Testing The Heat Distribution of Flat Plate Type Solar Collectors for LPG Solar Hybrid Dryers at P4S Bukit Melintang

Abdul Azis[1*], *Abdul* Waris[2], *Iqbal* Salim[2], *Masyhur* Syafiuddin[1], *Eka* Setiawan[1], *Nana* rezkiana[1], *Andi* Azizah[3] and *Muhammad* Azmi Alamsyah[4]

[1]Food Crop Production Technology Study Program, Faculty of Vocational, Hasanuddin University, 90245, Makassar, Indonesia
[2]Department of Agricultural Engineering Study Program, Faculty of Agricultural, Hasanuddin University, 90245, Makassar, Indonesia
[3]Faculty of Mechanical and Power Engineering, Wrocław University of Science and Technology, 50-370, Poland
[4]Department of Industrial Management National Taiwan University of Technology, Taiwan, Republic of China

Abstract. One of the uses of solar energy in agriculture is as a source of heat energy for dryers. Through the Kedaireka 2023 Matching Fund (MF) activity and in collaboration with the Independent Rural Agricultural Training Center (P4S) of Bukit Melintang, Sidrap Regency to develop a hybrid solar and LPG dryer. Thermal energy from the sun is obtained from a flat plate-type solar collector system. This research aims to obtain a flat plate-type solar collector system as an alternative heat source for hybrid dryers. The research was carried out to test the functional tool and determine its performance in converting solar energy into heat that can be used for drying equipment. The results of tests carried out on October 22, 2023, from 10.25 AM to 13.35 PM at the Agricultural Engineering Study Program, Hasanuddin University, with coordinates -5.131048, 119.485434 showed that the average environmental temperature was 36.5 °C, the highest temperature in the solar collector outlet was 57 °C which occurred at 11.15 – 11.40. and experienced a decrease in temperature until 13.35 to the lowest temperature of 42.5 °C. This shows that the solar collector can increase the temperature from 60 to 20.5 °C.

1 Introduction

Indonesia is located on the equator, so sunlight occurs almost all year round, lasting 6 to 8 hours per day. The potential for solar energy is abundant and can be used as an alternative energy source for agriculture. One process that can utilize this energy is the drying process

* Corresponding author: abdulazis@unhas.ac.id

of agricultural products, especially grains. The community generally uses only a direct drying system, either a drying floor or tarpaulin, para-para, nets, or other materials.

Apart from that, solar energy as an alternative source of heat energy for drying agricultural products has been widely used, both in single energy source systems and hybrid methods with other energy sources. A solar collector must be used to utilize this energy. A solar collector is a device that collects heat energy from solar insolation by absorbing, storing, and then flowing it through a fluid for a specific purpose [1]. According to [2], solar irradiation is absorbed by the solar collector as heat, which is then transferred to the fluid (air, water or oil) for solar heat applications.

Solar collectors generally have two types: flat plate and parabolic. Flat plate-type solar collectors have the advantage that they can absorb solar radiation well that hits the collector [3]. Flat plate solar collectors are usually permanently fixed in position and must be oriented precisely [2]. The flat plate collector consists of a transparent glass cover and an absorber plate with a parallel back plate [1].

The working principle of a solar collector is based on the absorption of solar radiation by a black sheet absorber. The resulting heat is transferred to the working medium and channeled through pipes under the absorber. Using a black sheet absorber, solar radiation energy hitting the absorber must be isolated for maximum transfer to the working medium [4].

Much research has been carried out regarding the characteristics and heat behavior of flat plate type solar collectors, including [5], who looked at the performance of flat plate solar collector type water heaters with one and two glass covers [6]. Regarding the influence of plate thickness and distance between pipes on the performance of flat plate solar collectors [7]. Design of a flat plate type solar collector prototype for producing heat in agricultural and plantation product dryers and [7] about Flat plate type solar collector prototype design for heat production in agricultural and plantation product dryers.

A flat plate type solar collector with a zinc spandex absorber has been created as an energy source for a solar hybrid dryer and LPG at P4S Bukit Melintang, Sidrap Regency. Therefore, it is necessary to test the distribution of heat produced by the collector.

2 Materials and methods

The research procedure consists of three stages: preparation of tools and materials, data collection and data analysis. The preparation stage consists of preparing the solar collector and temperature data logger system. The shape and profile of the solar collector are as in Figures 1 and 2. The solar collector consists of 3 layers: glass, zinc spandex, aluminum foil bubble insulation and plywood.

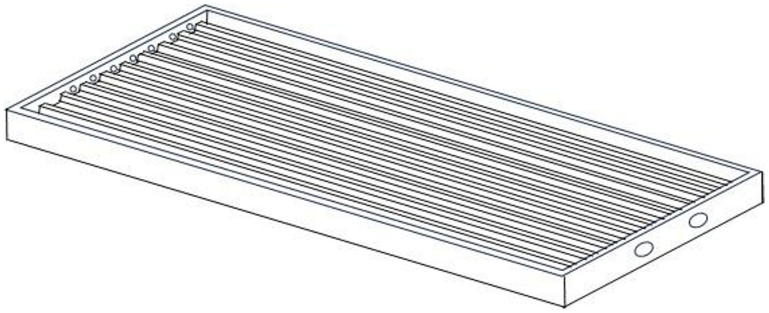

Fig. 1. Flat plate solar collector model

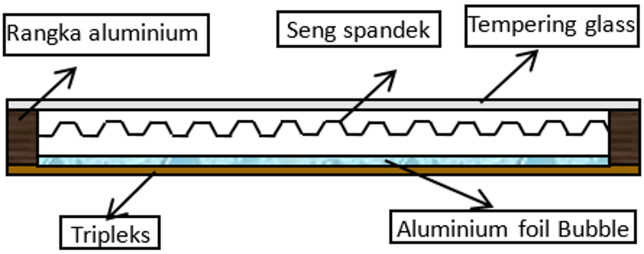

Fig. 2. Cross-sectional profile of solar collector

The temperature data logger system is installed on the collector where the DHT22 sensor is installed in the arrangement as in Figure 3. The collector is divided into 4 parts with a distance of 50 cm each, and then the DHT22 sensor is installed in the arrangement as in figure B1 (line 1) sensor near the inlet hole and B4 (Line 4) sensor near the outlet hole. Are 11 sensors installed in the collector and 1 sensor outside the collector to measure environmental temperature. A blower is installed at the outlet to circulate air from the inlet to the outlet.

Fig. 3. Installation of the DHT22 temperature data logger system

The data collection stage is carried out after the tool is installed. Data collection is carried out by activating the data logger so that the collector and environmental temperatures are read by the DHT22 sensor and then stored on the memory card. Data was collected at the Agricultural Engineering Study Program, Hasanuddin University, with coordinates -5.131048, 119.485434 on October 22, 2023, from 10.25 AM to 13.35 PM.

The data analysis stage was carried out using Microsoft Excel to see the collector's temperature distribution and the pattern of temperature increase from inlet to outlet.

3 Result and Discussion

3.1 The Temperature Distribution In The Collector

The temperature distribution in the collector is shown in Figure 4. There are 11 sensors installed on the collector, which are divided into 4 rows, namely row 1 (B1), row 2 (B2), row 3 (B3) and row 4 (B4).

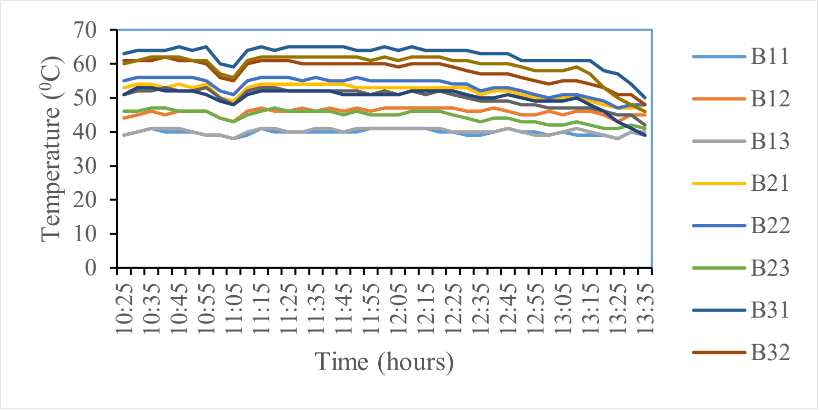

Fig. 4. Temperature distribution in the collector

The test results (Figure 4) show that from 10.35 to 12.45, the temperature in the collector has the same tendency for each treatment. However, from 11.05 to 11.15, the temperature decreased. This was because, at that time, the weather conditions turned cloudy, so the intensity of solar radiation captured by the collector became low. The temperature distribution resulting from heating from the solar collector is not the same for each distance to the inlet. In the first row of measurements (B1), the temperature at sensor positions B11, B12, and B13, respectively, were in the temperature range of 39.82 °C, 45.82 °C and 40.15 °C. In the second row of measurements (B2), the temperature at sensor positions B21, B22, and B23 were 51.97 °C, 53.49 °C, and 44.54 °C. In the third row of measurements (B3), the temperature at sensor positions B31, B32, and B33 was 62.51 °C, 57.95 °C and 50.05 °C. while measuring the fourth row (B4), the temperature at sensor positions B41 and B42, respectively, is 59.41 °C and 50.08 °C.

The results of measurement data analysis, as in Figure 5, show that the solar collector can increase the environmental temperature by 18.22 °C. The environmental temperature during testing was in the range of 36.52 (C), while the temperature measured at the outlet was in the range of 54.74 °C.

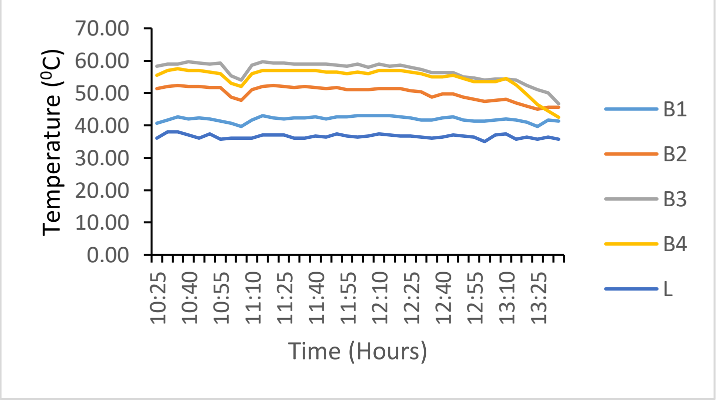

Fig. 5. Average temperature distribution in the collector

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3.2 The relationship pattern between the distance of measurement points on the collector

The relationship pattern between the distance from the measurement point to the collector and temperature changes is shown in Figure 6. It can be seen that the further the distance from the measurement point to the inlet, the measured temperature tends to increase. The temperature measured around the inlet (B1) was around 41.93 °C, which increased to 56. 84 °C at a distance of around 166 cm from the inlet (B3). However, it can also be seen that the temperature at the outlet was measured at around 54.74 °C, which means the temperature decreased by 2.1 °C. This is because the position of the sensor is installed at the outlet where the airflow occurs faster due to being sucked in by the blower.

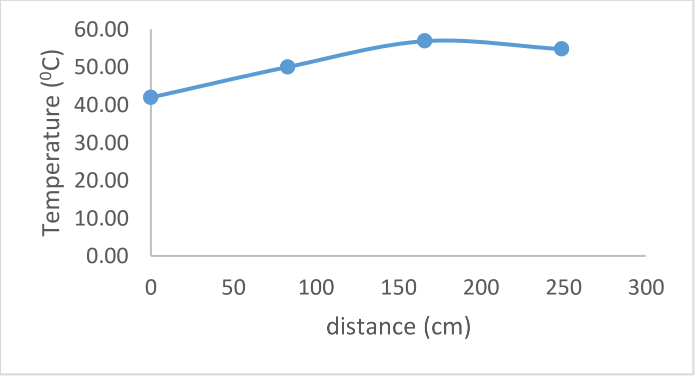

Fig. 6. Relationship between distance to inlet and collector temperature\

4 Conclusion

The distribution pattern of air temperature during heating in the solar collector varies with distance from the inlet and tends to increase but decreases around the outlet.

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