CEJOTER: Chelo Journal of Technology Development f Engineering
Vol. 1, No. 1, Month, 2023, pp. 13 – 22
ISSN (print) XXX ; ISSN (online) XXX

DESIGN OF SOLAR ENERGY-BASED ESSENTIAL OIL DISTILLATION DEVICE USING PHOTOVOLTAIC METHOD AS A SOURCE OF ELECTRICITY FOR HEATER

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ABSTRACT

In this study, we tried to design a distillation device using a solar cell to generate electricity which would later be used as a heating source. The highest yield obtained was 21.58% by distillation for 6 hours and 4 days of drying time. The highest patchouli oil density value was obtained at 4 days of drying time with 6 hours of operating time. While the lowest density value of Patchouli oil was obtained at 2 days of drying time at 6 hours of operating time. From the results of the analysis using GC-MS showed the presence of identified chemical compounds including azulene, seychellene and several other compounds, based on the GC-MS results obtained 31.75% patcholi alcohol, and 20.50% azulene. According to International Market Standards, patchouli alcohol content should be higher than 30%, therefore this material meets the Indonesian National Standard (SNI) and besides that the physical and chemical properties of Patchouli oil are produced from the distillation process by utilizing 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 in the market because it meets the Indonesian National Standard.

Keywords: Solar Cell, Distilation, Patchouli Oil, GC-MS, Density And Yield

INTRODUCTION

Before World War II, and even today, Indonesia ranks highest in the trade for a number of essential oils. Indonesia is a producer of a number of essential oils such as citronella oil, clove leaf oil, 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, Britain and Europe[1].

Of the twelve types of essential oils, six are the most prominent in Indonesia, namely: nutmeg oil, patchouli oil, clove oil, eucalyptus oil, citronella oil, and vetiver oil.The essential oil producer that has high prospects is patchouli

(PogostemoncablinBenth). This can be seen from the world market demand which averages 1,200 – 1,400 tons per year [2].

The oil refining process that has been carried out so far uses a lot of energy sources derived from fuel oil (BBM), gas fuel (BBG), firewood and electricity from PLN (State Electricity Company). The energy sources that are often used are energy sources that are not environmentally friendly and their availability can be disrupted at any time because they are needed in large quantities [3].

So far, the main buffer for energy needs still relies on petroleum. Meanwhile, it is unavoidable that petroleum is increasingly scarce and expensive. Reserves of fossil energy sources worldwide since 2002 are 40 years for oil, 60 years for natural gas, and 200 years for coal. With the depletion of these fossil energy sources, in today's world there is a shift from the use of non-renewable energy sources to renewable energy sources. Renewable energy potential, such as: biomass, geothermal, solar energy, water energy, wind energy, ocean energy, hydro power has not been widely utilized, even though the potential for renewable energy is very large, especially in Indonesia.

Solar energy investment in developing countries is essential to avoid energy crises arising from over-reliance on fossil fuels[4].

Utilization of solar energy is currently still very rarely used for the benefit of extracting essential oils such as from medicinal and aromatic plants. Therefore, the essential oil distillation 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 [5].

It is clear that solar-based distillation is very possible to operate with lower operating costs, thereby increasing revenue, especially in producing essential oils which require high operating costs. Of the various types of distillation processes used around the world to extract essential oils from plant materials, the commonly used processes include the use of hydro distillation, steam distillation and water distillation, steam distillation being considered the most profitable process [6].

EXPERIMENTAL

2.1 Activity Location

The implementation of this activity was carried out at PT. Fugha Pratama Mandiri which is located on Jalan Elak with 3 Lhokseumawe State Polytechnic students.

2.2 Methodology

2.2.1 Tools and Materials

The preparation of the tools and materials used are as follows: The materials used in this research are a set of distillation apparatus, 68 pieces of 100 WP solar panels), 24 V 200 Ah battery, Solar Charge Control (SCC), DC-AC inverter, heater element, a set of distillation apparatus (distilling kettle), 250 mL erlenmeyer, 250 mL measuring cup, scales, Separating Funnel, Scissors, Filter Paper, Power Cord, Socket and Screwdriver. The materials used in this research included patchouli leaves (Pogostemoncablin Benth), water and filter paper.

2.2.2 Essential Oil Distillation Methode

According to [7] generally in the processing of essential oils, 3 types of distillation methods are known:

1. Distillation with Water (water distillation)
   The method of distillation with water is the easiest method compared to other methods. In this method, the plant material is put into a distilled kettle that has been filled with water so that the raw material for lemongrass leaves is mixed with water.
2. Distillation with Water and Steam (Water And Steam Distillation)
   This method is also called the steam system. In the steaming method, the material is placed on a perforated iron plate like a sieve which is located a few inches above the water surface.
3. Distillation with Steam (Steam Distillation)
   This distillation system uses high steam pressure. The resulting water vapor pressure is higher than the outside air pressure. Water as a source of hot steam is contained in a separate "boiler" from the distillation kettle.

The design of the essential oil distillation apparatus using solar panels is as shown below:

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Vol. 1, No. 1, Month, 2023, pp. 13 – 22
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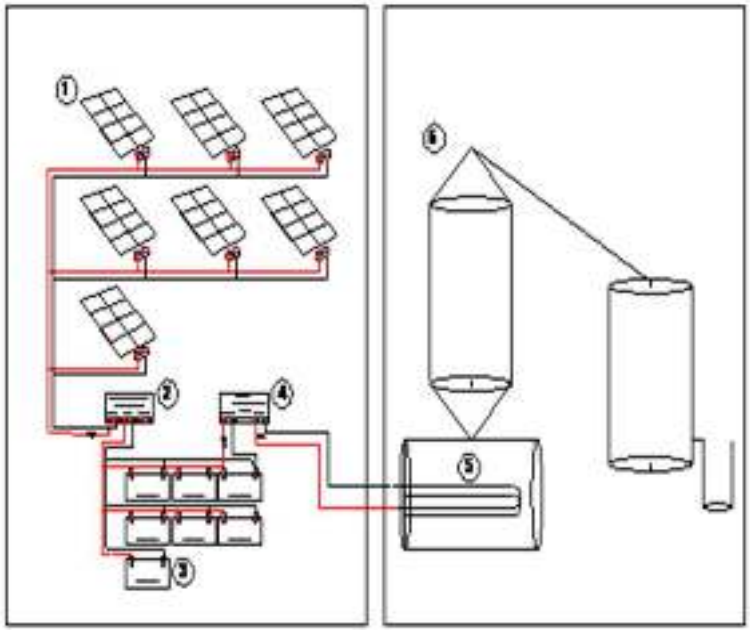

Figure 1. Scheme and Design of a Solar Cell-based Distillation Equipment

2.2.3 Working Principle of Solar Cells (Solar Cell)

Solar cells that can capture sunlight are one of the most promising power generators. Solar cells work using the pn junction principle, namely the junction between p-type and n-type semiconductors. This semiconductor consists of atomic bonds in which there are electrons as a basic constituent. The n-type semiconductor has an excess of electrons (negative charge), while the p-type semiconductor has an excess of holes (positive charge) in its atomic structure [8].

2.3 Sample Preparation

Preparation of patchouli leaves with various variations of variables namely, Drying time (2, 3 and 4 days):Distillation time (4, 5 and 6 hours).

2.3.1 Preparation of Patchouli Leaves

Patchouli leaves that have been harvested are chopped (reduced) with a size of ± 3-5 cm. Patchouli leaves that have been chopped (resized) with a size of ± 3-5 cm are dried in the sun according to a predetermined time. Then weighed as much as 5 kg for each variable and ready to be used for distillation.

2.3.2 Patchouli Oil Refinery

Water is put into a 25 liter distilled kettle. Patchouli leaves that have been weighed are put into a distilled kettle with the variables listed above.

2.4 Characterization Technique

2.4.1 Yield

Yield is the ratio of the amount (quantity) of oil produced from the extraction of aromatic plants. The higher the yield value indicates the value of the essential oil produced more and more. Factors that affect the yield start from the type of raw material, size, equipment used, accuracy, where it grows to the distillation process [9].

$$\text{Yield (\%)} = \frac{The\ amount\ of\ oil\ produced}{The\ amount\ of\ raw\ materials\ processed}\ x\ 100\%$$

2.4.2 Density

Density is a measurementmass per unit volume of an object. Where the higher the density of an object, the greater the mass of each volume (Nurhadi, 2015). According to the Essential Oil Association of O. basilicum Essential Oil, the density of Basil Essential Oil is 0.952 – 0.973 gr/ml [10].

2.4.3 Bias Index

The refractive index of patchouli oil is the ratio between the speed of light in air and the speed of light in the oil at a certain temperature.The more water content, the smaller the value of the refractive index. This is due to the nature of water which is easy to refract the incoming light [11]. To perform this refractive index analysis using a tool called a refractometer.

2.4.4 GC-MS (Gas Chromatography-Mass Spectrometry)

The working principle of gas-liquid chromatography is partition (solution). The basis of its work is that the sample is injected into the injector. The gas stream from the carrier gas will carry the evaporated sample into the column. The column will separate the components from the sample. Then the components are detected by the detector, and the signal in the peak form will be generated by the logger [12].

RESULTS AND DISCUSSION

3.1 Research Data

Drying Time (Days)	Distillation Time (Hours)	Yield (ml)	Density (Kg/m3)	Bias Index
2	4	30,1	0.9432	1.50573
	5	54,8	0.9435	1.50473

	6	87.5	0.9431	1.50469
	4	31,7	0.9455	1.50445
3	5	57,4	0.9460	1.50473
	6	88.8	0.9476	1.50449
	4	34.5	0.9471	1.50529
4	5	73,4	0.9435	1.50607
	6	107,9	0.9495	1.50527

3.2 The Effect of Drying Time & Distillation Time on the Yield of Patchouli Oil Quality

The highest yield obtained was 21.58% by distillation for 6 hours and 4 days of drying time. The efficient drying time for Patchouli is 4 days because the longer the drying time, the lower the oil content in the plant. The best distillation time is 6 hours, this occurs due to the longer a material receives heat, the diffusion process is more evenly distributed which causes the distillation process to be more efficient.

3.3 Density Analysis

The highest patchouli oil density value was obtained at 4 days of drying time with 6 hours of operating time. While the lowest density value of Patchouli oil was obtained at 2 days of drying time at 6 hours of operating time. Density expresses the intermolecular density in patchouli oil which is defined as the ratio between the mass and volume of the material.

3.4 Bias Index Analysis

Of all the experiments, there were 2 experiments whose refractive index values were higher than the others, namely with refractive index values of 1.50573 and 1.50607, namely at a distillation run time of 4 hours with 2 days of drying and 5 hours with 4 days of drying. This shows that the longer the patchouli distillation time, the better the refractive index produced. Meanwhile, the highest patchouli volume obtained a refractive index of 1.50527 on the 4-day drying experiment and the 6-hour refining time experiment.

CEJOTER: Chelo Journal of Technology Development f Engineering
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3.5 GC-MS Analysis

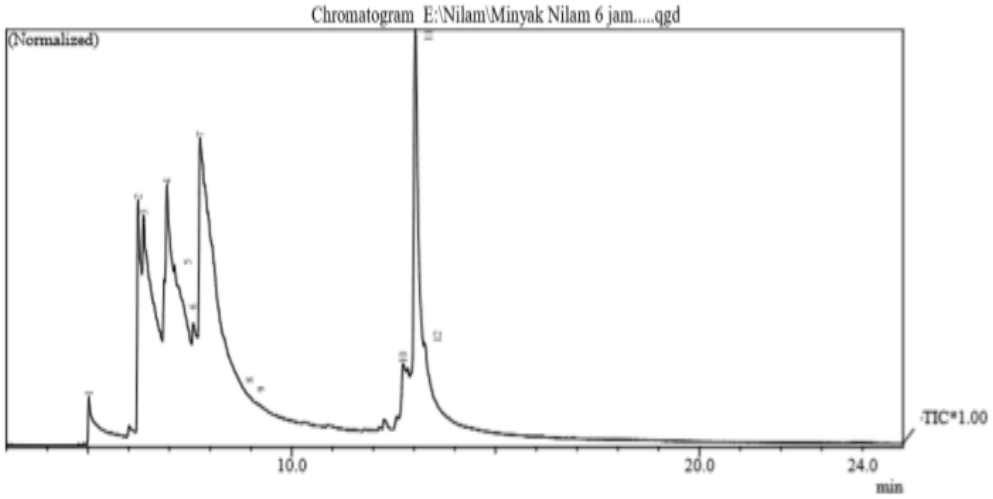

Figure 2. GC-MS analysis with patchouli oil

From the results of the analysis using GC-MS showed the presence of identified chemical compounds including azulene, seychellene and several other compounds, based on the GC-MS results obtained 31.75% patcholi alcohol, and 20.50% azulene.

CONCLUSION

Contains a The results showed that the highest yield was at 6 hours of distillation and 4 days of drying time. The effect of drying time on yield proved that the condition of the material that produced the highest % yield was when the material began to wither compared to the condition of the fresh material. So the conditions and treatment of these materials can increase the % yield of essential oils in accordance with the literature which states that the withering process aims to reduce the water content in the glands of the material, so that the extraction process is easier to carry out and the enumeration is an effort to expand the area of evaporation and contact with water so that patchouli oil easier to extract. Based on the patchouli oil density test the highest value was at 4 days of drying time with 6 hours of operating time. Density expresses the intermolecular density in Patchouli oil which is defined as the ratio between the mass and volume of the material. In general, density is related to viscosity, that is, a liquid with a higher density (higher density) has a higher viscosity than a liquid with a lower density. Patchouli oil density values range from 0.943-0.983. The effect of distillation time on the density of patchouli oil shows that at the three heating times the material shows a significant effect on the density value. From the results of the analysis using GC-MS showed the presence of identified chemical compounds including azulene, seychellene and several other compounds, based on the GC-MS results

obtained 31.75% patcholi alcohol, and 20.50% azulene. According to International Market Standards, the content of patchouli alcohol must be higher than 30%, therefore this material meets the Indonesian National Standard (SNI) and besides that the physical and chemical properties of Patchouli oil are produced from the distillation process by utilizing 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 in the market because it meets the Indonesian National Standard.

ACKNOWLEDGEMENTS

The authors express their gratitude and thanks to Politeknik Negeri Lhokseumawe for the educational support.

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