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Production Process About Alcohol Distillation from Sugar Palm as A Model

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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 potential for palm trees, which are 3 million trees spread throughout North Sumatra. The model planned for the manufacture of this distillation is water distillation, where the collected palm juice is placed in a container that is in direct contact with heating water and then the juice vapor is passed through a pipe connected to it. then condensed through a condenser and the results are accommodated through an alcohol container. A total of 5 liters of palm sap raw material has been mixed with coconut shell charcoal and lime in a ratio of 3: 1 (a good ratio is recommended 150 and 50 grams) is inserted into the heating tank which flows through the top hole by opening the cover, accompanied by filling the water in the heating tank. 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. (7) The result of the distillation process of palm sap with the addition of coconut-lime shell charcoal exceeds the alcohol content of the disinfectant (62%) which has a higher economy. (10) The efficiency of distalization is 82%. equipped with a thermometer above the water surface so that the temperature of the distillate coming out of the condenser can be known. (7) The result of the distillation process of palm sap with the addition of coconut-lime shell charcoal exceeds the alcohol content of the disinfectant (62%) which has a higher economy. (10) The efficiency of distalization is 82%. equipped with a thermometer above the water surface so that the temperature of the distillate coming out of the condenser can be known. (7) The result of the distillation process of palm sap with the addition of coconut-lime shell charcoal exceeds the alcohol content of the disinfectant (62%) which has a higher economy. (10) The efficiency of distalization is 82%.

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1. INTRODUCTION

Palm sap is a sweet liquid obtained from the sugar palm plant (Arenga pinnata MEER) by cutting the flower stalk (Hazwi, 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 data from 1994/1995 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 grade of 20-40%, known as rat stamp, whose raw material is palm sap. From this amount, about 4 million liters of alcohol are obtained per year which are only used for alcoholic beverages (Rumagit & Tulung, 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, in hospitals as a disinfectant and burning spirit for household purposes (Budiaman et al., 2017). The separation of alcohol from fermented palm sap is generally carried out by traditional distillation, but the main problem in this distillation is that it is not effective in separating compounds with different boiling points below 80°C. In addition, the method that is done many times to get the results to be very pure is time consuming and not economical (Piryadi, 2013).

The main problem faced by small entrepreneurs is the distillation system (distillation) of palm sap into alcoholic beverages, which is still very simple (Rumagit & Tulung, 2017), namely by using distillation equipment which is generally made of bamboo which is 25 meters long and the cooking place is made of used drums (Mangun & Waluyo, 2008). Through touch and refinery processing technology refinement (Smith et al., 2020), then the quality of alcohol can be increased to high purity industrial alcohol so that the product can be marketed at a higher price than the alcohol produced by traditional distillations (Sulistijowati, 2018). The apparatus for fractional distillation is very different from traditional distillation (Mulyono et al., 2016). Fractionated distilleries have fraction columns inserted between heating tanks via distillation necks or connected via pipes (Fatimah & Rubiyanto, 2005), wherein the pipe is inserted from the side of the fractionating column tube vertically. In the fermented palm sap, there are various components (Mahfud & Sabara, 2018), but there are two major components that must be separated, namely water and alcohol in addition to fusel oil as the cause of smell and taste (Yunilawati & Badriyah, 2016). The two components have different boiling points at atmospheric pressure, namely 100°C for water and 87°C for alcohol (Irawan, 2010). Fusel oil contains high alcohols such as pentanol in addition to ketones, aldehydes, esters and water (Faida, 2019). In general, fractionation distillation is used to separate a mixture of 2 types of volatile liquids, for example a mixture of 2 liquids A and B, where B is more volatile than A (boiling point B) (Rahayu & Purnavita, 2008). Based on the results of the study above, industrial alcohol can be made from palm sap that has been fermented by microorganisms (Leasa & Matdoan, 2015).

The objectives of the Production Process on Alcohol Distillation from Palm Sugar as a model are: 1 Knowing the process of making alcohol distillation equipment from palm sap. 2 Knowing the process of making alcohol from palm sap. 3 Knowing the number of materials and tools needed. 4 Knowing how much it costs to make alcohol distillation from palm sap. Benefits of the Production Process of Alcohol Distillation from Nira Aren as a model. are: 1. Can add insight into the process of making alcohol from palm sap and apply the knowledge gained during lectures which is used to analyze the rate of heat transfer in Alcohol Distillation from palm sap 2. To support the development of appropriate technology for small and medium-sized 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 Model and Working Principle of the Tool

The model planned in the manufacture of this distillation is water distillation, where the accommodated palm sap is placed in a container that is in direct contact with heating water

(Mahfud & Sabara, 2018), then the sap vapor is passed through a pipe which is then condensed through a condenser and the result is accommodated through an alcohol container (Sri, 2011).

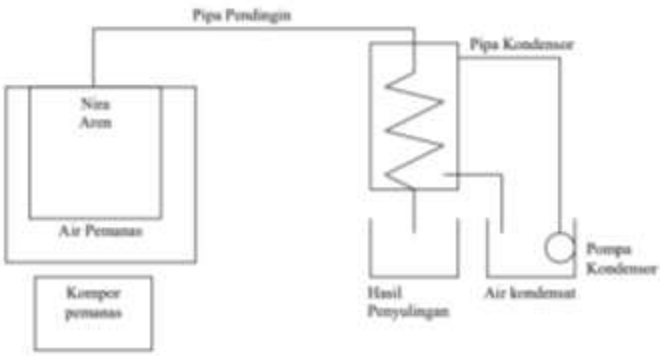


Figure 1. Heating Water System Distillation Model

The working principle of this distillation tool is that because there is a difference in boiling temperature between the two substances to be separated, namely the separation between water and alcohol, because alcohol boils at a temperature of 87ºC, the temperature of the heating water must be kept constant around the boiling temperature of the alcohol or should not exceed the boiling point of water so that the water does not evaporate, then the alcohol vapor is flowed through the condenser pipe and the results are accommodated through the alcohol container.

2.2 Tool Making Order

The sequence of making the planned tools are: 1. Manufacture of the sap place frame, condenser frame and destalation tool holder plate. 2. Making a place for sap, a water bath, a place for condensed water and condenser tube. 3. Installation of the sap place, the water bath, the condensate water container and the condenser tube that has been made on the distal plate holder. 4. Installation of a condenser pipe that has been made into a spiral shape and a series of pump cooling water piping installations. Or it can be seen in the following diagram of manufacture:

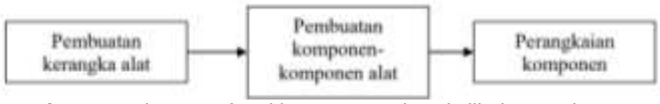


Figure 2. Diagram of Making Sugar Palm Distillation Equipment

3 RESULTS AND DISCUSSIONS

3.1 The Process of Processing Sap into Alcohol

A total of 5 liters of palm sap raw material which has been mixed with coconut shell charcoal and lime in a ratio of 3: 1 (a good ratio is recommended 150 and 50 grams) is put into a heating tank which flows through the top hole by opening the cover, accompanied by filling with water at the top. heating tank. 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. The process of distillation of palm sap alcohol can be seen in the following figure.

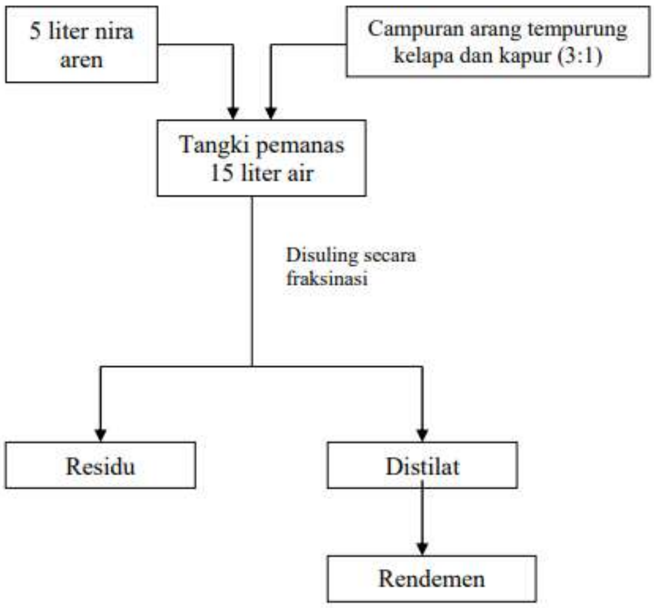


Figure 3. The Process of Distillation of Palm Sugar into Alcohol

The results of the distillation process of palm sap into alcohol using a mixture of coconut shell charcoal and lime (150: 50 grams) can be seen in the table below: Environment 29 C Coconut shell charcoal = 150 gr. Fuel Kerosene 2 Liters Lime = 50 gr Palm Oil 5 Liters Tawal = 30ºC Heating Water 15 Liters Tawal = 29ºC. At the 68th minute, the evaporation of palm juice occurs, marked by an increase in the temperature in 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 distillation process does not use a mixture of coconut shell charcoal and lime, the data can be seen in the table below. TLEnvironment 29 C. 2 Liters of Kerosene Fuel Palm Oil 5 Liters Tawal = 30ºC. 15 Liter Tawal Heating Water = 29ºC.

Table 2. Data from the distillation process without using a mixture

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 raw material used in this distillation process is palm sap. The time needed to boil 5 liters of raw materials until the first drop using a kerosene stove heater is:

$$t_{rata-rata} = \frac{68+65}{2} = 66{,}5 \text{ menit}$$

The average time is 68.5 minutes

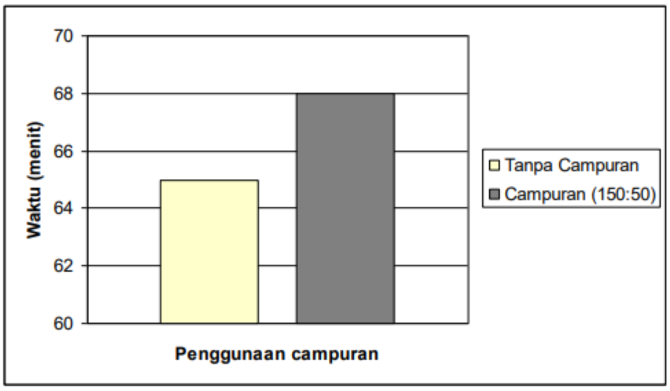


Figure 4. Graph of Time Relationship Used for Boiling Nira Aren

After reaching the boiling point, the alcohol will become a vapor (gas) through a spiral cooling pipe. The alcohol vapor is cooled by circulating water with water in and water out. With cooling, condensation will occur, so that the steam turns back into a liquid and is accommodated in a distillation container. After the speed of condensation begins to decrease, it shows that the alcohol content in the palm sap has started to run out.

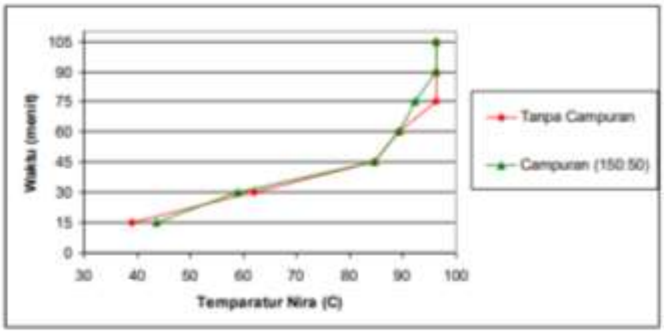


Figure 5. Graph of Increase in Nira Temperature Every Minute

From Figure 4.3 above, it can be seen that the palm sap with a mixture of 150: 50 grams has a temperature of 43.7 C higher than the distillation process without using a mixture. This is because there is more mixture of coconut shell charcoal and lime so that the specific heat is higher, but at the boiling temperature of alcohol (87ºC), the sap temperature is the same as the temperature in the distillation process without using a mixture because the mixture of coconut shell charcoal and lime has evaporated with the alcohol.

3.2 Alcohol Distillation Performance Test From Sugar Palm Nira.

The performance of alcohol distillation from palm sap can be seen on the examination of the level of purity with the effect of coconut shell charcoal powder as an absorbent on the alcohol of palm sap. 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 lime can increase the level of alcohol purity. The quality of alcohol after adding coconut-lime 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.

The performance of the palm sap distillation apparatus that was made shows that the average condensation speed of the distillation process until it stops dripping distillate with temperatures reaching 89.3-94.3ºC is 66.5 minutes with the average yield as follows:

$$\text{Campuran (150:50)} = \frac{0{,}08}{5} \times 100 = 1{,}6\%$$

$$\text{Tanpa campuran} = \frac{0{,}25}{5} \times 100 = 5\%$$

Table 3. Alcohol Purity Levels From Both Distillation Processes

Pengggunaan campuran	Volume Nira aren (L)	Rendemen (%)	Kadar Alkohol (%)
150:50 gram	5	1,6	80
Tanpa	5	5	62

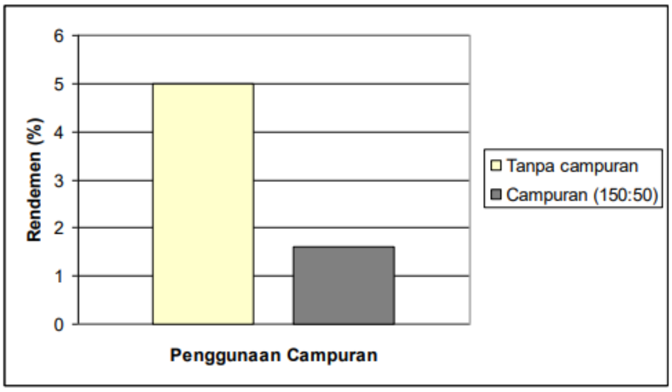
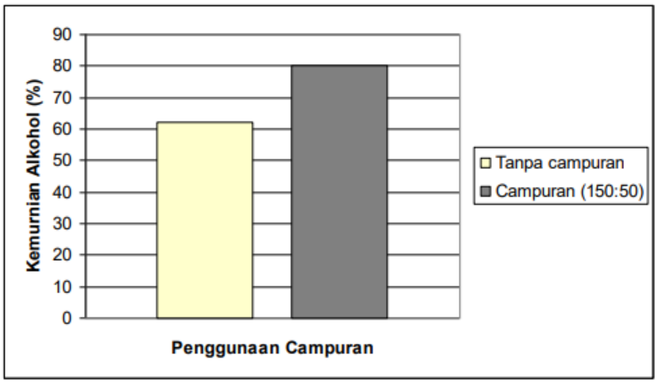


Figure 6. Graph of yield of palm juice distillation From the graph above, it shows that the highest alcohol yield from palm juice distillation is 5% and the lowest is 1.6%.



The results show that the highest alcohol content from the distillation of palm sap is 80% and the lowest is 62%.

3.3 Calculation of palm sap distillation efficiency

The comparison of the energy required to evaporate the palm juice with the energy produced by the fuel in the distillation process is called the distillation efficiency, it can be calculated by the formula below:

$$\eta = \frac{\left(m_{air}.Cp_{air}.(Ta - Tb) + H_L\,(m_{Uapair})\right) + \left(m_{nira}.Cp_{Alkohol}.(Ta - Tb) + H_L\,(M_{uapnira})\right)}{mf.LHV} \quad (1)$$

Where: Cp specific heat of alcohol at a temperature of 32 C (2,437 kJ/Kg C)o o =(Ta-Tb) = Sap temperature before and after testing (ºC) mf = Weight of kerosene fuel LHV = Lower calorific value of fuel (kJ/kg) = Distalation efficiency (%) mf = fuel mass (kg).

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.

3.4 Calculation of palm sap distillation efficiency

The comparison of the energy required to evaporate the palm sap with the energy produced by the fuel in the distillation process is called the distalization efficiency, it can be calculated by the formula below:

$$\eta = \frac{\left(m_{air}.Cp_{air}.(Ta - Tb) + H_L\,(m_{Uapair})\right) + \left(m_{nira}.Cp_{Alkohol}.(Ta - Tb) + H_L\,(M_{uapnira})\right)}{mf.LHV} \quad (2)$$

Where : Cp specific heat of alcohol at a temperature of 32 C (2.437 kJ/Kg C)o o= (Ta-Tb) = Sap temperature before and after testing (ºC) mf = Weight of kerosene fuel LHV = Lower calorific value of fuel (kJ/kg) = Distalation efficiency (%) mf = mass of fuel (kg) .

Table 4. Gross Calorific Value (GCV) For Some Fuel Oils

Bahan bakar minyak	Nilai Kalor kotor (HHV) (kJ/kg)
Minyak Tanah	46459,05
Minyak Diesel	45203,40
L.D.O	44784,85
Minyak Tungku/*Furnace*	43947,75
LSHS	44366,30

The HHV value of kerosene is 46459.05 kJ/kg. Kerosene has a carbon chain C10 to C15, based on the general formula CnH2n+2, the molecular formula for kerosene is C13H28. If it is assumed that the combustion that occurs is complete combustion, the amount of water vapor formed from the combustion of fuel can be calculated using the following equation:

$$\%\ \text{Berat H dalam bahan bakar} = \frac{y.AR.H}{MR(C_X H_Y O_Z)} \text{ x } 100\ \% \quad (3)$$

where:
x,y, and z = constant (number of atoms)
AR H = Hydrogen atomic weight
( ) MR CX HYOZ
= molecular weight
CX HYOZ
Mass of water formed = xyx (% weight H in fuel) x mass of fuel where:
x,y, and z = constant (number of atoms)
AR H = Hydrogen atomic weight
( ) MR CX HYOZ
= molecular weight
CX HYOZ
Mass of water formed = xyx (% weight H in fuel) x mass of fuel:

$$\%\ \text{Berat H dalam minyak tanah} = \frac{y.AR.H}{MR(C_{13}H_{28})} \text{ x } 100\ \%$$

$$= \frac{28.1}{(13.12)+(28.1)} \text{ x } 100\ \%$$

$$= 15{,}217\ \%$$

The amount of water vapor formed from burning 1 kg of kerosene is:

$$\tfrac{1}{2} \text{ x } 28 \text{ x } \frac{15{,}217}{100} \text{ x } 1 \text{ kg } = 2{,}13038 \text{ kg}$$

The latent heat of condensation of water vapor formed from burning 1 kg of kerosene is:
Qlc of kerosene = 2400 kJ/kg x 2.13038 kg
= 5112.9 kJ per kg of kerosene
The amount of LHV of kerosene = 46459.05 – 5112.9
= 41346.15 kJ/ kg
From the previous test data, the average price can be taken for:
Remaining heating water = 13.4 liters = 13.4 kg
Remaining palm sap = 2.5 liters = 2.5 kg
Remaining fuel = 1.5 liters = 1.23 kg

Then 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 Liters = 0.5 liters = 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

From the previous chapters, the following conclusions can be drawn: (1) Construction: a. Distillation Capacity: 5 liters, b. Heating media: Kerosene burner, c. Distillation Model: Distillation with water, equipped with a condenser, d. Skeleton Material: Iron profile plate 40, e. Base material: 12 mm plywood. (2) In the manufacture of alcohol distillation equipment from palm sap, the order of processing is: a. Frame making, b. Tool component manufacture. c. A series of components that have been made. (3) The works carried out are cutting, welding and desoldering. (4) Maintenance and checking can be carried out on the water bath, sap holder and condenser because they are the main parts. (5) To produce a good level of alcohol purity (80%) a good mixture ratio is 150: 50 grams of coconut shell charcoal and lime. (6) The average yield and distillation of palm sap obtained is 3.3%, with an alcohol purity level of 62 - 80%. (7) The result of the distillation process of palm sap with the addition of coconut-lime shell charcoal exceeds the alcohol content of the disinfectant (62%) which has a higher economy. (8) The yield and level of alcohol purity in each distillation process are: a. In experiments with a comparison (150:50gram) can produce 1.6% alcohol with an alcohol purity level of 80%. b. In experiments without using a mixture can produce 5% alcohol with an alcohol purity level of 62%. (9) To produce a good level of alcohol purity (80%) a good mixture ratio is 150: 50 grams of coconut shell charcoal and lime. (10) The efficiency of distalization is 82%. Suggestions from this research are: (1) It is better to make a semicircular model in the section where the water bath is placed.

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