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Design of a Portable Solar Powered Solar Incubator

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Abstract: ***The incubation technology is having been an efficient means of producing chicks from eggs. The incubation technology does not require the service of hen before the chick is obtained from the laid eggs. The process automatically transforms eggs into chicks with some required number of days. Various types of egg incubator have been designed and fabricated by many researchers using different approach. This paper presents a more efficient incubator that was fabricated mechanically and powered by a solar energy. The fabricated poultry incubator is portable, user friendly, not expensive, and has a very low cost of maintenance. Solar energy was incorporated to take care of any power failure of electricity. The fabricated incubator was evaluated for its efficiency. The temperature supplied by the solar source was about 37°C which is enough to heat up the incubator to hatch the eggs. The average range of value obtained for the humidity was 56.15°C and the angle of tilt to rotate the tray was 46.58°. 95% of the eggs were fully hatched.***

Keywords*: Design, Incubator, Solar powered, Temperature***.**

I. INTRODUCTION

Egg incubation process is a technology of producing eggs from chicks without involving the mother hen in the process of hatching. The natural way of egg incubation is that the hen shields the eggs by providing warmth to generate heat to enhance the growth of the embryo [1] [2]. This will continue for days until the chick is fully developed and finds its way out from the shell. During this process, heat, air and moisture play different roles to get the egg hatched [3]. But the growth in technology results into the use of artificial means of incubating eggs to bring out chicks upon development. This artificial process has been in existence over thousands of years, and kept improving for a better efficiency [4]. The Chinese, Egyptian and most developing countries have been using charcoal and fire wood to provide warmth required to hatch the eggs. But advent of technology came up with the use of electricity to generate heat [4] [5]. Eventually, there exist untimely power failure that lead to the development of using solar to power incubators [6] [7]. The solar powered incubators are automatic appliance that is incorporated with an automatic egg turning device with a controller to maintain the heat level, required moisture and air needed to carry out the task [8] [9].

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II. METHODOLOGY

The solar powered incubator with capacity of hatching 30 chicken egg was fabricated and tested for efficient performance. Plywood with dimension 550mm long, 400mm width and 700mm height was used to obtain the incubator box. Two tungsten bulbs of 100 Watts were incorporated to heat up the eggs, a dimmer switch was also incorporated to regulate the temperature of the incubator to 37°C, the fan shown in Figure 2, was also installed to ventilate and control the air needed by the incubator. A water tray was fabricated with thin sheet and placed on the bottom of the cabinet to increase and recover humidity in the incubator during the experimental period. A solar Panel of 200W, 12V battery and a DC to AC converter (inverter) is also incorporated. The 12V battery connected to the inverter to convert the DC to AC current and the inverter is connected to the bulb through the dimmer. The charged solar supplies the required energy to heat up the incubator

A. Mechanical Design

The project construction was achieved using various components which consist of the incubator box, fan, 2 pieces of 100 watts tungsten bulbs, electrical component and the egg turning trays.

B. Incubator Box

Plywood with good quality was purchased to create a box-like shape to form the body of the incubator as shown in Figure 1. The plywood was chosen due to its insulation properties, ease in construction, flexibility and durability. The incubator box was constructed having a dimension of 550mm long, 400mm width and 700mm height, with 4mm thickness.

C. Fan

A fan was incorporated into the design of the incubator to cool and control the amount of air circulating within the incubation system. This is shown in Figure 2.

D. Egg Turning Trays

The egg turning trays were positioned inside the incubator box to change the position of eggs at various intervals at least once in a day to enable uniformity in temperature and humidity level. Two of the trays were made using flexible wire net and soft wood as illustrated in Fig. 3. Holding 30 eggs, the inner tray was made up of light wood and cylindrical

round light aluminum material so that the eggs can rotate easily, when the DC motor is moving from clockwise direction to anticlockwise direction or vice versa. This aluminum, was used to divide the egg tray into five equal parts so that the eggs can be placed inside it, (at least five eggs in each division). The eggs turning trays as shown in figure 3.

E. Electrical Component

The incubator has electrical connection of two circuit board. The first circuit board was used to connect the electric bulbs and thermistor. This was incorporated to regulate the bulb to off immediately when the temperature is above required temperature and pick up back when the temperature is below required temperature. The second circuit (Figure 5), was meant to control the movement of electric motor. The electric motor rotates at every two hours from clockwise direction to anticlockwise direction and vice versa to change the position of the eggs, so that the eggs yolk will not being in single position and allow the egg to develop properly.

F. The Electric Bulb, Solar Panel, Inverter and Battery

100W tungsten electric light bulb, which served as the source of heat, to warm the inner unit to a temperature of 37°C. the solar panel, battery and AC to DC converter (inverter) is shown below.

III. WORKING PRINCIPLE OF THE INCUBATOR

The temperature of incubator was maintained between 37-38°C. this was enabled by measuring the temperature by placing the thermometer slightly above the center point of the egg. Adequate control of the heat was maintained to avoid overheating and underheating which can affect the hatchability of the embryo. The moisture level was also maintained around 50-55% and later increased to around 65% in the last few days of incubation. Water surface was maintained as large as the wideness of the egg tray and positioned inside a pan under the egg tray, this helps to humidify the system. This air regulation is necessary during embryo development for efficient output. This was achieved by using the fan to effectively circulate the air. The eggs were placed inside the trays and turned at least three times a day to ensure all sides get exposed to heat. This process continues and temperature regulated until the eggs are hatched. Table 1 gives the temperature range during incubation process.

Table1: Average Temperature of the incubator on daily basis (°C).

Days	Average Temperature of the incubator on daily basis (°C)
1	38.0
2	37.6
3	37.6
4	36.8
5	37.7
6	37.7
7	37.0
8	37.1
9	37.2
10	37.4
11	37.4
12	37.8
13	37.7
14	37.2
15	37.8
16	38.0
17	37.7
18	37.0
19	37.2
20	37.0
21	37.0

IV. RESULT AND DISCUSSION

It is not possible to achieve hatching success of 100%. This is as a result of unstable factors such as unstable humidity, fluctuations in temperature, non-uniformity on the eggs conditions as a result of turning, power failure from the sun as a result of prolonged raining. Hatchability rate above 70 percent was achieved, which shows an efficiency in the design conditions and can be suitable for use in poultry enterprise. 95% of all the fertile eggs were successfully hatched. The remaining 5% could represent those that failed to hatch as a result of infections, wrong handling or unnoticeable cracks on the eggs.

V. FIGURES AND TABLES

Figure1: Incubation box

Figure 2: A portable fan

Figure. 3: Egg turning trays

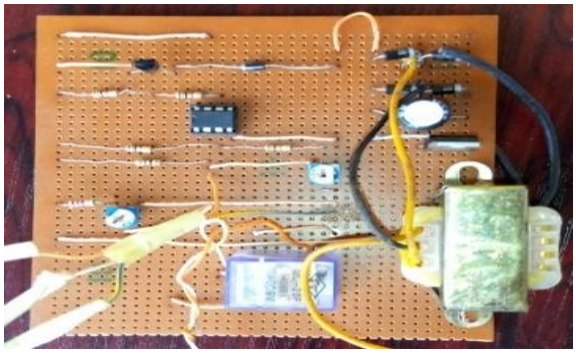

Figure. 4: Circuit Board

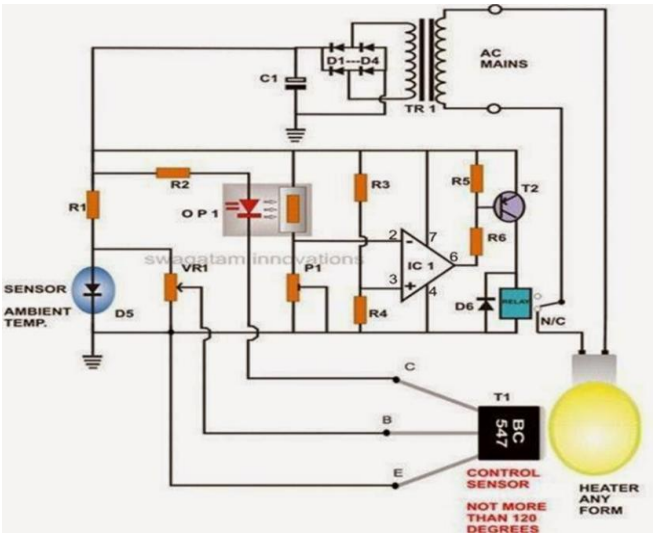

Figure 5: Circuit Diagram for Heating Incubator

12V Battery

Solar Panel and Inverter

VI. CONCLUSION

A solar powered poultry incubator was designed. This was designed and fabricated using readily available and affordable materials. The material used can withstand any weather condition without deteriorating. It can be easily operated without the assistance of any expert and the maintenance cost is very minimal. The solar panel that was incorporated served as a new technology to tackle the power failure that might set in during incubation stage. This make a good revolution in poultry farming especially among small scale farmers. The designed incubator can be placed at home and used locally to hatch different kinds of poultry eggs such as chicks, ostrich, goose, turkey, guinea fowl, duck, etc.

REFERENCES

1 D. O.A, O. J.O and S. H.D, "Proposed Development of a Solar Powered Automated Incubator for Chickens," International Journal of Engineering and Techniques, vol. 4, no. 1, pp. 517-524, 2018.

2 U. A. B, L. K, M. M and a. M. Adamu, "Construction of an ElectricallyOperated Egg Incubator," International Journal of Modern Engineering Sciences, 5(1):1-18, vol. 5, no. 1, pp. 1-18, 2016.

3 R. K, N. J, S. S.G, T. C and V. K. R, " Design and Implementation of a Fully Automated Egg Incubator.," Incubator. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering , vol. 3, no. 2, pp. 7666-7772, 2014.

4 I. E, O. G.O and a. I. F.T, "DESIGN AND IMPLEMENTATION OF AUTOMATIC FIXED FACTORS EGG INCUBATOR," INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD, vol. 5, no. 6, pp. 1-8, 2019.

5 K. T, I. Z, R. M and R. k, "Solar Powered Egg Incubator Design," IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), vol. 14, no. 6, pp. 13-19, 2019.

6 A. W. Okpagu P. E. & Nwosu, "DEVELOPMENT AND TEMPERATURE CONTROL OF SMART EGG INCUBATOR SYSTEM FOR VARIOUS TYPES OF EGG," European Journal of Engineering and Technology, vol. 4, no. 2, pp. 13-21, 2016.

7 K. L. O, A. A. A, O. R.A and E. S.A.A, "Performance Evaluation of a Solar Powered Poultry Egg Incubator," International Research Journal of Advanced Engineering and Science, vol. 3, no. 2, pp. 255-264, 2018.

8 B. a. V. H. Rogelio, "Design and Development of a Microcontroller based Egg Incubator for Small Scale Poultry Production," Global Journal of Science Frontier Research: The Agriculture and Veterinary 16 (2): 1-7. , vol. 16, no. 2, pp. 1-7, 2016.

9 K. a. Y. O. Mansaray, "Evaluation of a Solar Powered Chicken Egg Incubator.," International Journal of Emerging Technology and Advanced Engineering , vol. 5, pp. 31-36, 2015.

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