

MODELING OF PHOTOVOLTAIC PANELS FOR GAHARU ESSENTIAL OIL DISTILLATION SYSTEMS

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ABSTRACT

Solar energy has now been converted into electrical energy by using alternative solar panels to absorb heat energy which is converted into electrical energy. Solar panels or often referred to as photovoltaic systems are an alternative that is being actively developed to deal with the global status of energy shortages because fossil energy sources, which have been the main energy source, will run out as population growth increases. In this study used a solar cell with a capacity of 100 Wp which required 27 units of solar cells. used solar. The absorption power of the solar cell energy used is 2,500 watts with varying operating times, namely 1.5 hours, 3 hours, 4.5 hours and 6 hours. The use of solar cell energy will later be used for agarwood oil distillation. Gaharu wood is pre-treated in the form of drying and soaking before the distillation process is carried out. Pretreatment is carried out with the aim that the resulting essential oil can increase in yield. The results obtained yield showed the best quality at the 20th day immersion time and 10 hours of distillation time (0.51%). The results of the GC-MS gas chromatogram analysis were indicated by the presence of guaiol, selinene and panasinsen compounds, namely (55.90%), (19.56%) and (5.53%).

Keywords: *solar cell, renewable energy, agarwood, distillation*

1. INTRODUCTION

Renewable energy sources are currently alternative energy to replace dependence on increasingly limited fossil fuels. Renewable energy sources such as sun, wind, water, marine energy, biomass, biofuels, biogas, and many other renewable energy sources. [1] Currently many countries are developing renewable energy for the growth of dwindling fossil energy technologies. Including energy needs in Indonesia which have increased from year to year in line with increasing economic growth and Indonesia's population.

The REN21 Global Renewable Status Report (GSR) has highlighted the ongoing developments and new trends shaping the future of renewable energy. Currently the International Energy Agency has estimated

that higher fossil fuel prices will lead to a 90% increase in electricity prices by 2022. [2]

Solar cells or photovoltaic systems are a renewable energy source that uses solar energy as a source of energy that is converted from heat energy into electrical energy. The photovoltaic system is exposed to sunlight. directly to generate electricity, the surface temperature of the photovoltaic panels rises, resulting in a significant reduction in the photovoltaic output power. To optimize the use of solar panels, a control system is needed that can control the position of the solar panels so that they always follow the direction and position of the sun automatically. This system is called a tracking solar cell so that the efficiency of utilizing sunlight can be increased [3-4].

The high demand for gaharu essential oil is due to the fact that gaharu can be used as an anti-asthmatic, anti-microbial, nerve and digestive stimulant. In several countries, such as China, Europe and India, gaharu is used as a medicine for stomachaches, pain relievers, cancer, diarrhea, choking, kidney, lung tumors, intestinal tumors and so on. In addition, in Singapore, China, Korea, Japan and the United States, gaharu has been developed as a stress reliever drug, kidney disorders, stomach aches, hepatitis, cirrhosis, swelling of the liver and spleen (Raintree, 1996 Masakazu, 1990). In Indonesia, especially in Papua, gaharu has been used traditionally by local people for treatment. [5].

Gaharu oil is categorized as a non-timber forest product (NTFP) commodity containing resin or mastic which emits a distinctive aroma which is often used as raw material for the perfume industry, medicines, cosmetics, incense, preservatives and for the purposes of religious activities. This characteristic aroma is formed from a mixture of compounds contained in the agarwood essential oil. It is this diversity of natural compounds that makes gaharu essential oil have high economic value. [6]

Gaharu comes from gaharu tree trunks that have been inoculated for about 6 months to 1 year. The felling of the gaharu trees was carried out after checking the tree trunks and they were considered to contain the aroma of gaharu by means of a manual test. The agarwood oil is usually yellow to black in color with a high viscosity level, has a distinctive aroma of balsam and wood. [7]

The many advantages of aroma and pharmacological activity contained in gaharu essential oil make the need for agarwood essential oil increase and cause many researchers to look for the best method to improve the conventional method of hydrodistillation in producing agarwood essential oil, as well as reduce costs, energy and the use of chemicals in the oil extraction process. agarwood essential [8].

Agarwood essential oil has many advantages in aroma and pharmacological activity contained therein. There are many methods carried out and planned to be able to increase gaharu essential oil in order to reduce costs, energy and the use of chemicals in the distillation process (4) To produce high quality agarwood essential oil and have a large yield, it is done by selecting selective cuttings of gaharu trees. has been feasible to be used as a raw material for distillation. Then the gaharu selection was carried out consisting of the medang class, carving or dregs of carving and the slate class. Enumeration (cut into small pieces) then dried in the sun for 2 to 6 days. [9]

2. METODOLOGY

The material used is the gaharu plant. The equipment used is a 100 Wp solar panel, 24 V 200 Ah battery, solar charge control, AC-DC inverter, Element Heater, a set of distillation apparatus, 10 kg of agarwood.

The raw material used is agarwood which is ready to be harvested. Pre-treatment of the raw material for agarwood is carried out where the agarwood is first cut into small pieces and then mashed. Furthermore, it is dried for 2-6 days with different variations of drying time. Gaharu wood pieces were weighed as much as 10 kg for agarwood distillation using steam distillation technique. Where first the pieces of agarwood are put into the steam distillation equipment. Put 50 liters of aquadest into the kettle. In principle, this distillation technique has the same method as water distillation. However, there is a difference in the steam-producing water which is not filled together in the distillation kettle. Gaharu oil distillation time varied in 4, 5, 6 and 7 hours. By using this steam distillation technique it can cause plant cells to open, aromatic compounds, and oil to come out. Water vapor containing aromatic compounds will condense back into liquid. A heterogeneous liquid will form between the water and oil mixture. This heterogeneous liquid will be separated using a separating funnel.

3. CHARACTERIZATION

Analysis of the characteristics of the agarwood oil used for the process, namely gas chromatography-mass spectrometry (GC-MS) analysis, oil yield analysis and moisture content analysis.

3.1 Gas Chromatography-Mass Spectrometry (GC-MS) Analysis

Analysis of gaharu essential oil samples was carried out by GC-MS gas chromatography (GC-Shimadzu 2010 with an autosampler and ionization detector. The GC-MS was connected to a mass spectrometer (Agilent 5975C) using a DB-1MS capillary column (30 x 0.25 mm 1. D 0.25 μ m layer thickness). Injector and detector temperatures were set at 250 oC. Oven temperature was programmed at 40 oC for 8 minutes, increased at 3 oC/min to 240 oC and then held for 10 minutes. Helium as carrier gas was set to flow rate of 1.2 mL/min. The sample volume injected was 10 μ L with the aim of qualitatively identifying the presence of compounds present in gaharu essential oil.[10]

3.2 Oil Yield Analysis

Calculate the weight of the citronella to be refined (input), then calculate the final weight of the agarwood oil obtained (output).

$$\text{Yield (\%)} = \frac{\text{Weight of refined oil (output)} \times 100\%}{\text{Weight of refined citronella (input)}}$$

4. RESULT AND DISCUSSION

Gaharu is the most expensive aromatic material in the world, because the price of agarwood as the best quality on the world market can be priced at 58 million per stem weighing 2 kg. Gaharu essential oil is oil from the distillation of the gaharu plant which has the main component of the oil in the form of chromone. Chromone can cause a fragrant smell from agarwood when burned.

Gaharu essential oil distillation using steam distillation technique by utilizing sunlight packaged in a solar panel system (Photovoltaic). The solar panel system used consists of a heater (electrical element) which has an energy absorption of 2,500 watts with varying operating times of 1.5 hours, 3 hours, 4.5 hours and 6 hours. Then the energy required for this system is 3,750, 7,500, 11,250 and 15,000 (watts). The energy required for this system is taken at maximum energy, which is 7 hours, thus the total energy requirement for an electric element (Heater) 2500 watts x 7 hours = 17,500 Watts. And a pump that has an absorption capacity of 125 watts/hour of electrical energy, the amount of electrical energy needed for the pump is 125 watts/hour x 7 hours = 875 watts. Thus the total electrical energy requirement for the citronella oil refining process is 17,500 watts + 875 watts = 18,375 watts.

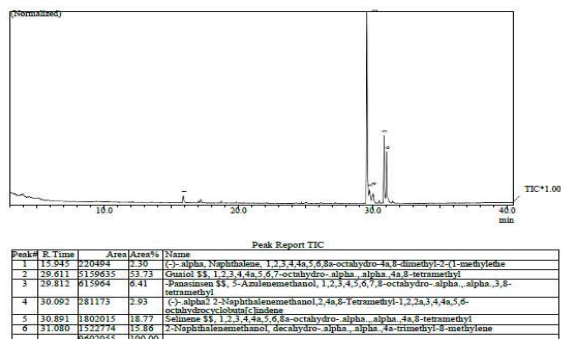
Analysis of photovoltaic system performance regarding power calculation is a parameter that must be carried out before application. Thus it will facilitate the process of preparing solar cells for their application where to calculate the total power used x usage time.[11]

Energy absorption time for 7 hours starting from 09.00 to 16.00. Solar Cell use uses a capacity of 100 Wp. With consideration of the energy needed as much as 18,375 watts. Thus the energy required to set at maximum usage is 18,375 watts. So with a power of 18,375 watts with an irradiation time of 7 hours/day with a solar cell capacity of 100 Wp, the number of solar cells needed is 18,375: (7 x 100) = 26.25 (27) units of solar cells needed, with consideration of saving energy 2 times the required electrical energy.[11]

Power storage using a battery (battery) with a capacity of 24 V/200 Ah to distribute the energy produced is 18,375 watts, so the number of batteries needed to store electric current is 18,375: (24 x 200) = 3.82 (4) battery units with a capacity of 24 V/200 Ah.[14,15]

The following are the results of the tests carried out in this study, including Gas Chromatography-Mass Spectrometry (GC-MS) Analysis and Oil Yield Analysis.

a. Analisa Kromatografi Gas-Spektrometri Massa (GC-MS)



Gambar 4.1 Hasil Analisa GC-MS Minyak Gaharu

The picture above shows the results of the GC-MS test of gaharu essential oil using distillation using solar cell panel heat. It is known that the largest components obtained were guaiol, selinene and panasinsen, namely (55.90%), (19.56%) and (5.53%).

From the results that have been obtained based on the distillation journal of gaharu oil for perfume raw materials using solar energy (photovoltaic) it is found that the largest % area of oil components is guaia, selina and selinene. It was found that the values of the compound components approached the values obtained by research conducted by (Nelly, et al, 2022).

The results of gaharu oil obtained from distillation using photovoltaic solar cell heat are better marked by a darker color, higher concentration and a strong aroma typical of balsam and wood (Mimi, et al, 2020).

b. Gaharu Oil Yield Analysis

Agarwood soaking time affects the yield of agarwood oil. During the immersion process, the cells expand causing the cells to break down over time. Water entering the cell wall through diffusion will increase

turgor pressure. Cell turgidity or cell turgor is cell pressure due to the entry of water into the cell. When a plant cell loses a lot of water so that it wilts, at that time the cell has a turgor pressure value that is equal to zero. The longer soaking time of agarwood causes damage to the cell walls, so that more oil content is added to the soaking water. [12]

This study emphasized the effect of hydration (by immersion technique) on the morphology of gaharu flakes. Gaharu flakes are obtained from the stems of *Aquilaria malaccensis*. The hydration effect was evaluated by varying the soaking time. During the immersion process, the cells have expanded and finally broken. Water enters the cell wall by diffusion and increases turgor pressure. The soaking water becomes more acidic with time and damages the cell walls. This causes the process of increasing the destruction of the cell wall. However, the longer soaking time causes more oil content to be wasted into the soaking water. From the research that has been done, it is known that the most oil is obtained from the hydrodistillation process with 20 days of soaking and 10 hours of hydrodistillation process, which is equal to 0.51%. The following data has been obtained from research that has been interpreted in the form of graphs and tables.

Table 4.1 Effect of soaking time and hydrodistillation time on the amount of yield produced

Hydrodistillation time (Hours)	Soaking Time (Day)			
	10	15	20	25
8	0,35%	0,40%	0,45%	0,29%
9	0,40%	0,42%	0,47%	0,30%
10	0,38%	0,43%	0,51%	0,27%

Based on the yield percentage, the highest yield was by soaking for 18 days and hydrodistillation for 10 hours, which was 0.51%. It is known that immersion time

affects the effectiveness and the amount of yield. Where the longer the soaking time it will destroy the plant cell walls and bind the constituent components of agarwood essential oil into the water. [13]

5. CONCLUSION

From the results of the research that has been done, the use of solar energy sources using the sun to convert electricity into electricity is very effective and environmentally friendly. Research on modeling photovoltaic panels for gaharu essential oil distillation systems found that the yield that showed the best quality was at 20 days of soaking time and 10 hours of distillation time (0.51%). The results of the GC-MS gas chromatogram analysis were indicated by the presence of guaicol, selinene and panasinsen compounds, namely (55.90%), (19.56%) and (5.53%).

The analysis of gaharu essential oil was carried out within 4 days of gaharu wood immersion experimental parameters along with 3 distillation times. Soaking time was carried out in 4 days, namely 10, 15, 20 and 25 days. Hydrodistillation time in 3 time variations, namely 8.9 and 10 hours. The yield of gaharu essential oil was obtained when soaking on the 25th day which was distilled for up to 10 hours, the smallest yield value was 0.27%. While the highest was on the 20th day of immersion at 10 hours of distillation. The maximum yield of oil obtained was obtained at 20 days of immersion. This is in line with research conducted by Veronica Alexander that the longer the soaking time, the more oil content is wasted into the soaking water.

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