kg)	Duration of Milling Operation (Second)	Percent Losses (%)	Efficiency (%)
1	1.0	0.76	252.0	24.0	76.0

2	2.0	1.62	426.0	19.0	81.0
3	3.0	2.34	673.8	22.0	78.0
4	4.0	3.56	948.0	11.0	89.0
5	5.0	4.40	1044.0	12.0	88.0
Total	**15**	**12.68**	**3343.8**		
Mean	**3.0**	**2.54**	**668.8**	**17.6**	**82.4**

The machine which was loaded with 1 kg of wood shavings at 12 % moisture content through the feed hopper, produced 0.76 kg feedstock after milling operation within a duration of 252 seconds at 76 % efficiency. Following the successful completion of mass 1 kg feedstock, the same procedure was followed for mass 2, 3, 4, and 5 kg, with their corresponding output of 1.62, 2.34, 3.56, and 4.40 kg respectively. The milling duration recorded during the operation were 426.0, 673.8, 948.0, and 1044.0 seconds with efficiencies of 81, 78, 89, and 88 % respectively.

Table 2 revealed the machine performance with a mean mass of the feedstock (wood shavings) before milling is 3.0 kg with a mean output of 2.54 kg. This implies that the efficiency of the developed hammer mill is 84.6 % with the percentage loss of 15.3 % respectively, with the throughput capacity of 13.63 kg/hr. From the test result obtained it is obvious that increase in quantity of feedstock loaded is corresponding to the increase in quantity of output and even the efficiency of the machine. The reason for this is that the particles milled has to be transferred through suction pump of the cyclone to the pre-treatment chamber, this usually increase the pressure of the hammers in the machine compartment. The milling of the feedstock was achieved through the constructed hammer mill, while the cyclone developed was employed in transferring of the particles in the pre-treatment chamber of the plant.

Pre-Treatment Unit Evaluation Report

Table 3: Test for the Pre-Treatment Wood Shavings

Mass of wood shavings (kg)	1 Kg	2 Kg	3 Kg	4 Kg	5 Kg
Volume of Water V_1 (ml)	5000	7500	10000	12500	15000
H_2SO_4 V_2(ml)	35	70	105	140	175
Duration t (mins)	10	15	20	25	30
Initial Temperature T_1 (oC)	25.20	27.00	27.50	29.80	30.20
Final Temperature T_2 (oC)	28.00	30.30	32.00	35.70	38.30
Input Slurry (kg)	6.02	9.69	14.68	16.90	21.65
Output Slurry (kg)	4.98	7.24	12.02	14.10	19.20
Efficiency (%)	82.72	74.72	81.88	83.43	88.68

The mean efficiency of the pre-treatment chamber was calculated to be 82.29 % with throughput capacity of 38.4 kg/hr as revealed in table 3. Change in temperature of the feedstock occurs because of the mechanical agitation of the feedstock by the stirrer, with the temperature ranges from 25.20 to 38.30 oC. The input slurry was recorded between the range of 6.02 to 21.65kg, while the output slurry ranges between 4.98 to 19.20kg respectively. Since there are recordable increases in the temperature of the slurry, this has showed that there is breakdown of the lignocellulose materials in the feedstock.

Liquid Biofuel Fermentation Unit Evaluation Report

Table 4: Quantity of Liquid Biofuel obtained from Wood Shavings

Mass of wood shavings (kg)	1	2	3	4	5
Input Slurry (kg)	4.98	7.24	12.02	14.10	19.20
Mass of biofuel (kg)	0.202	0.587	1.034	1.089	1.210
H_2SO_4 (ml)	35	70	105	140	175
Duration (mins)	150	155	159	162	163
Volume of biofuel (L)	0.256	0.744	1.311	1.380	1.534

Density of ethanol = 0.789kg/L

The table above revealed the preliminary test of the constructed ethanol fermentation chamber. The quantity of ethanol obtained from the feedstock increases in relation to increase in the wood shavings. The table 4 shows that from 1kg mass of wood shavings, there will be 0.256 liter of ethanol with the addition of 35ml of concentrated Tetraoxosulphate VI acid (H2SO4) with a heating period of 30 minutes. Furthermore, the amount of biofuel obtained from the wood shavings increases as the quantity of the feedstock increases. With a mass of wood shavings at 5kg, the amount of ethanol obtained increases to 1.534 liters with the addition of 175ml of concentrated Tetraoxosulphate VI acid (H2SO4) over a period of 150 minutes of heating.

It was also recorded that the boiling point temperature for vapor formation that later leads to ethanol production was 820C, which was later regulated by the use of a thermostat to 600C over the period of time used in the production process. The result obtained is in accordance with Adelekan (2015) where the author research on laboratory production of ethanol from Iroko tree. The researcher also reported that the amount of feedstock will also determine the amount of ethanol produced. The only thing is that it takes Adelekan (2015) seven days before he can produce ethanol because of the laboratory preparation while the pilot scale takes only 30 minutes for the production.

Laboratory Report of the Liquid Bio-Fuel Obtained

Table 5: Determination of the Liquid Properties Obtained

Liquid	pH	Melting point (^{0}C)	Vapourisation point (^{0}C)	Density at 20 ^{0}C
Ethanol	7	--- 114.1 ^{0}C	78.5 ^{0}C	0.789
Ethanol produced	7		82.0^{0}C	0.791

The qualities of some physical and chemical properties assessed to affirm the liquid produced to be ethanol. The fluid created is dismal with a sweet smell. The ethanol acquired was additionally subjected to basic tests in the research facility. Flame was noticed as the liquid was put nearer to the fire and it demonstrated that the ethanol acquired is exceptionally combustible and backings ignition.

The table 5 above uncovered that the higher the amount of feedstock the higher the measure of ethanol created. The properties of the fluid got were resolved at the Federal College of Agriculture, Ibadan liquid mechanics research center. The pH was 7, breaking point was 82.00C while the relative thickness of the fluid delivered was 0.791g/cm^3. These qualities fit in with the standard properties of the ethanol as appeared in Table 4 as concurred by Adelekan (2015).

Table 6: Analysis of Variance for Production of Biofuel from Wood Shavings

SUMMARY				
Groups	***Count***	***Sum***	***Average***	***Variance***
Col 1	4	236.7	59.175	1504.476
Col 2	4	246.7	61.675	1583.316
Col 3	4	247.7	61.925	1543.509
Col 4	4	254.7	63.675	1582.943
Col 5	4	251.9	62.975	1493.949

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	47.128	4	11.782	0.007643	0.999869	3.055568
Within Groups	23124.58	15	1541.639			
Total	23171.71	19				

The ANOVA table revealed the results of the statistical test used to determine if there are significant differences in the means of production of biofuel from wood shavings across five different groups (Col 1-5). The table shows the number of observations (count), the sum, average, and variance of each group.

The ANOVA source of variation shows the sum of squares (SS), degrees of freedom (df), mean squares (MS), F-value, P-value, and F critical value. The F-value compares the ratio of variation between groups to the variation within groups, and the P-value is the probability of getting an F-value as large or larger than the one observed, assuming the null hypothesis is true.

In this case, the P-value (0.999869) is very high, which indicates that there is not a significant difference in the means of production of biofuel from wood shavings across the five groups. The F-critical value (3.055568) is also not met, further supporting the conclusion that there is no significant difference.

The result simply implies that the effect of input parameters which include the feedstock, water, H2SO4 had no significant difference at R2 = 0.999. The temperature at vaporization point significantly ($p < 0.005$) influence on the mass of the feedstock.

Conclusions

From the result obtained from this research work; it has been established that alternative fuel can be obtained from waste of the wood (wood shavings) when subjected to some certain operations which include; size reduction, pretreatment which is the hydrolysis stage, fermentation and condensation. The inference drawing from the field work has revealed that the above listed procedure are standard for production of biofuel through the integrated facility.

Recommendations

Given the impact of these findings, the following actions are recommended to address the problem of energy availability in Nigeria and around the world while also addressing environmental pollution:

Increased efforts should be made to find biofuels from various waste materials, both natural and non-natural.

Efforts should be made to develop engines that can run on 100% ethanol using locally sourced materials.

The government should provide more funding for the research and development of alternate and renewable energy sources, to help make the country self-sufficient in this area.

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