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DISTILLATION OF ESSENTIAL OILS FROM PATCHOULI LEAVES USING SOLAR ENERGY (PHOTOVOLTAIC) AS A HEATING SOURCE

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ABSTRACT

Currently, the use of the sun as renewable energy is very effective. Solar Cells or commonly called Photovoltaic systems are components used to absorb heat from sunlight which is converted into electrical energy. This photovoltaic technology is very well implemented in Indonesia because of the tropical climate and long exposure to sunlight. Of the many types of essential oils, one of the most prominent in Indonesia is patchouli oil. Currently, essential oil refining still uses energy sources that can be scarce at any time and are less environmentally friendly. In this research, we tried to design a distillation device using solar cells to produce electricity which will later be used as a heating source. The highest yield obtained was 2.60% at a drying time of 32 hours and a distillation time of 420 minutes and the lowest yield obtained was 0.94% at a drying time of 0 hours and a distillation time of 300 minutes. From the results of analysis using GC-MS, it shows that the chemical compounds identified include 4,7-Methanoazulene, Seychellene, and several other compounds. Based on the GC-MS results, patchouli alcohol was 37.18% and 4,7-Methanoazulene was 2.78%. According to International Market Standards, the patcholi alcohol content must be higher than 30%, therefore this material meets the Indonesian National Standard (SNI).

Keywords : *Solar Cell, Patchouli Oil, Distillation Equipment, Indonesian National Standard*

1. INTRODUCTION

Before World War II, and even now, Indonesia ranks highest in trade for a number of essential oils. Indonesia is a producer of a number of essential oils such as lemongrass oil, clove leaf oil, ylang-ylang oil, vetiver oil, sandalwood oil, patchouli oil, and so on. Most of these essential oils are exported or sold abroad to Japan, the United States, England and Europe [1]. (Sastrohamidjojo, 2021). Of the twelve types of essential oils, there are six types of oil that are most prominent in Indonesia, namely: nutmeg oil, patchouli oil, clove oil, eucalyptus oil, citronella oil, and vetiver oil. An essential oil producer that has quite high prospects is the patchouli plant (Pogostemon cablin Benth). This can be seen from the world market demand which averages 1,200 – 1,400 tons per year [2].

Research Urgency

The oil refining process that has been carried out so far uses energy sources originating from fuel oil, gas fuel, firewood and electrical energy from PLN. This frequently used energy source is an energy source that is less environmentally friendly and its availability can be disrupted at any time due to the need for large quantities [3]. So far, the main support for energy needs still relies on petroleum. Meanwhile, it cannot be avoided that petroleum is increasingly scarce and expensive. The reserves of fossil energy sources throughout the world as of 2002 are 40 years for oil, 60 years for natural gas and 200 years for coal. With the increasing depletion of fossil energy sources, in today's world there is a shift from the use of non-renewable energy sources to renewable energy sources. The potential for renewable energy, such as: biomass, geothermal energy, solar energy, water energy, wind energy, ocean energy, hydro power, has not yet been widely exploited, even though the potential for this renewable energy is very large, especially in Indonesia. Of the many renewable energy sources as above, the use of energy through solar cells is the alternative with the most potential to be implemented in Indonesia [4]. Investment in solar energy in developing countries is essential to avoid an energy crisis arising from over-reliance on fossil fuels [5]. Currently, the use of solar energy is still rarely used for the extraction of essential oils such as from medicinal and aromatic plants. Therefore, the essential oil refining process utilizes sufficient alternative energy sources such as solar energy sources which can be available for a long period of time because the energy comes from the sun [6]. It is clear that solar-based distillation is very possible to operate with lower operating costs, thereby increasing income, especially in producing essential oils which require high operating costs. Of the various types of distillation processes used throughout the world to extract essential oils from plant materials, the commonly used processes include hydro distillation, steam distillation and water distillation, steam distillation is considered the most profitable process [7].

2. RESEARCH OBJECTIVES, BENEFITS AND LIMITATIONS

In this research, researchers want to replace the usual heat or steam energy source from gas, firewood or electricity by absorbing the sun's heat as an electricity source using solar cells which will be used in the patchouli oil refining process. This is done as a form of environmental friendliness by not causing pollution and not requiring large costs. This means that to use this energy, it is enough to initially procure the equipment, the rest is just to carry out maintenance on the equipment. The following are several things that are the objectives of this research, namely determining how to design a solar cell that is suitable for the essential oil distillation process, determining the quality of the distillation results in accordance with SNI, getting the effect of the best drying time on the yield and quality of patchouli oil in the

distillation process, getting the effect of the best distillation time on the yield and quality of patchouli oil in the refining process. Research limitations include variations in drying time and distillation time as proven by the results of the analysis tests that will be carried out.

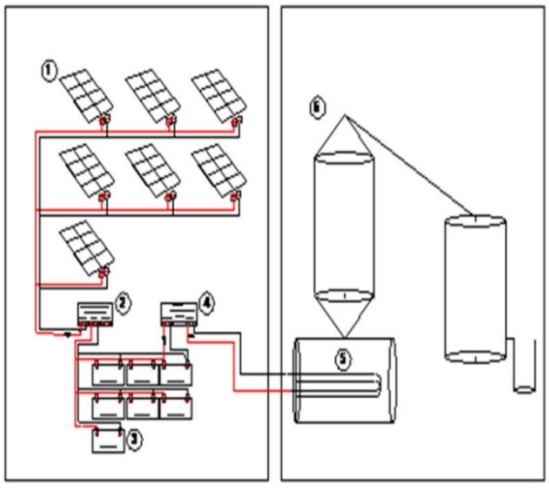
3. RESEARCH METHODS

Research methodology

Before conducting research, the preparation stage must first be carried out, namely the preparation of the tools and materials used as follows: The materials used in this research are, 100 WP Solar Panels (4 pieces), 24 V 200 Ah Battery, Solar Charge Control (SCC), DC-AC Inverter, Heater Element, Set of Distillation Tools (Distilled Kettle), 250 mL Erlenmeyer, 250 mL Measuring Cup, Scales, Separating Funnel, Scissors, Filter Paper, Electrical Cable, Socket and Screwdriver. The materials used in this research include Patchouli Leaves (Pogostemon cablin Benth), Water and Filter Paper

Solar Cell Distillation Design Plan

The 100 WP (Watt Peak) solar panels are arranged and assembled then connected to the SSC (Solar Charger Controller) to convert solar energy into electric current then connected to the battery for storing electric current if the weather conditions are no sun (cloudy) then connected to the Inverter, namely to convert DC current into AC current then the heater socket is connected to the inverter.



Preparation of Patchouli Leaves

The patchouli leaves that have been harvested are chopped (smallened) to a size of ± 3-5 cm. Ilam leaves that have been chopped (reduced) to a size of ± 3-5 cm are dried in the sun according to the specified time. Next, 10 kg is weighed and ready to be used in the distillation process.

Patchouli Oil Refining

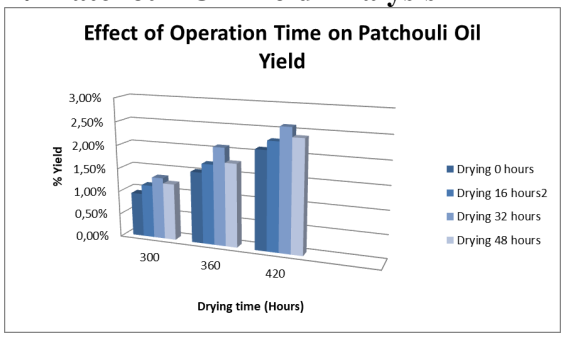
The flute kettle equipment is cleaned first. Water is put into a distilled kettle as much as 25 liters. The weighed patchouli leaves are put into a distilled kettle. Turn on the pump to circulate the cooling water, then turn on the heater until it reaches the distillation temperature (110-120 °C) and then the distillation process is stopped according to the specified time. After the distillation time is complete the process is stopped. The water and essential oil content of patchouli leaves were put into a separating funnel and then separated based on differences in specific gravity. The patchouli oil obtained was analyzed

- **Experimental Treatment**

1) Fixed variables
   - Weight of raw materials (patchouli leaves): 5 Kg
   - Distillation temperature:110-110 ºC
2) Independent variable
   - Drying time: 0.16, 32 and 48 hours
   - Distillation time: 300, 360 and 420 minutes
3) Dependent variable
   - Patchouli Oil Yield Analysis
   - Density Analysis
   - GC-MS analysis

4. RESULTS AND DISCUSSION

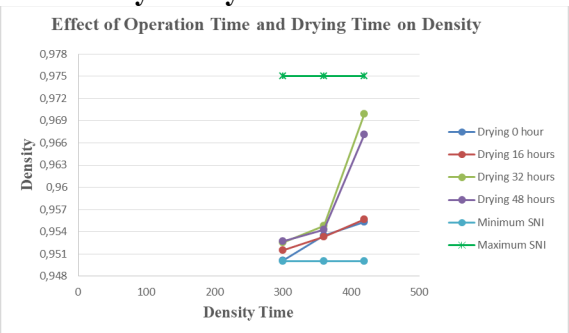
1. Patchouli Oil Yield Analysis



From this figure, it can be concluded that the amount of yield produced has fluctuated. The highest yield, around 2.60%, was obtained by distilling for 420 minutes and drying for 32 hours. This data shows that the optimal drying time for patchouli leaves is 32 hours. If drying is done for less than 18 hours, the water content in the yield will be higher than the oil. On the other hand, if drying lasts more than 32 hours, the oil in patchouli leaves will evaporate because they have been exposed to sunlight for too long. The best distillation time is 7 hours, because the longer the material receives heat, the more even the diffusion process becomes, which makes the distillation process more efficient.

The effect of drying time on yield proves that material that is starting to wilt has a greater yield than fresh material. Therefore, the conditions and treatment of these materials can increase the yield of essential oils, in accordance with the literature which explains that the withering process aims to reduce the water content in the glands of the material, so that extraction becomes easier. Chopping also helps expand the area of evaporation and contact with water, making patchouli oil easier to extract.

2. Density Analysis

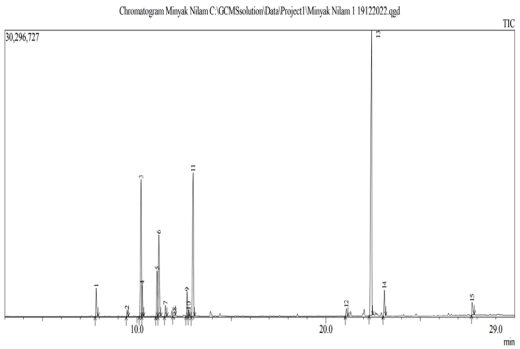


From the picture above, it can be concluded that the density of patchouli oil is in the range of values in accordance with SNI standards and this density has a significant impact on operating time and drying time. The highest density of patchouli oil was achieved in a drying time of 32 hours with an operating time of 420 minutes. Meanwhile, the lowest density occurred when the drying time was 0 hours with an operating time of 300 minutes.

Density is a parameter that measures the extent to which the molecules in patchouli oil are close to each other and is measured as a ratio between the mass and volume of the material. Typically, density is correlated with viscosity, where high-density fluids tend to have higher viscosity compared to lower-density fluids. In the case of patchouli oil, the density values range from 0.9501 to 0.9699. The effect of distillation time on the density of patchouli oil shows that all four heating times of the material have a significant effect on the density value.

3. Analisa GC-MS

Analysis using GC-MS was carried out to determine the levels of citronellal and geraniol from distillation products using sunlight using a solar cell (photovoltaic).



From the results of analysis using GC-MS, it shows that the chemical compounds identified include 4,7-Methanoazulene, Seychellene, and several other compounds. Based on the GC-MS results, patchouli alcohol was 37.18% and 4,7-Methanoazulene was 2.78%. According to International Market Standards, the patchouli alcohol content must be higher than 30%, therefore this ingredient meets the Indonesian National Standard (SNI). Apart from that, the physical and chemical properties of patchouli oil are produced from the refining process using sunlight using solar cells (photovoltaic). From these results it can be seen that the patchouli oil that has been produced during this research can be sold on the

market because it meets the Indonesian National Standards (SNI).

CONCLUSION

- The design of a steam distillation device with solar panels can be applied well. For the heating capacity of 5 kg of patchouli leaf raw material, electrical energy is required of 57,559 Kj, with 4 solar panels with a power of 100 Wp, the total energy requirement during the 6 hour distillation process is 8,664 Kj.
- In the results of patchouli oil distillation, the highest yield obtained was 2.60% at a drying time of 32 hours and a distillation time of 420 minutes and the lowest yield obtained was 0.94% at a drying time of 0 hours and a distillation time of 300 minutes.
- Drying time has an impact on the resulting yield. More precisely, the shorter the drying time, the lower the yield obtained, while the longer the drying time, the higher the yield obtained. Meanwhile, distillation time also influences the yield. More specifically, the shorter the distillation time used, the smaller the yield produced, while the longer the distillation time used, the greater the yield obtained.
- Patchouli oil obtained from the distillation process using a solar cell meets the quality requirements for patchouli oil according to SNI 06-2388-2006

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