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Effects of Yeast's Weight and Fermentation Time to Percent Yield of Bioethanol from Peatlan

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Abstract: ***Renewable energy development in Indonesia is one of the government's programs to reduce carbon dioxide emission and dependence to fossil fuel. Bioethanol is an alternative energy that can be developed to replace solar fuel. Peat is a source of bio-ethanol which is very potential because of its abundant source in Indonesia. This research investigated the lifecycle of bio-ethanol from peat, resulting in carbon dioxide emission reduction and energy net. Fermentation method was used to produce bio-ethanol from peat. In the fermentation, yeast was used and the fermentation temperature was from 20℃ to 40℃. The products were analyzed by a gas chromatograph (GC). The results showed that at the 10th day, the bio-ethanol production was the highest. This research also concerns to the side effects of by-products from bioethanol production. The use of by-products may improve the environmental performance and bioethanol energy until 30-70%. This research showed that bioethanol (from peat) development in Indonesia is much better compared to other countries.***

Index Terms: Bioethanol; Peat; Renewable energy; Strong acid; Yeast

I.INTRODUCTION

Peat is a plant formed from the accumulation of the remains of half-rotten plants. Therefore, the content of organic material is very high. As an organic material, peat can be used as an energy material. Peat volumes around the world are estimated at 4 trillion m3, covering an area of approximately 3 million km2 or about 2% of the world's land area, and contain about 8 billion terajoules of energy. The area of peat lands on the island of Sumatra is about 7.3-9.7 million hectares or about a quarter of the area of peat lands throughout the tropics [1].The peat ecological function is as a carbon storehouse, water storage, climate regulation and biodiversity source [1]. The conversion of peat land to agricultural land and plantation land will result in changes in ecological functions resulting in environmental impacts, especially increased CO2 emissions released by peat lands. This is believed to be one of the factors causing global warming, climate change and rising sea levels [2].

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Therefore, peat soils need to be utilized in other ways, one of them as raw material for making bio ethanol.

Peat soil has lingo cellulosic material composition which is potential raw material for bio-ethanol manufacture and has low emission level. Ligno cellulosic components in peat soil are: Cellulose 0.2 - 10%, hemicelluloses 1 - 2% and lignin 64 - 74%. Cellulose is a carbon rich material. Carbon contained in cellulose can be utilized in microbial fermentation process.

Fermentation of ethanol using Saccharomyces Cerevisiae is done by using mixed culture method. It is used to optimize ethanol production because each microorganism will work synergistically. The process of producing ethanol with microbial culture mixing is very possible to do especially after the process of saccharification. The saccharification process is a very important part of ethanol production. Therefore, it is necessary to do the study so that the optimum result will be obtained by saccharification and ethanol

This study aims to know the effect of concentration, yeast type, acid type, time of fermentation, and temperature on bio-ethanol produced from peat soil.

If the study provides good results, the expected benefits are: 1. For the state and society: a) Increase the value of the use of peat land, b) reduce the environmental pollution caused by the lack of public knowledge because peat no longer used, c) Obtain alternative renewable energy sources. 2. For the Science: obtained data influence the concentration, yeast type, acid type, fermentation time, and temperature on bio-ethanol produced from peat soil.

State of The Art In relation to this research, Kiagus Ahmad Roni has previously conducted research studies related to bio-ethanol or petroleum-auxiliary fuels. The studies describe / analyze the fuel-making of petroleum refining from vegetables in a comprehensive manner with the aim of obtaining other sources of energy from oil vegetable oils such as rubber seed oil, seed oil and cooking oil used during which the oil from the raw material has not been utilized while the fuel needs increased and petroleum fuel sources are running low [3].

Theories and the means used in the manufacture of fuels

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from vegetable oils are to be used as a reference or basis in conducting a research based on pre-existing knowledge and related views.

A. Peat

Peat is formed by the accumulation of tropical vegetation residues that are rich in lignin and cellulose [4]. Hair contains organic material that can not be directly utilized because it is still in the form of complex compounds, one of which is cellulose. Cellulose is a linear polymer greater than 1000 long glucose subunits with a 1,4-β bond [5].

The existing peat in Sumatra and Kalimantan is usually dominated by woody materials. Therefore, the composition of the organic material is mostly lignin which generally exceeds 60% of the dry matter, while the other component content such as cellulose, hemi cellulose and protein generally does not exceed 11%.

Fig.1: Peat land

Lignin is a complex molecule composed of Phenyl Phropane units bonded in a three-dimensional structure. Because of its very high carbon content compared to cellulose or hemicellulose, lignin has a high energy content.
Hemicellulose is similar to cellulose which is a sugar polymer. Cellulose can be hydrolyzed into glucose by using an acid or enzyme. Furthermore the resulting glucose can be fermented into ethanol.

B. Bioetanol

Bioethanol derived from potential carbohydrates as raw materials such as sugarcane, sap, sorgum, cassava, arrowroot, sweet potato, sago, maize, straw, corncob and wood, after fermentation process, ethanol [6].

Ethanol is an organic compound comprising carbon, hydrogen and oxygen, so it can be seen as differed hydrocarbon compounds having hydrogsil groups with the formula C_2H_5OH.
Ethanol is a liquid, colorless, specific, flammable and evaporated, can be mixed in water with any comparison.
Chemical Properties

1. Bioethanol Formation

2O6 ENZYM → 2C2H5OH + 2CO2 (1)
ose) (Ethanol) (Carbonide)

2. Ethanol

CH3¬CH2OH +3O2 → 2CO2 + 3H2O + Energy (2)

[7]

Ethanol burning is cleaner than fossil fuels which means reducing greenhouse gas emissions. This is the most significant ethanol advantage for the environment compared to fossil fuels [7].
Bioethanol production is done with the process of delignification, hydrolysis and fermentation and purification (Distillation). Preparation of raw materials is done to get glucose. Glucose is obtained through 2 stages of delignification and hydrolysis. In the process of delignification produce cellulose. Cellulose will be processed further by hydrolysis process so that it will produce glucose.

C. Delignification

Lignin contains a complex substance and is a combination of several compounds namely carbon, hydrogen and oxygen. In addition to lignin, the other part of peat is cellulose. Cellulose is a polysaccharide that contain sugar substances [8]. The process of separation and removal of lignin from cellulose fibers called delignification or pulping.

D. Hydrolysis

Hydrolysis lignin include solving process, removing lignin and hemicellulose, damaging the crystal structure of cellulose and improve porositasi materials [9]. The breakdown of cellulose crystals will facilitate the breakdown of cellulose into glucose. In addition, co-decomposed hemicellulose into simple sugars: glucose, galactose, mannose, hexose, pentose, xylose, and arabinosa. After that, sugar compounds will be fermented by microganism produce ethanol [10].

E. Acid Hydrolysis

Braconnot in 1819 first discovered that cellulose could be converted into fermentable sugars using concentrated acids (Sherrad and Kressman 1945 in [11]. Hydrolysis of a concentrated acid produces high sugar (90% of theoretical results) compared with dilute acid hydrolysis, and thus will result in higher ethanol [12]. Enriched cellulose hydrolysis member Yeild ethanol is slightly higher than the acid hydrolysis method [13]. But the enzymatic process is the most expensive process. The Recycle & Recovery process of cellulosic enzymes is required to suppress the high cost of production [14]; [15].

The main advantage of hydrolysis with dilute acid is the absence of acid recovery, and the absence of acid loss in the process [14]. Generally the acids used are H_2SO_4 ± or HCl [16], at a 2-5% concentration range [14,9], and reaction temperatures ± 160 °C. Breaking of sugar molecules, complex carbohydrates and celluloses into monosaccharide molecules is easy to do with laboratories by boiling arbohydrate solutions or suspensions with a dilute acid solution.:

$(C_6H_{10}¬O_5)n$ + nH_2O → $nC_6H_{12}O_6$ (3)
Cellulose Water Glucose

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F. Fermentation

Fermentation is an activity of decomposition of carbohydrate substances that do not produce odor and produce carbon dioxide gas. The alcohol-forming fermentation of the sugar is carried out by microbes. The microbes that can be used are Saccharomyces cereviseae. The changes occurring are usually expressed in a given equation :

$C_6H_{12}O_6$+*Saccharomyces cereviseae* → 2 C_2H_5OH +2CO_2 (4)

For that purpose that needs to be considered is a dissolved acid substance. Therefore, the bottle making starter is covered with cotton or filter paper, shaken to give isasi. Ariasi is important because the starter making is not desirable fermented alcohol.

$$C_6H_{12}O_6 + 6O \rightarrow 6CO_2 + 6H_2O + \quad (5)$$

G. Purification (Distillation)

To separate the alcohol from the fermentation can be done by distillation. The distillation can be carried out at 80 °C, because the boiling point of alcohol is 78 °C while the boiling point of water is 100 °C. The distillation is to separate the volatile components in a liquid mixture by evaporating them (heat separating agent), followed by condensation of the vapour formed and accommodating the resulting condensate. The vapour released from the mixture is called as free vapour, the condensate that falls as a distillate and as a non-volatile mixture is called a residue (McCabe, 1993)[17].

I. Previous Research

Making bioethanol from peat soil by fermentation hydrolysis process, by Wahyuni Fitri Anggraeni, Miftakhul Jannah, and Noni Indrianti, 2009, University of Muhammadiyah Purwokerto. The method used by fermentation hydrolysis on peat soil, hydrolysis using 10% sulfuric acid (H_2SO_4) and fermentation using Saccharomyces cereviciae yeast. The making of bio-ethanol from fermented peat using tapai (made from fermented cassava) yeast by Heppy Rikana and Risky Adam, UNDIP Semarang. This research was conducted to get the bio-ethanol from cassava fermentation using yeast tape.

II. RESEARCH DESIGN

A. Lignification Process

a. Removal of peat soil

Peat soil is taken from peatland, and weighs 100 grams, then dried in an oven with a temperature of 70 °C for 20 minutes and then smoothed to 3 mm or 3-6 mesh.

b. Addition of NaOH In Peatlands

A total of 100 grams of dry peat soil was treated using 200 ml of 0.1 M NaOH solution for 30 min at 120 °C then filtered. In the above process can be produced wet peat soil with pH 9.

B. Purification of Peatland Deposits Using Aquadest

In this process the treated peat soil pulp using 200ml of 1 M NaOH solution and obtained wet soil moisture with pH 9 will be washed with aquadest 5 times until the concentration in peat to neutral soil (pH 6,5-7.5).d. Hydrolysis of H_2SO_4 Acid at this stage the peat soil peat that has been washed with aquadest to neutral levels, then peat soil is hydrolyzed with 200 ml of H_2SO_4 solution with concentration 1 M for 1 hour with temperature 120 °C then filtered. In this process it will get acid peat soil with pH 2.

a. Purification of Peatland Deposits Using Aquadest

In this process peat soil peat that has been hydrolyzed with H_2SO_4 acid is washed with aquadest 6 times to get peat soil dregs with acid content of cellulose with pH 5.

b. Bioethanol Preparation Procedure

The process of making bio-ethanol is done by fermentation process. At this stage peat soil dregs will be fermented with yeast bread as much as 10 grams at a temperature of 20-40 °C and accompanied by urea as much as 10 grams as nutrients. In this process the fermented peat soil pulp will be left for 2, 4, 6, 8, and 10 days. After the fermentation stage is done purification step (distillation). At this stage the fermented peat soil dregs will be distilled with a temperature of 80 °C. In this process the solution results from fermentation of peat soil as much as 4-6 ml.

c. Process Analysis

At this stage the solution of fermentation pulp of peat soil will be analyzed by using Gas Cromatography tool to know the content of bioethanol contained in the solution.

II. METHODS

A. Materials Research

The peat soil used is derived from the peat soil in Jakabaring area and Indralaya. It is dried in an oven with a temperature of 70 C for 20 minutes, then poured to 3-6 mess. After drying the peat soil then washed with aquadest to neutralize the pH using NaOH / H2SO4 solution. The peat soil is then fermented by examining the effect of yeast weight and fermentation time.

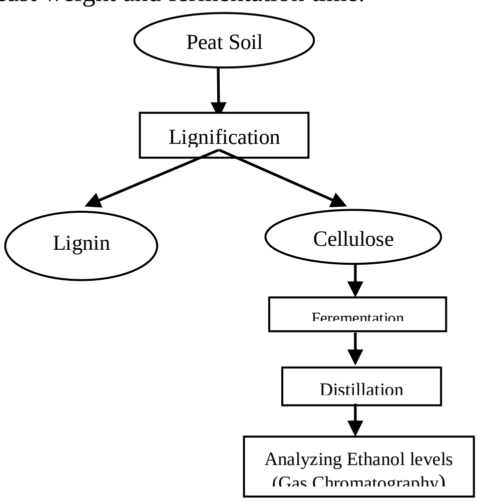

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Fig.2: Bioethanol Production Flow Diagram

B. Research Methodology

Effect of fermentation time and yeast weight. The process of making bioethanol by fermentation process. In this case, mix the fermentation with fermented bread with variations of 9, 10, 11 and 12 gram at temperature of 20 - 40o C and with urea as much as 10 gram of nutrients. In this process, the fermented peat is 2, 4, 6, 8, and 10 days. After the phases are treated for purification stages (Distillation). This is the temperature of the dehydrated peat in distillation at 80° C. In this process there will be 4-6 ml of fermented peat soil solution.

III.RESULTS AND DISCUSSION

A. Preparation Stage

Peat soils obtained from several locations in the Jakabaring Palembang area were processed, namely enumeration, drying, and grinding into flour.

B. Stage Analysis and treatment Raw material for peat soil: grams NaOH: gram

a. Drying and Smoothing

Peat soil is taken from peatlands, and weighing 100 grams, then dried in an oven with a temperature of 70 ° C for 20 minutes and then smoothed to 3 mm or 3-6 mesh.

C. Addition of NaOH In Peatlands

A total of 100 grams of dry peat soil were treated using 200 ml of 0.1 M NaOH solution for 30 min at 120 ° C and then filtered. In the above process can be produced wet peat soil with pH 9.

a. Purification of Peatland

Deposits Using Aquadest. In this process the treated peat soil pulp using 200 ml of 1M NaOH solution and obtained wet peat soil with pH 9 will be washed with aquadests up to 5 times to a concentration in peat soil to neutral (pH 6.5 - 7, 5).

b. Hydrolysis of H_2SO_4 Acid

At this stage the peat of washed peat soil with aquadest to neutral level, then peat soil is hydrolyzed with 200 ml of H_2SO_4 solution with concentration 0,1 M for 1 hour with temperature 120 °C then filtered. In this process it will get acid peat soil with pH 2.

c. Purification of Peatland Deposits Using Aquadest

In this process the peat soil that has been hydrolyzed with H_2SO_4 acid will be washed with aquadest 6 times to obtain peat soil dregs with acid content of cellulose with pH 5.

b. Effect Of Fermentation Time On Yield Percentage By Yeast Weight Variation

The effect of fermentation time, distillation time and yeast weight to yield percentage generatedin the bioethanol process from peat soil can be examined in Figure 3 to Figure 6.

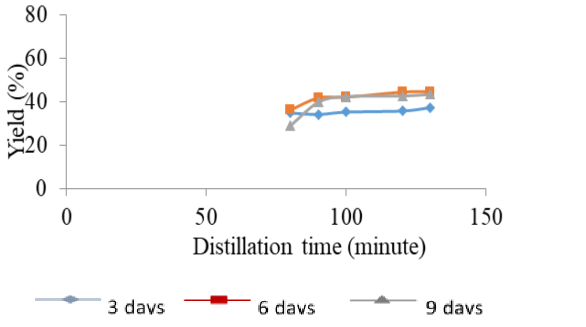

Fig. 4: Fermentation time versus yield (%) for 10 grams yeast

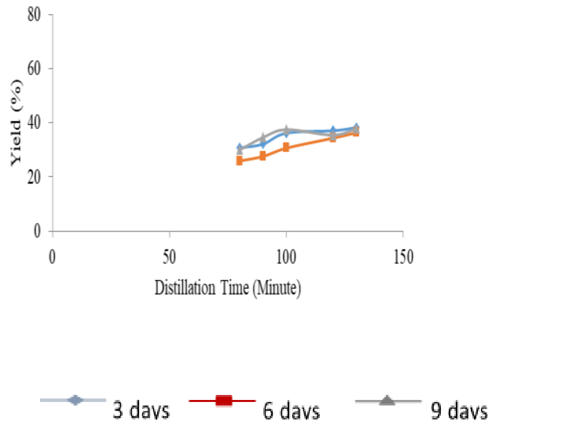

Fig.5: Fermentation time versus yield (%) for 11 grams yeast

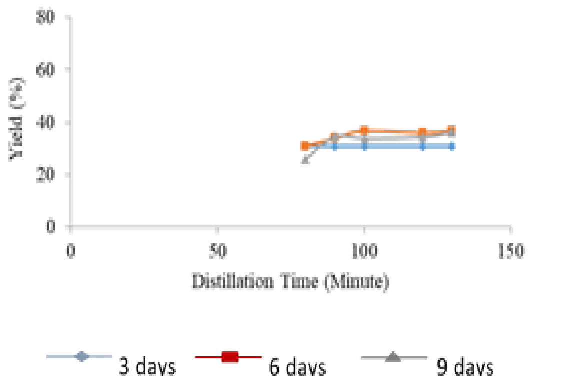

Fig. 6: Fermentation time versus yield (%) for 12 grams yeast

D. Effect Of Fermentation Time On Produced Bioethanol Density

Effect of ferementation time, distillation time and yeast weight compared to produced bioethanol of peat soil density can be seen from Figure 7 to 10. Density analysis on distillation volume produced is very important to know the quality of bioethanol.

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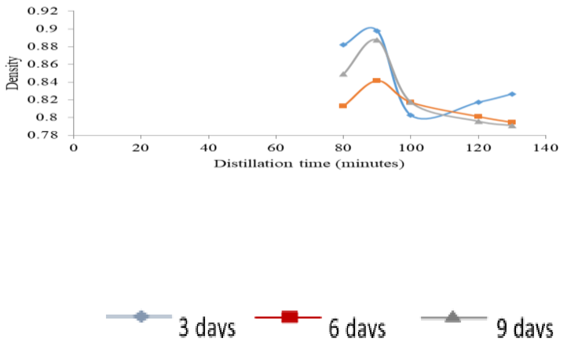

Fig.7: Fermentation time vs density of 9 gram yeast weight

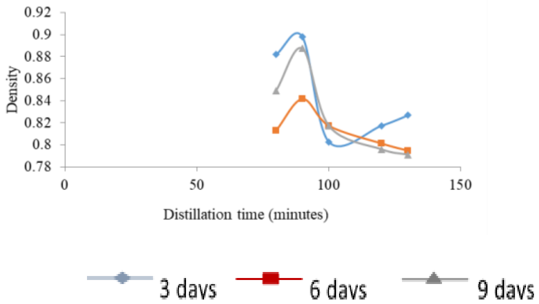

Fig.8: Fermentation time vs density of 10 gram yeast weight

From Figure 7 to 10 it can be seen that the density close to bioethanol density is 0.7893 gr/ml is found on 9 gram of yeast weight, 3 days of fermentation time and 120 minutes of distillation time which is 0.7901. For 10 gram of yeast weight, 6 days of fermentation time and 130 minutes is 0.7911 and 12 gram of yeast weight, 9 days of fermentation time and 130 minutes is 0.7842.

The best result for density is at 9 days of experiment, 130 minutes of distillation time and 12 gram of yeast weight we found bioethanol density that is close enough to bio-ethanol density which are 0.7803 gr/ml and 0.7842 gr/ml.

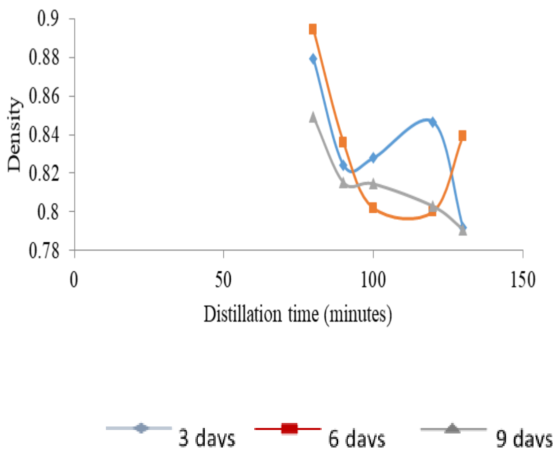

Fig.9: Fermentation time vs density of 11 gram yeast weight

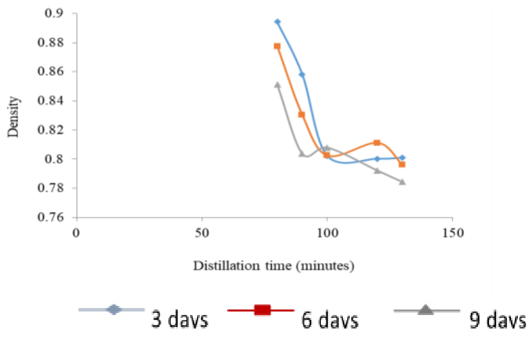

Fig.10: Fermentation time vs density of 12 gram yeast weight Graph

IV.CONCLUSION

1. Research has been done by doing variation on yeast weight, fermentation time and distillation time to produce bio-ethanol.
2. Bio-ethanol is made by lignification reaction with the addition of NaOH, hydrolysis reaction with the addition of strong acid, and fermentation process to produce the optimum model for the next experiment.
3. On bioethanol production from peat soil has been obtained the volume of bioethanol and density approaching bioethanol density is 12 g yeast weight and fermentation length for 9 days, yielding specific gravity 0.7842 grm / ml.

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