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System Circuit Analysis of Solar Panel Chicken Egg Incubator

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Abstract: The chicken egg incubator is an innovation in the method of hatching chicken eggs that has higher efficiency and is up-to-date compared to using incubating hens. With this incubator machine, the incubation process of chicken eggs can be controlled and can reach the ideal temperature and humidity for the hatching process of chicken eggs. This research was conducted to find out how much power is used by this chicken egg incubator machine, as well as how long it takes for 300 Wp solar panels to charge a battery with a capacity of 12 V / 80 Ah. The research was conducted to find out the percentage of success of this egg hatching and to calculate how long it takes to reach the BEP (Break Even Point). This chicken egg incubator machine is powered by a 300 Wp solar panel with a 12 V / 80 Ah battery. In the incubator circuit there is a humidifier mist maker component to maintain the incubator humidity at 50%–60%. Lighting uses 2 incandescent lamps with a total power of 50 W, as well as a ventilation fan that turns on when the temperature in the incubator is excessive in order to keep the temperature at 36 ℃–38.5 ℃. The drive motor is set to move for 3 seconds every 3 hours. This chicken egg incubator has a power consumption of 74.55 W with an egg hatching success rate of 86%. This chicken egg incubator takes about 500 days or 1 year and 5 months to reach its BEP (Break Even Point).

Keywords: Solar Panel, Temperature, Humidity, Egg Hatching Machine, Break-Even Point.

Abstrak: *Inkubator telur ayam merupakan inovasi dalam metode penetasan telur ayam yang memiliki efisiensi lebih tinggi dan lebih modern dibandingkan menggunakan indukan ayam secara langsung. Dengan mesin inkubator ini, proses penetasan dapat dikendalikan sehingga dapat mencapai suhu dan kelembapan ideal untuk proses penetasan telur. Penelitian ini dilakukan untuk mengetahui berapa besar daya yang digunakan oleh mesin inkubator telur ayam ini, serta berapa lama waktu yang dibutuhkan oleh panel surya 300 Wp untuk mengisi baterai berkapasitas 12 V / 80 Ah. Penelitian ini juga bertujuan untuk mengetahui persentase keberhasilan penetasan telur serta menghitung waktu yang diperlukan untuk mencapai titik impas (Break Even Point). Mesin inkubator ini menggunakan sumber daya dari panel surya 300 Wp dengan baterai 12 V / 80 Ah. Pada rangkaian inkubator terdapat komponen humidifier mist maker untuk menjaga kelembapan pada kisaran 50%–60%. Pencahayaan menggunakan dua lampu pijar dengan total daya 50 W, serta kipas ventilasi yang menyala ketika suhu di dalam inkubator melebihi batas untuk menjaga suhu pada kisaran 36 ℃–38,5 ℃. Motor penggerak diatur untuk bergerak selama 3 detik setiap 3 jam. Inkubator telur ayam ini memiliki konsumsi daya sebesar 74,55 W dengan tingkat keberhasilan penetasan 86%. Waktu yang dibutuhkan untuk mencapai titik impas adalah sekitar 500 hari atau setara dengan 1 tahun 5 bulan.*

Kata kunci: *Panel Surya, Suhu, Kelembapan, Mesin Penetas Telur, Titik Impas.*

INTRODUCTION

In this modern era, the development of renewable technology is very rapid, especially in the poultry farming sector, and the demand for chicken meat supply is quite high in the market. While this will not be achieved just by waiting for brooding chickens to sit incubating eggs. So a more efficient and sophisticated egg hatching system is needed with the help of renewable technology, namely the "chicken egg incubator." The chicken egg incubator itself is a machined egg hatching system in which all egg hatching processes are controlled by the machine, starting from optimal and controlled temperature and humidity conditions to stimulate embryo growth until the eggs hatch. The temperature and relative humidity inside the incubator are controlled at 36–40 ℃ and 50–60% relative humidity [1].

A very abundant source of energy and a source of life on earth is the sun, which is very much needed for life, especially its use in engineering as a power plant. Solar energy is one form of utilization of renewable energy sources that are environmentally friendly [2]. In its development, Solar Power Plant technology is an alternative technology to meet human electricity needs. Solar power plants have three types of systems, namely on-grid, off-grid, and hybrid. The on-grid Solar Power Plant system is directly connected to the State Electricity Company's electricity network, while the off-grid Solar Power Plant system uses batteries to store energy so that it can still provide electricity and is not connected to the State Electricity Company's electricity network. As for the hybrid Solar Power Plant system, it combines the advantages of both on-grid and off-grid systems [3]. If the irradiation intensity does not reach its peak, the battery has to work harder when discharging. This condition usually occurs when it is not the maximum sunshine hour (Peak Sun Hour). Peak Sun Hour (PSH) is a parameter that indicates the duration of maximum solar irradiation each day in hours. However, the design of a typical Solar PV system already considers the accumulation of this time in the autonomous period (autonomous day) when it is built [4].

In previous research, the chicken egg incubator with energy resources from solar panels used 120 Wp solar panels, 12 V / 50 Ah batteries, 10 A solar charge controller, 500 W inverter, and 2 lamps (10 W). The incubator temperature is 37.5 ℃–39 ℃ and the humidity is about 52%–55%. The eggs used were 50 eggs. The research was conducted for 20–21 days until the eggs hatched; from the study, 90% of the eggs hatched and 10% failed to hatch [5]. In general, the hatching time of chicken eggs is in the range of 21 days at a temperature of 36–40 ℃ with humidity of 50%–60%, while for duck eggs it is in the range of 28 days at a temperature of 36–40 ℃ with humidity of 60%–70% [6].

Therefore, research will be carried out on an egg incubator system using solar panels. This tool has a temperature, humidity, and lighting control system with automatic sensors. Lighting and temperature are obtained from 50 W incandescent lamps (2 pieces). Temperature and humidity measurements use the Automatic Computer Control Incubator XM-18 Thermohygrostat tool. As for the power supply, the incubator uses 150 Wp solar panels, as many as 2 pieces, for charging a 12 V / 80 Ah battery, with an additional solar charge controller (20 A) and inverter (500 W). The research was conducted using chicken egg media to shorten data collection on the performance of solar panel chicken egg incubators from the beginning of the incubation period until the eggs hatch.

METHODS

This study uses a research method designed to systematically obtain accurate and relevant data and information in order to provide a clear and comprehensive understanding of the solar-powered egg incubator being analyzed. This research employs a qualitative descriptive method, which is used to systematically describe and interpret the observed data without conducting statistical hypothesis testing.

Data collection in this research is carried out through two main techniques: literature study and direct observation. The literature study involves reviewing relevant references such as journals, books, scientific articles, and other sources related to solar-powered incubator technology. The observation method is conducted by directly observing the operation and performance of the solar panel-based chicken egg incubator. The data obtained from these observations are used to analyze the effectiveness and reliability of the system.

The equipment used in this study includes a solar-powered incubator system composed of two 300 Wp solar panels, a 20 A solar charge controller, a 12 V / 80 Ah battery, a 1000 W inverter, an automatic transfer switch, an XM-18 automatic computer incubator controller, a rack drive motor, two 50 W incandescent lamps, a ventilation fan, and a mist maker humidifier. These components work together to create and maintain the necessary environment for egg incubation using solar energy. To support data measurement and monitoring, several measuring instruments are used, including a clamp meter, a multimeter, and a stopwatch. The experimental

materials used in this study consist of 15 free-range chicken eggs, which are incubated using the designed solar-powered incubator system.

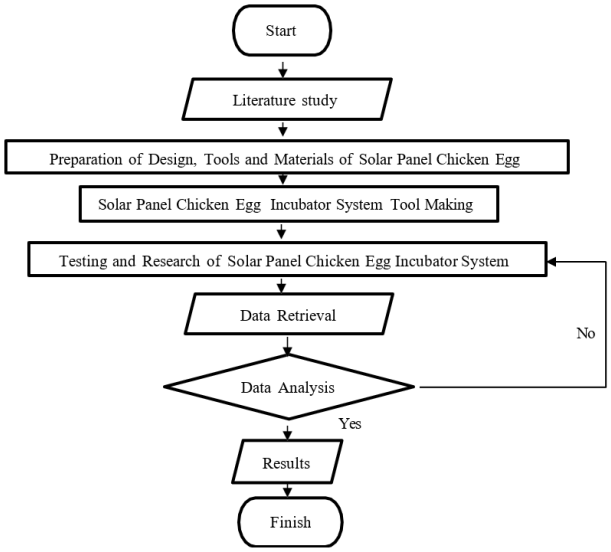

Figure 1. Schematic diagram of a solar-powered chicken egg incubator

Incubator Circuit Design

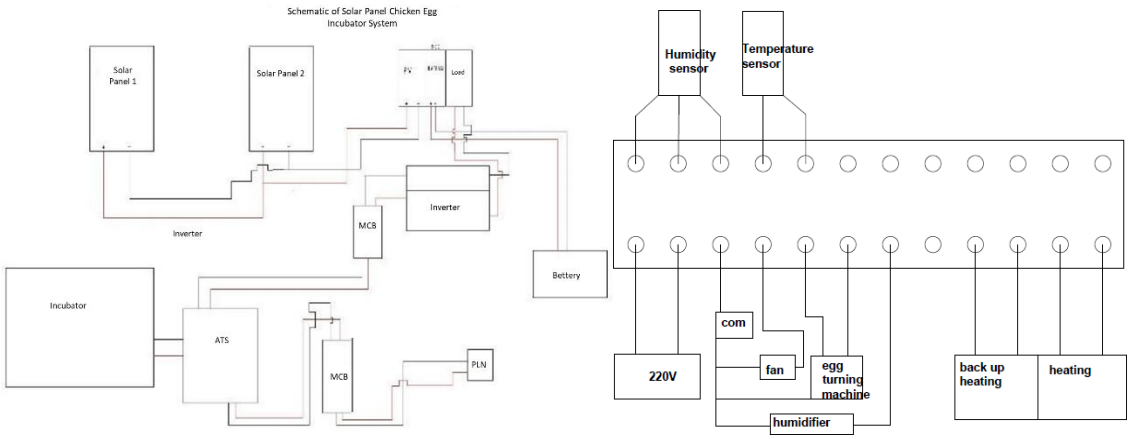

Figure 2. Electrical schematic drawings: (a) solar-powered chicken egg incubator circuit and (b) automatic incubator machine

Figure 3. (a) Incubator design drawing; (b) physical drawing of the electrical circuit and solar-powered chicken egg incubator

Investment Cost of Solar-Powered Chicken Egg Incubator

Table 1. Investment Cost

No	Item Name	Total	Item Price
1	Solar Panel 150 Wp	2	Rp2.420.000
2	Battery 12 V / 60 Ah	1	Rp1.020.000
3	Solar Charge Controller 20 A	1	Rp375.000
4	Inverter 500 W	1	Rp320.000
5	Automatic Transfer Switch 2P 125A 230V	1	Rp330.000
6	Transformer Box	1	Rp130.000
7	MCB	2	Rp60.000
8	AC Current Installation Cable (10 m)	1	Rp50.000
9	Automatic Computer Control Incubator XM-18	1	Rp320.000
10	DC Current Installation Cable (10 m)	1	Rp15.000
11	Iron Elbow (7 m)	4	Rp210.000
12	Plywood Board 6 mm (100 × 60 cm)	4	Rp155.000
13	Plywood Board 6 mm (60 × 60 cm)	2	Rp40.000
14	Egg Rack	1	Rp10.000
15	Mist Maker Humidity Ultrasonic	1	Rp110.000
16	Lamp (25 W)	2	Rp10.000
17	Motor Synchronous 50KTYZ	1	Rp90.000
18	Other costs		Rp335.000
	Total		**Rp6.000.000**

Calculation Design Basis

In the design of this solar panel chicken egg incubator machine, the production process is run by a battery as an energy source, where the battery function is very important in this tool. To find out the electrical power needed by the incubator, the following equation is used [7].

$$E = P \,.\, t \tag{1}$$

Description:

E = Electrical Energy (Watt-hours)
P = Electrical Power (Watt)
t = Time (Hours)

Input Power Calculation [8]:

$$P = V \,.\, I \tag{2}$$

Description:

P = Electrical Power (Watt)
V = Voltage (Volt)
I = Current (Ampere)

The calculation formula for battery charging time by solar panels is as follows [9]:

$$t = \frac{c}{i} \tag{3}$$

Description:

t = Charging Time (Hours)
c = Battery Capacity (Ah)
i = Battery Charging Current (Ampere)

For the formula to calculate BEP (Break Even Point), the following is used [10]:

$$BEP = \frac{FC}{P - VC} \tag{4}$$

Description:

BEP = Break Even Point
FC = Fixed Cost
P = Price per Unit
VC = Variable Cost per Unit

RESULT AND DISCUSSION

Battery Power Consumption

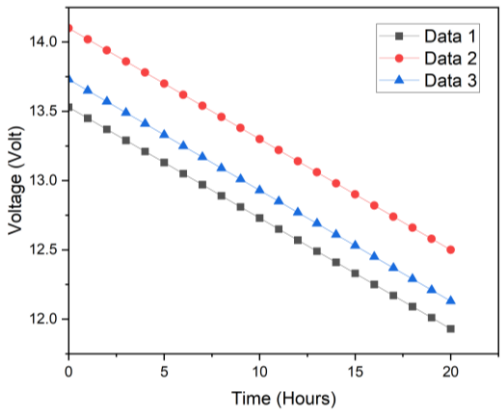

Figure 4. Battery power consumption

From the table and graph above, it can be seen that this solar panel chicken egg incubator works for 20 hours from 14.00 WIB to 10.00 WIB. The incubator power consumption obtained shows that every 1 hour the voltage drops by 0.08 V constantly. In three instances of taking data at the same time and in the same hot weather conditions, the three data sets have exactly the same voltage drop. From the formula calculation, it is found that when the incubator system turns on to increase the temperature in the incubator from 36 ℃ to 38.5 ℃, it takes 4 minutes with a current flow of 0.32 A and a voltage of 213 V. Meanwhile, when it reaches a temperature of 38.5 ℃, the system will turn off until the temperature drops to 36 ℃, which takes 4 minutes with a current flow of 0.003 A and a voltage of 213 V. So, the power required by this solar panel chicken egg incubator is 74.55 W. Then the total power required by this solar panel chicken egg incubator to work for 20 hours is 745.5 Wh.

Battery Charging Time

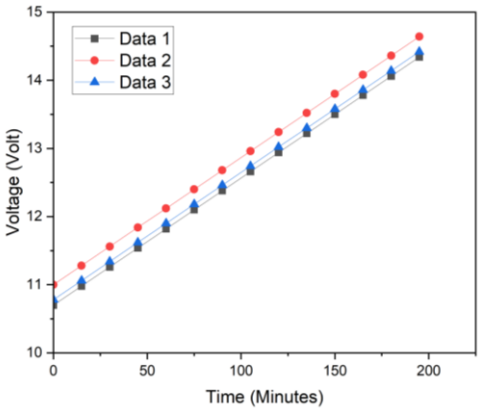

Figure 5. Battery charging time

Based on the table and graph above, it can be seen that battery charging is carried out from 10:30 WIB to 14:00 WIB. Every 15 minutes, the battery voltage (V) rises by 0.28 V constantly for 195 minutes or 3 hours 15 minutes. In the three instances of data collection, the exact same results were obtained because the data collection was carried out in a state of very hot sunlight during these three data collections. From the calculation of the formula carried out, it is found that the solar panel with a capacity of 300 Wp is able to charge the battery from a drop state, namely at 10.7 V to a full battery at a voltage of about 14.5 V, taking 3 hours 12 minutes.

BEP (Break Even Point)

In this experiment, 15 native chicken eggs were used for hatching trials. After incubating for about 20 days, 13 native chicks hatched and 2 native chicks failed to hatch, so it can be known that the success rate of this egg hatching machine is 86.6%. Before calculating the BEP (Break Even Point), it is necessary to know the age of use of this series of solar panel chicken egg incubators, which has a general life of 20 years. The percentage of success of the incubator machine in hatching eggs is 86%. The selling price of 1-week-old native chicks is generally Rp 10,000/head. The cost of 1 chicken egg and others is Rp 7,000.

Because the capacity of this chicken egg incubator machine is large, able to accommodate up to 100 native chicken eggs, it is assumed that if once incubating 100 native chicken eggs, the eggs that will hatch are as many as 86 chicks. One incubation takes 20 days. Then BEP can be achieved within 500 days or 1 year and 5 months.

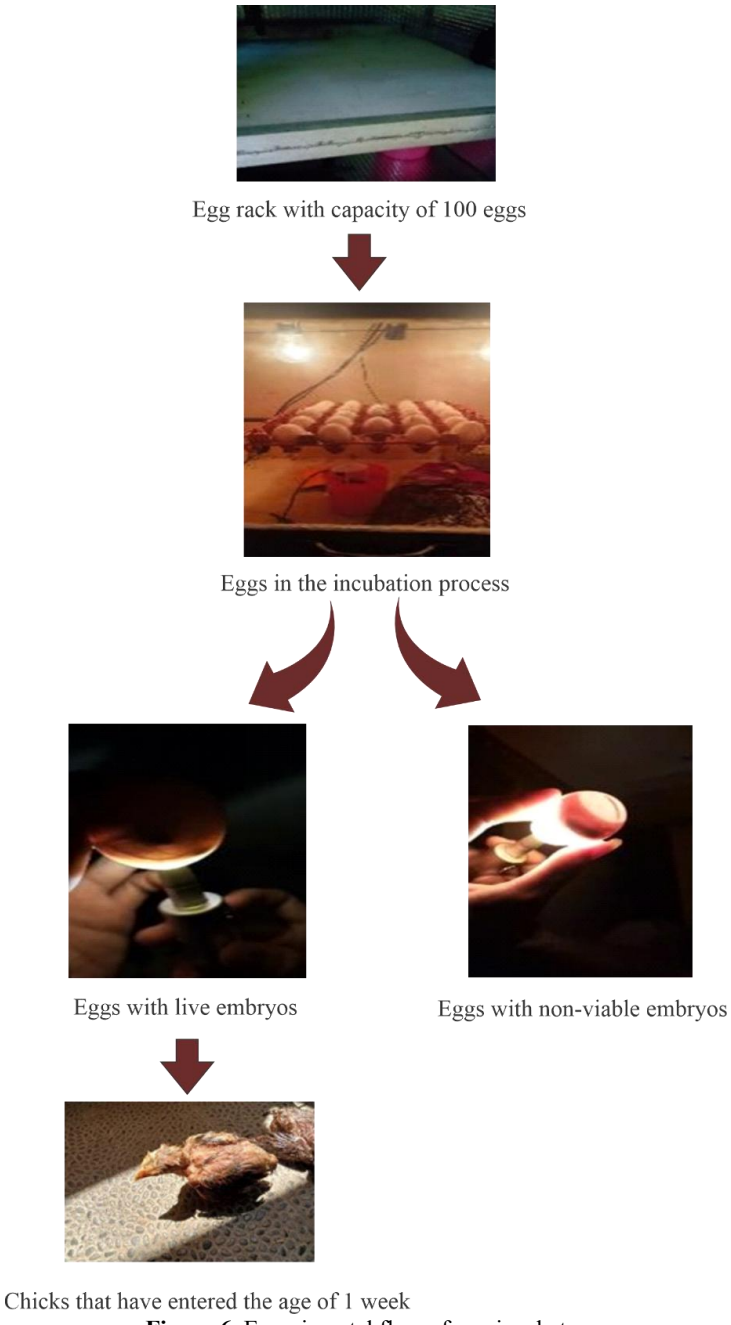

Figure 6. Experimental flow of egg incubator

CONCLUSIONS

From this study, it was found that the incubator power is 74.55 W, which works for 20 hours a day. The current flowing when the system is on is 0.32 A, and when the system is off, the current flow is 0.03 A, at a voltage of 213 V. With a battery capacity of 12 V / 80 Ah, the battery is only used for 20 hours a day and 4 hours using State Electricity Company electricity when charging the battery. For battery charging with 150 Wp solar panels, as many as 2 pieces in series to a total of 300 Wp, can charge the battery to 14.6 V in 3 hours 15 minutes. For the percentage of success of hatching chicken eggs from testing, the value is 86%. Therefore, in the calculation of BEP (Break Even Point) or break-even point, it can be achieved within 500 days or 1 year and 5 months in the incubation process carried out continuously.

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