Analysis Of The Coefficien Of Performance (Cop) Freezer Produced By Solar Cell

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***Abstract**.*
The use of freezer machines has now become a necessity for the wider community, because it is very helpful for humans in everyday life. The cooling load given greatly affects the performance of the freezer, both in terms of electrical energy consumption and the ability to increase system usage time. The greater the cooling load will increase the use of electrical energy during operation. This is very worrying in the future where the issue of depleting fossil energy sources which is currently a priority for producing electrical energy is increasing and filling the media. In recent years, solar energy has been rumored to be the answer to this problem. Where heat energy from the sun is used to move protons and electrons in a solar panel media to produce electrical energy that can be used for the needs of many people. This has become the attraction of researchers to make an innovation in the use of solar energy in a freezer system. Judging from the research roadmap related to solar energy and the vapor compression system in the freezer that was launched in the last few years, not many innovations have been carried out in the use of energy sources. The cooling load to be used will be adjusted to the capacity of the energy source used, which is 410 WP. With the capacity of the freezer that is used with a power of 1/4 PK which will increase its ability/ efficiency to be used and replace the paid electric energy freezer. This is expected to be useful for the public and contribute knowledge and help realize the university roadmap in the future.

Keywords: *COP Value, Cooling Time, Solar Cell.*

I. INTRODUCTION

The need for electricity for both industrial, office and commercial circlesthe general public and individuals have greatly increased. This increase in electricity demand has resulted in an energy crisis. For this reason, solar energy is chosen as an alternative energy to produce electrical energy. A solar panel module works optimally to convert solar energy into solar energy at a temperature of around 25 degrees Celsius with a production capacity of 1 kW/m². However, when operating in the field, solar panels will usually receive heat due to solar radiation so that the temperature of the panel exceeds its optimal temperature value which causes the performance and efficiency of monocrystalline and polycrystalline solar cells to drop dramatically when the temperature rises At this time, especially in urban areas, cooling machines can be found in almost every shop, office building and household. The refrigeration machine can be refrigerator, freezer, chiller and water conditioning (air conditioning). The most common use of refrigeration machines is for room conditioning and preservation of food or beverage ingredients. The main purpose of the air conditioning system is to maintain the condition of the air in the room which includes setting temperature, relative humidity, air circulation speed and air quality. The air conditioning system installed must have proper cooling capacity and can be controlled in operation. The capacity of the equipment that can be calculated based on the cooling load at any time which is constantly changing [2].

Cooling

Cooling load is actually the amount of heat transferred by the air conditioning system over time. Cooling load consists of heat from space and additional heat. Additional heat is the amount of heat at any time that enters the room through the glass by radiation or through the walls due to temperature differences, the effect of energy storage on building structures, as well as electrical equipment such as lights and other electronic equipment. The refrigeration machine is one of the machines that has the main function to cools a substance so that its temperature is lower than the ambient temperature. The main components of the refrigeration machine are compressor, condenser, expansion device and evaporator, as well as refrigerant as a working fluid that circulates in these parts [3].

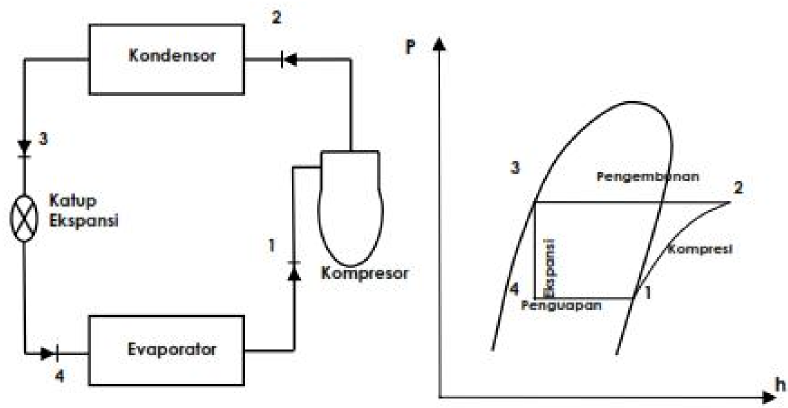


Fig 1. Ph chart

Cooling Machine Working System

When refrigerant flows through Evaporator, heat transfer from the cooled room causes the refrigerant to evaporate. By taking Refrigerant from Evaporator as control volume, from mass balance and law In thermodynamics, the heat transfer is obtained by:

$$Qe = \dot{m}(h_1 - h_4)(Kw) \dots (1)$$

Refrigerant leave Evaporator then go to Compressor. Furthermore, the refrigerant is compressed until the pressure and temperature increase. It is assumed that there is no heat transfer from and to the compressor. By applying the mass balance and energy rate (Law of Thermodynamics I) to the control volume surrounding the compressor, the compressor power is obtained, namely :

$$P = \dot{m}(h_2 - h_1)(Kw) \ldots (2)$$

Then the refrigerant flows through the condenser, where the refrigerant condenses and gives heat to the lower temperature ambient air. For the control volume surrounding the refrigerant in the condenser, the heat rate of the refrigerant is.

$$Qc = \dot{m}(h_2 - h_3)(Kw) \ldots (3)$$

Finally, the refrigerant in state 3 enters the expansion device and expands to the evaporator pressure. Refrigerant pressure decreases in an irreversible expansion and is accompanied by an increase in specific entropy. The refrigerant exits the expansion valve at point 4 in the form of a vapor-liquid mixed phase. The quality of the vapor contained at point 4 can be found by the equation [4]:

$$x_1 = \frac{h_4 - h_{f4}}{h_{fg4}} \ldots (4)$$

Cooling Beans

Several factors need to be considered when calculating the cooling load and determining the equipment for the air conditioning system and control system, including: use or function of space, type of building construction, conditioning load patterns, indoor conditions. At the planning stage, the correct calculation of the cooling load must be carried out because the results of the correct cooling load calculation will be the basis for selecting the type and capacity of the cooling equipment. In the General Teaching room there are 2 kinds of cooling loads, namely: sensible loads and latent loads. Sensible loads include: heat loads through walls, roofs, ceilings, floors, electrical equipment (computers and lights) due to room infiltration loads. Walls made of plywood and glass have no heat load because they are not exposed to the heat of solar radiation. While the latent heat load includes: occupants (people) and the heat load on the infiltration of the room. Previously, the condition of the design room was determined before calculating the heat load from the room [5].

Solar Cell

A solar panel is a device consisting of solar cells that convert light into electricity. Solar panels are often called cells*PhotoVoltaic* which can be interpreted as "light-electric". Solar cells or cells*PhotoVoltaic* to absorb solar energy and cause currents to flow between two oppositely charged layers. Solar cells need to be protected from moisture and mechanical damage as this can significantly impair the efficiency of the solar panels, and decrease their expected lifetime. Solar panels are power plants that are able to convert sunlight which is converted into electrical energy. Solar energy is actually a promising source of energy considering its nature*continue* as well as large numbers and abundant availability. The sun is an energy source that is expected to be able to overcome or solve the problem of future energy needs after various conventional energy sources are reduced in number and are not friendly to the environment. Solar panels also have the advantage of being a practical and environmentally friendly energy source considering that they do not require transmission such as an electricity grid conventional, because it can be installed modularly in any location that requires it [6].

Fig 2. Solar Cell

II. METHODS

Sunlight is converted into electricity by photovoltaic panels, mostly using Poly Cristallyne Silicon as their photocell semiconductor material. The principle is the same as the p-n diode principle [7,8].

Fig 3. Solar panel working principle

[1] The manuscript is written with Times New Roman, a font size 11, single-spaced, left-justified, on Doing Solar Test *cell* In an open place that gets sunlight, the test is carried out at 07:00 WIB to 15:00 WIB.

[2] Measure the resulting voltage and current from the output *solar cells.*

[3] Install the freezer and make sure it is attached with the solar panels.

[4] Next run the test equipment until the system and refrigerant flow are stable.

[5] Record the temperature and time indicated by a temperature gauge and a stopwatch.

[6] Record the total time taken from the temperature of 25^0 C to 0 . temperature 0^0C

III. RESULT AND DISCUSSION

Current and Power Results in Solar Cell

Installation of a solar cell panel at a tilt position of 40˚, to the angle of incidence of the sun as shown above. From solar cell panels. Data retrieval of the position / angle of the sun is very necessary. This aims to find out how much the shift in the angle of the sun at an interval of timecertain time. This data retrieval was carried out at 08.00 to 17.00. The test results can be seen in Table 1 as follows.

Table 1. Test Results on 09-08-2020

NO	Time	Flow	Voltage	Power
1	8:00	6,84	27,3	186,732
2	8:30	7,31	29,2	213,452
3	9:00	7,55	30,2	228,01
4	9:30	7,45	29,8	222,01
5	10:00	7,86	31,5	247,59
6	10:30	8,75	32,3	282,625
7	11:00	8,25	32,9	271,425
8	11:30	8,30	33,2	275,56
9	12:00	8,45	33,8	285,61
10	12:30	9,25	36,1	333,925
11	13:00	8,95	35,8	320,41
12	13:30	8,90	35,6	316,84
13	14:00	8,57	34,3	293,951
14	14:30	8,50	34,0	289
15	15:00	8,37	33,5	280,395
Amount		123,3	489,5	4047,535

Table 1 is the result of testing to determine the ratio of current, voltage and power generated by solar panels. The results from table 1 are taken from the first day on December 6, 2020 and start at 08.00 WIB to 15.00 WIB. To see the results of the comparison of current, voltage and power can be seen in the following graphic image.

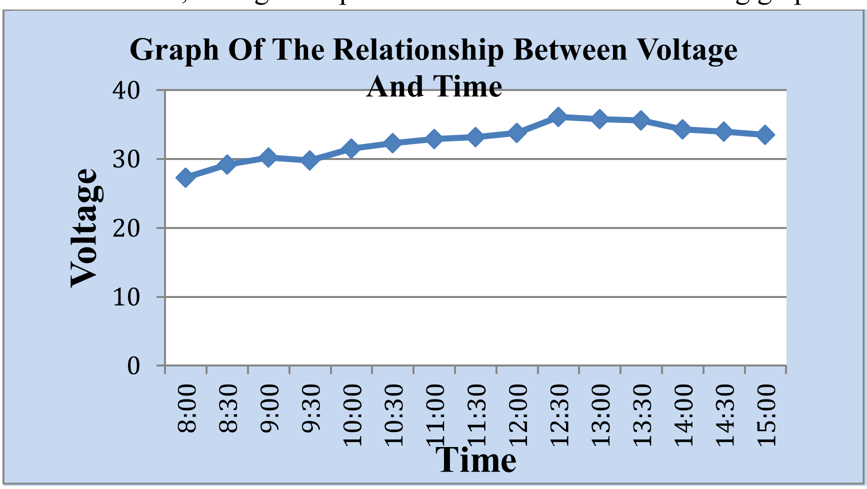


Fig 4. Time graph with voltage

From table 1 test data can be obtained and can graph the relationship between time and voltage as described in Figure 4. The highest voltage that can be obtained is 36.1 V at 12.30 wib. At 13:00 the panel position is changed to facing west until 15:00, which is from 08:00 to 12:30 the panel position is facing east. The maximum voltage that can be obtained is 36.1 V at 12.30 wib, while the minimum voltage obtained is 27.3 V at 08:00.

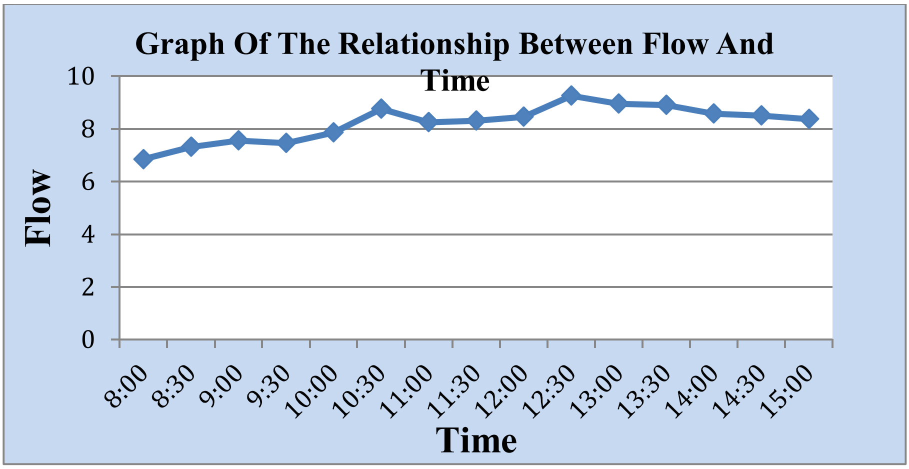


Fig 5. Flow chart with time

Figure 5 describes the graph of the relationship between current and time. This test is also carried out from 08:00 to 15:00 with test results taking every 30 minutes. From Figure 5, it can be seen that the current rose steadily even though it decreased at 9:30 and rose again at 10:00 to 10:30 WIB. The maximum current generated is 9.25 Ampere at 12:30 wib and the minimum current is 6.84 Ampere at 8:00 wib.

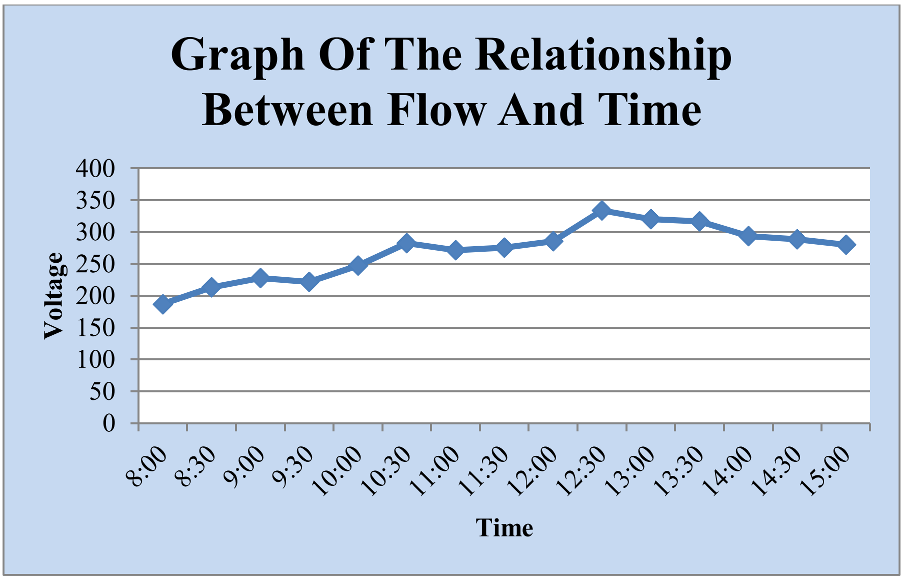


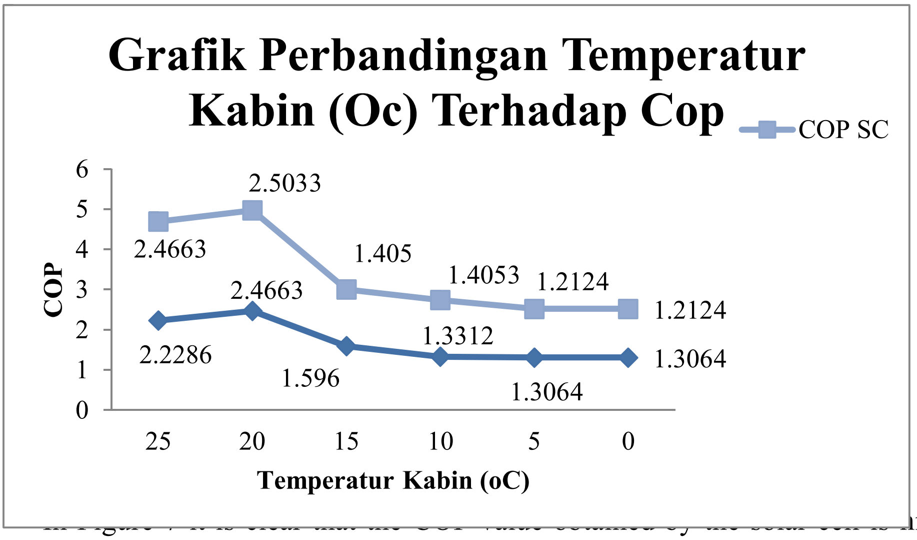
Fig 6. Graph Of The Relationship Between flow And Time

Figure 6 shows the graph of the relationship between time and power. The results of the power obtained from the multiplication of the voltage (V) with the current (I) every 30 minutes, starting from 08.00 WIB until 15.00 WIB. As explained in Figure 5, it is very clear that the power generated at 08.00 WIB to 09.00 wib there is a constant increase in power starting from186.732 watts to 228.01 watts and a decrease occurs at

09.30 WIB, namely 222.01 watts, but at 10.00 WIB it increased again to 247.59 watts. Starting at 10.30 wib the power rose slightly and decreased again until 12.00 WIB and the power reached 285.61 Watts, but at 12:30 WIB the power experienced a very high increase, namely 333.925 Watt Then start at 12.30 WIB until 15:00 WIB experienced a decrease in power to 280.395 Watt [9].

Table 2. COP value result from freezer temperature 25^0C to 0^0C

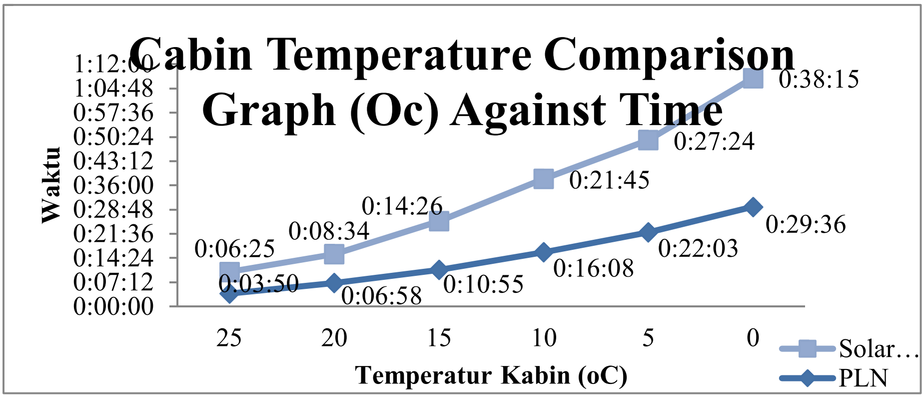
T Kabin (°c)	25	20	15	10	5	0
P1/Low Pressure (Bar)	1,1	1,4	0,6	0,4	0,4	0,3
P2/Low Pressure (Bar)	13,2	14,6	15,3	16,2	16,8	15,2
COP PLN	2,2286	2,4663	1,596	1,3312	1,3064	1,3064
COP SC	2,2436	2,5033	1,405	1,4053	1,2124	1,2124



In Figure 7 it is clear that the COP value obtained by the solar cell is higher than the COP value obtained by the PLN electric current. At 25^0C the COP value of the Solar Cell is 2.4663 and increases at a temperature of 200C of 2.5033 and decreased drastically to temperature 0^0C is 1.2124. While at a temperature of 250C the COP value of the PLN electric current is 2.2286 and increases at a temperature of 20^0C of 2.4663 and decreased and finally stabilized at a temperature of 0^0C is 1.3064 [10].

Table 3. Time result of freezer temperature 25^0C to 0^0C

T Cabin (°c)	25	20	15	10	5	0
Time PLN	3:50	6:58	10:55	16:08	22:03	29:36
Time Solar Cell	6:25	8:34	14:26	21:45	27:24	38:15



Binding media

Fig 8. Cabin Temperature Comparison Graph (Oc) Against Time

IV. CONCLUSION

Based on results study which carried out that the COP value at a temperature of 25^{0}C to 0^{0}C generated by the flow of electric current PLN is

2,2286 2,4663 1,596 1,3312 1,3064 1,3064

with the time required for the freezer using PLN electricity to reach the freezing point of 0^{0}C is

00:3:50 00:6:58 00:10:55 00:16:08 00:22:03 00:29:36

while the COP value generated by the flow of electric current from the solar cell is

2,2436 2,5033 1,405 1,4053 1,2124 1,2124

with the time it takes for the freezer to use Solar Cell electricity to reach the freezing point of 0^{0}C is

00:6:25 00:8:34 00:14:26 00:21:45 00:27:24 00:38:15

Then the voltage, current and power generated by the 410 WP solar cell are as follows:

1. The optimal power generated by the 410 WP solar cell is 333.925 Watt.
2. The optimal voltage generated by the 410 WP solar cell is 36.1 Volts.

The optimal current generated by the 410 WP solar cell is 9.25 Ampere

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