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# The Test of Alcohol Distallation Equipment from A Mix of Palm Sap with Coconut Shell Charcoal and Lime

**Giarman**

Department of Mechanical Engineering, University of North Sumatra, Indonesia

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**ABSTRACT**

Palm sap is a sweet liquid obtained from the sugar palm plant (Arenga pinnata MEER) by cutting the flower stalk. Generally, palm sap is widely used for the manufacture of brown sugar, fresh drink of palm sap (saguer), vinegar and alcoholic beverages. The testing procedure carried out is as follows: Beginning of the test 1. Recording the air temperature 2. Recording the temperature of the water and palm sap 3. Heating is done using a kerosene stove with an estimated temperature of up to 100 C boiling. A total of 5 liters of palm sap raw material is put into the heating tank which is flowed through the top hole by opening the cover, accompanied by filling water in the heating tank. On checking the level of purity with the influence of coconut shell charcoal powder as an absorbent on palm sap alcohol, it was seen that there was an effect in increasing alcohol content. However, it cannot be completely absorbed considering that the coconut shell charcoal used is not active coconut shell charcoal. To produce a good level of alcohol purity (80%) a good mixture ratio is 150 grams: 50 grams of coconut shell charcoal and lime. The efficiency of distalization is 83%. 50 grams of coconut shell charcoal and lime. The efficiency of distalization is 83%. 50 grams of coconut shell charcoal and lime. The efficiency of distalization is 83%.



***Corresponding Author:***

Giarman
Department of Mechanical Engineering
University of North Sumatra
Jln. Dr. T. Mansur No.9, Medan City, North Sumatra, 20222, Indonesia
Email: giarman@gmail.com

## 1. INTRODUCTION

Palm sap is a sweet liquid obtained from the sugar palm plant (Arenga pinnata MEER) by cutting the flower stalk (Suhartono, 2009). Generally, palm sap is widely used for the manufacture of brown sugar, fresh drink of palm sap (saguer), vinegar and alcoholic beverages (Lempang, 2012). There are 3 million palm trees that are spread throughout North Sumatra (Sebayang, 2016). According to 1994/1995 data from the Regional Office of the Ministry of Industry and Trade of North Sumatra, there were 854 business units in the alcoholic beverage industry with a concentration of 20-40%, known as stamp rat whose raw material is palm sap (Hazwi, 2009). From this amount, about 4 million liters of alcohol are obtained per year which are only used for alcoholic beverages (Pribadi, 2017).

As for the business of making alcohol with high purity, no effort has been made, even though the need for high alcohol content is for the pharmaceutical industry (Armando, 2009), cosmetics, and chemicals are quite large and tend to increase. Alcohol, another name is ethanol (C2H5OH) which is a very important raw material for the pharmaceutical industry as a mixture of drugs

(Juwita, 2012), for cosmetics as an antiseptic, as a chemical solvent in the laboratory and industry (Siregar et al., 2012), in the hospital as a disinfectant and burning spirit for household use (Hanum et al., 2013). Separation of alcohol from fermented palm sap is generally carried out by traditional distillation (Gugule et al., 2019), but the main problem in this distillation is that it is not effective in separating compounds having a boiling point difference below 80°C. Besides that (Kristanti, 2019), the way that is done many times so that the results become very pure takes a lot of time and is not economical (Piryadi, 2013).

The main problem faced by small entrepreneurs is the system of distillation (distillation) of palm sap into alcoholic beverages which is still very simple (Rumagit & Tulung, 2017), namely by using distillation tools which are generally made of bamboo which is 25 meters long and the cooking place is made of used drums (Mangun & Waluyo, 2008). Through the touch and refinement of processing distillation technology, the quality of alcohol can be increased to industrial alcohol with purity so that the product can be marketed at a higher price than the alcohol produced by traditional distilleries (Teti Indrawati, N.D.)

The apparatus for fractionating distillation is very different from traditional distillation. Fractional distillation has a column of fractions e is inserted from the side of the tube of the fractionating column vertically. In fermented palm sap, there are various components, but there are two major components that must be separated, namely water and alcohol fusel oil as the cause of odor and taste. The two components have different boiling points at atmospheric pressure, namely 100°C for water and 87°C for alcohol. Fusel oils contain high alcohols such as pentanol in addition to ketones, aldehydes, esters and water. In general, fractionation distillation is used to separate a mixture of 2 kinds of volatile liquids, for example a mixture of 2 liquids A and B, where B is more volatile than A (boiling point B). basic ingredients of palm sap that have been fermented by microorganisms.

The purposes of testing the alcohol fractionation distillation apparatus from palm sugar are: (1) To know the role of coconut shell charcoal and lime as absorbent materials in increasing alcohol content. (2) Knowing the performance of the fractionation distillation equipment made. (3) Knowing the extent to which the absorption of coconut shell charcoal powder against the odor contained in palm sap - traditional alcohol. The benefits of testing the alcohol fractionation distillation apparatus from palm sap are: (1) it can add insight into the process of making alcohol fractionation from palm sap and apply the knowledge gained during lectures which is used to design the alcohol fractionation distillation apparatus from palm sap. (2) To support the development of appropriate technology for small and medium industries. (3) For students who want and are interested, they can develop this alcohol fractionation tool from palm sap. (4) For small and medium industries that need this tool.

## 2. RESEARCH METHOD

### 2.1 Tool

The tools used are: (1) 100 C thermometer. (2) 1000 cc measuring cup (3) Thermocouple LM-8000 (4) Stopwatch (5) Stove (6) Palm juice distiller:

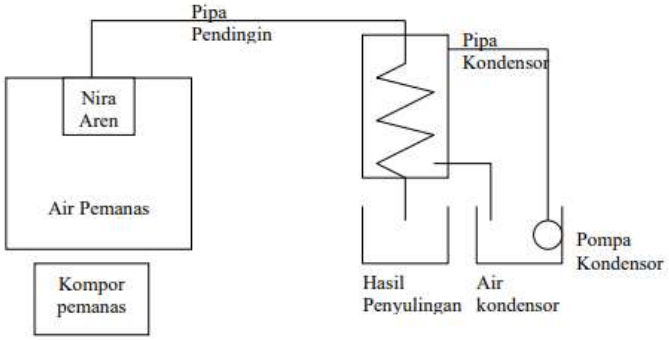


**Figure 1.** Sugar Palm Distiller

### 2.2 Ingredient

The materials used are: (1) palm juice (2) water (cooling water and heating water) (3) kerosene fuel. (4) Coconut shell charcoal and lime(Delly et al., 2016).

**Figure 2.**Nira Aren

### 2.3 Test Procedure

The testing procedures carried out are as follows: Initial testing: (1) Recording the air temperature (2) Recording the temperature of water and palm sap (3) Heating is carried out using a kerosene stove with an estimated temperature of 100 C boiling (Bahtiar, 2014) A total of 5 liters of raw material for palm sap is put into the heating tank which is flowed through the top hole by opening the cover, accompanied by filling water in the heating tank (Pengolahan, n.d.). This water bath can function as a heat regulator, equipped with a thermometer above the water surface so that the temperature of the distillate coming out of the condenser can be known. Then the kerosene stove fire is turned on to heat the water. This hot water will heat the heating tank containing the raw materials, so that the temperature of the alcohol in the heating tank does not exceed the boiling point of the alcohol (Ernita & Zola, 2016)Repeat the experiment by adding coconut shell charcoal and lime in a ratio of 3:1 (90 and 30 grams, 150 and 30 grams). The process of palm sap alcohol fractionation distillation can be seen in the following picture: (Swadaya & Trubus, 2018).

## 3 RESULTS AND DISCUSSIONS

### 3.1 Test Results Data on the Process of Palm Oil Refining

The test results data on the palm sap distillation process by not using a mixture of coconut shell charcoal and lime can be seen in table 4.1 below: Without a mixture. TLEnvironment 29 C. Kerosene Fuel 2 Liters. Nira Palm 5 Liter Tawal = 30ºC. 15 Liter Tawal Heating Water = 29ºC.

**Table 1.**Test Result Data Without Using Mixture After Heating

| No. | Waktu (menit) | $T_{air}$ (°C) | $T_{nira}$ (°C) | $T_{air\ pendingin}$(°C) |
|---|---|---|---|---|
| 1 | 15 | 47 | 39,1 | 29 |
| 2 | 30 | 67 | 62 | 29 |
| 3 | 45 | 87 | 84,7 | 29 |
| 4 | 60 | 92 | 89,3 | 29 |
| 5 | 75 | 97 | 96,3 | 29 |
| 6 | 90 | 100 | 96,3 | 29 |
| 7 | 105 | 100 | 96,3 | 29 |

At the time of 65 minutes the evaporation of palm sap occurs marked by an increase in the temperature of the condenser pipe, which is 40 C. The resulting alcohol = 250 mL. Remaining heating water = 13.7 liters. Remaining palm juice = 2.6 liters. Remaining Fuel = 1.5 Liters. The test results data on the process of distilling palm sap using a mixture of coconut shell charcoal and lime (90: 30 grams) can be seen in the table below: With a mixture. Environment 29 C Coconut shell charcoal = 90 gr. Fuel Kerosene 2 Liter Lime = 30 gr. Nira Palm 5 Liter Tawal = 30ºC. 15 Liter Tawal Heating Water = 29ºC.

**Table 2.**Test Result Data Using a Mixture (90: 30 Grams) After Heating

| No. | Waktu (menit) | $T_{air}$ (°C) | $T_{nira}$ (°C) | $T_{air\ pendingin}$(°C) |
|---|---|---|---|---|
| 1 | 15 | 45 | 37,1 | 29 |
| 2 | 30 | 67 | 62 | 29 |
| 3 | 45 | 87 | 84,7 | 29 |
| 4 | 60 | 92 | 89,3 | 29 |
| 5 | 75 | 96 | 92,3 | 29 |
| 6 | 90 | 100 | 96,3 | 29 |
| 7 | 105 | 100 | 96,3 | 29 |

At the 68th minute, the evaporation of palm sap occurs marked by an increase in the temperature of the condenser pipe, which is 40 C. The resulting alcohol = 100 mL. Remaining heating water = 13.7 liters. Remaining palm juice = 2.6 liters. Remaining fuel = 1.5 liters. Test results data on the process of distilling palm sap using a mixture of coconut shell charcoal and lime (50: 50 grams) can be seen in the table below: With a mixture. Environment 29 C Coconut shell charcoal = 50 gr. Fuel Kerosene 2 Liter Lime = 50 gr. Nira Palm 5 Liter Tawal = 30ºC. 15 Liter Tawal Heating Water = 29ºC.

**Table 3.** Test Result Data Using a Mix (50: 50 Gram) After Heating

| No. | Waktu (menit) | $T_{air}$ (°C) | $T_{nira}$ (°C) | $T_{air\ pendingin}$ (°C) |
|---|---|---|---|---|
| 1 | 15 | 40 | 42,5 | 29 |
| 2 | 30 | 62 | 60 | 29 |
| 3 | 45 | 87 | 85,2 | 29 |
| 4 | 60 | 92 | 90 | 29 |
| 5 | 75 | 97 | 92 | 29 |
| 6 | 90 | 100 | 96,5 | 29 |
| 7 | 105 | 100 | 96,5 | 29 |

At the time of 65 minutes the evaporation of palm sap occurs marked by an increase in the temperature of the condenser pipe, which is 40 C. Alcohol produced = 80 mL. Remaining heating water = 13 Liters. Remaining palm juice = 2.4 liters. Remaining fuel = 1.5 liters. The test results data on the palm sap distillation process using a mixture of coconut shell charcoal and lime (150: 50 grams) can be seen in the table below: With a mixture. Environment 29 C Coconut shell charcoal = 150 gr. Fuel Kerosene 2 Liter Lime = 50 gr. Nira Aren 5 Liters of Tawal = 30ºC. Heating Water 15 Liters of Tawal = 29ºC.

At the time of 68 minutes the evaporation of palm sap occurs marked by an increase in the temperature of the condenser pipe, which is 40 C. Alcohol produced = 80 mL. Remaining heating water = 13 litersRemaining palm juice = 2.4 liters. Remaining fuel = 1.5 liters. The raw material used in this activity is palm sap. The time needed to boil 5 liters of raw materials until the first drop using a kerosene stove heater is:

$$t_{rata-rata} = \frac{65 + 68 + 65 + 68}{4} = 66{,}5 \text{ menit}$$

The average time is 68 minutes.

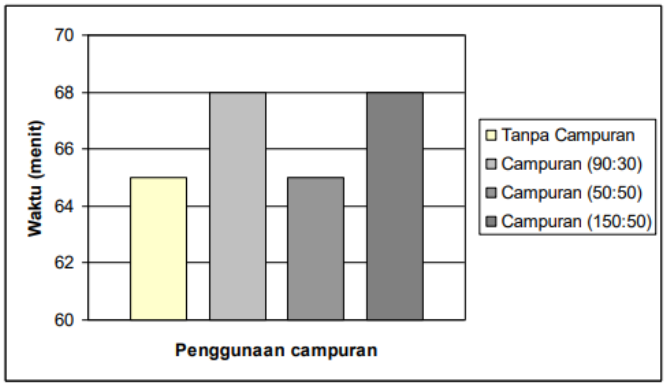


**Figure 3.** Graph of Time Relationship Used for Boiling Nira Aren

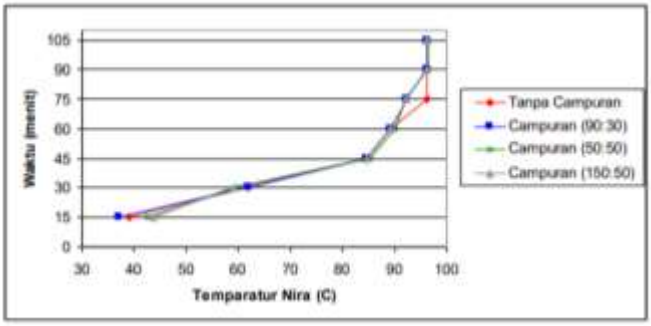


**Figure 4.** Graph of Increase in Nira Temperature Every Minute

After reaching the boiling point, the alcohol will become a vapor (gas) through a spiral cooling pipe. alcohol vapor is cooled by circulating water with water in and water out. With cooling there will be condensation. so that the steam turns back into a liquid and is accommodated in a distillate container. After the condensation speed begins to decrease, the liquid present in the heating tank is removed

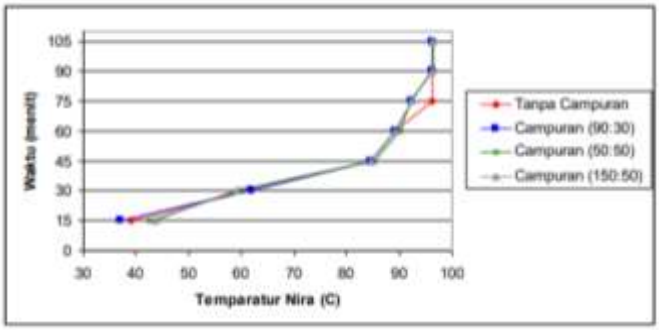


**Figure 5**. Graph of Increase in Nira Temperature Every Minute

From Figure 4.2 above, it can be seen that the palm sap with a mixture of 150: 50 grams has a temperature of 43.7 oC higher than the other mixtures, this is due to the more mixture of coconut shell charcoal and lime so that the specific heat is higher, but at the boiling temperature of the alcohol (87ºC), the sap temperature is the same as the temperature in the other mixtures, this is because the mixture of coconut shell charcoal and lime has evaporated with the alcohol. As for the performance of the fractionated distillation apparatus made, it shows that the average condensation speed from the four experiments until the distillate dripping stops with temperatures reaching 89.3-94.3ºC is 66.5 minutes with the average yield as follows:

**Table 4.** Alcohol yield

| Pengggunaan campuran | Volume Nira aren (L) | Suhu Nira Aren (ºC) | Volume distilat (L) | Rendemen (%) |
|---|---|---|---|---|
| Tanpa | 5 | 89,3-96,3 | 0,25 | 5 |
| 90:30 gram | 5 | 89,3-92,3 | 0,10 | 2 |
| 90:30 gram | 5 | 89,3-923 | 0,08 | 1,6 |
| 150:50 gram | 5 | 89,3-923 | 0,08 | 1,6 |

$$\text{Rendemen rata-rarta} = \frac{5+2+1{,}6+1{,}6}{4} = 2{,}55\%$$

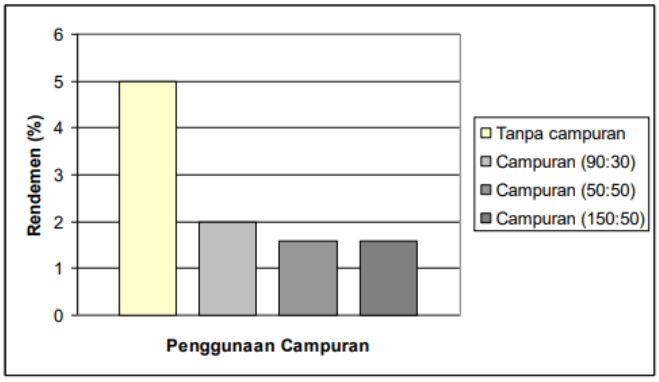


**Figure 6.** Nira Aren Distillery Yield Chart

The distillate was analyzed for its purity level using an alcoholmeter. The result shows that the highest alcohol content from fractionated distillation is 80% and the lowest is 62%. The results obtained indicate that the alcohol from fractionated distillation still contains water and organic compounds carried during the condensation process. This is due to an increase in temperature that exceeds the boiling point of alcohol during the distillation process, so that water molecules and organic compounds evaporate along with the alcohol.

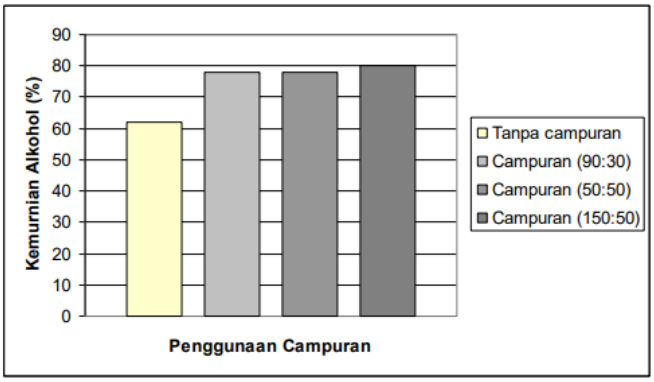


**Figure 7.**Sugar Palm Distillation Alcohol Purity Chart

### 3.2 Discussion Of Test Results On The Process Of Distilling Palm Sap

On examination of the level of purity with the influence of coconut shell charcoal powder as an absorbent on palm sap alcohol, it was seen that there was an effect in increasing alcohol levels. However, it cannot be completely absorbed considering that the coconut shell charcoal used is not active coconut shell charcoal. To find out to what extent the absorption of coconut shell charcoal powder to the smell of palm sap - alcohol needs further examination. The effect of coconut shell charcoal on increasing the purity of alcohol depends on several factors, including: the amount of charcoal used, the fineness and fineness of coconut shell charcoal and the length of time the coconut shell charcoal is in contact with sugar palm-alcoholic juice. Giving lime can also increase the alcohol content, because lime can bind water and form a calcium hydroxide base. Thus, the addition of coconut shell charcoal can increase the level of alcohol purity. The quality of alcohol after adding coconut shell charcoal can produce a level of purity with an alcohol content ranging from up to 80%. This figure is sufficient to meet the requirements for disinfectant alcohol because it is greater than 62%. The alcohol content before the addition of coconut-lime shell charcoal could not reach 62%. This means that impurities in the form of fusel oil as a by-product in palm sap alcohol can be absorbed by a mixture of coconut shell charcoal and lime.

### 3.3 Distalization Efficiency

From the previous test data it can be taken the average price for. Remaining heating water = 13.4 liters = 13.4 kg. The rest of the palm juice = 2.5 liters = 2.5 kg. Remaining fuel = 1.5 liters = 1.23 kg. Then we get: Mass of water used = 15 liters – 13.4 liters = 1.6 liters = 1.6 kg. The mass of used palm sap = 5 liters – 2.5 liters = 2.5 liters = 2.5 kg. Mass of fuel used = 2 Liters –1.5 Liter = 0.5 liter = 0.41 kg.

$$\eta = \frac{(15 \times 4{,}186 \times (96{,}3 - 30) + 2260\,(1{,}6)) + (5 \times 2{,}437 \times (89{,}3 - 30) + 2260(2{,}5)}{0{,}41 \times 41346{,}15} = 0{,}83$$

So the distalization efficiency is 0.83 (83%)

## 4. CONCLUSION

The conclusions in this study are:(1) Distillation distillation using a water bath can be applied to the process of distilling palm sap alcohol in rural areas. (2) The average yield and distillation results obtained are 2.55%, with an alcohol purity level between 62 - 80%. (3) All the results of the distillation process with the addition of coconut-lime shell charcoal exceed the disinfectant alcohol content (62%) which has a higher economy. (4) The yield and level of alcohol purity in each experiment are: a. In experiments without using a mixture can produce 5% alcohol with an alcohol purity level of 62%. b. In experiments with a comparison (90 grams: 30 grams) can produce 2% alcohol with alcohol purity level of 78%. c. In experiments with a ratio (50 grams: 50 grams) can produce 1, 6% alcohol with an alcohol purity level of 78%. d. In experiments with a comparison (150 grams: 50 grams) can produce 1.6% alcohol with an alcohol purity level of 80%. (5) To produce a good level of alcohol purity (80%) a good mixture ratio is 150 grams: 50 grams of coconut shell charcoal and lime. (6) The efficiency of distalization is 83%.

Suggestions in this study are: (1) To find out a more accurate alcohol yield, an experiment should be carried out for 25 liters of sap. (2) Tests can be carried out with other mixed materials, not only by using coconut shell charcoal and lime, such as laru wood. (3) We recommend that in testing we must use the original palm sap material and ferment it for 4-5 days.

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