SOLAR INCUBATOR BY USING TEMPERATURE CONTROLLER

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Abstract - *In this project a new method of solar poultry incubator design is suggested which could be used to hatch eggs from solar pv and hence could reduce the usage of power and can increasing at maximum usage of solar power which is a renewable source of energy. It is a prototype temperature control of hatchery incubator using microcontroller. The nature of hatching process takes 21 days with a temperature of 99-102°F or 37 to 38.9°C, with proper humidity and the egg must be moved several times for certain hour for optimum performance. In this project, the lamps were used as heaters to develop suitable heat temperature for the eggs. By using water and controlling fan, it is can make sure the humidity and ventilation in good condition. The health condition of egg is very important for the development of embryo within the eggs.*

Key Words: *Battery, Charge controller, Solar PV, Temperature, Humidity, Ventilation, Hatchability, egg incubator.*

1. INTRODUCTION

A mother hen performs hatching function at low efficiency, using artificial method, in an incubator system simulates the environmental conditions required for such operation is used by poultry farmers within specified temperature and relative humidity range. These range between 36°c-39°c and increases efficiency 50%- 90%.In this project a new method of solar poultry incubator design is suggested which could be used to hatch eggs from solar pv and hence could reduce the usage of power and can maximize the usage of solar power which is a renewable source of energy. Solar power-based Egg incubator are used to produce clean energy without harmful effects to environment.

It is a prototype temperature control of hatchery incubator using microcontroller. The nature of hatching process takes 21days with a temperature of 99-102°F or 37 to 38.9°C, with proper humidity and the egg must be moved several times for certain hour for optimum performance. In this project, the lamps were used as heaters to develop suitable heat temperature for the eggs. By using water and controlling fan, it is can make sure the humidity and ventilation in good conditions.

- A mother hen performs hatching function at low efficiency.
- Using artificial method, in an incubator, a system simulates the environmental conditions required for such operation is used by poultry farmers within specified temperature and relative humidity range.
- These range between 36°c-39°c and increases efficiency 50%- 90%.
- Solar power-based Egg incubator are used to produce clean energy without harmful effects to environment.

1.2 OBJECTIVES

Following are the main objective of the present study:

- Design a solar powered egg incubator.
- Fabricate the incubator with more of locally source materials.
- Hatch eggs in a clean environment devoid of any energy related pollution.
- Encourage the youth to venture into agriculture (poultry farm), small and large scale.

1.3 SCOPE OF PROJECT

The Scope of this project work is limited to design and fabrication of a tiny size solar powered egg incubator. Its capacity is limited to fifty eggs per time. It covers design, component fabrication and assembly of the various components to form the incubation.

2.1 METHODOLOGY

Electrical power has been proven to be one of the most important resource in every country and due to its high demand and widely used, it has become exhaustible at one day because of it's a non-renewable energy source. So, we generate continuous power by using renewable energy sources like wind energy, solar energy etc., in my project in existing system i.e., natural hatching requires continuous heating to the eggs up to completion of its hatching, but due to more eggs provided below the hen some eggs will spoil due to lack of good hatching. So, we avoid that problem we are implement the solar incubator by using temperature controller. By this project we get 100% good hatching and no spoiling of eggs are appeared here. Its renewable energy source so maintenance cost also low and eco-friendly.

According to Siriluk S. (2011) designed an automatic solar incubator consist a number of chicks produce through natural hatching is very low due to irregular heating, humidity etc., So A Solar powered automatic incubator system was designed to operate in place where there is no source of electricity. The solar energy is used in two forms to provide solar electric energy and also to provide solar heat energy the solar to provide the electricity by using reflectors. Microcontroller, while the solar PV was used to charge the battery and supply to the power system during a day. At night or poor whether when battery used to power system, if the temperature goes below 36°C an electric heater will be used to increase the temperature band to 36-37 °C and the heat of the heater will be decrease if temperature is getting greater than 37°C.The turning eggs is done 12 times daily and is achieved by using stepper motor which drive the egg tray either in clockwise or counter clockwise direction. Thus, good hatching will achieve.

2.2 EXISTING SYSTEM

Many domestic bird growers in incubate eggs to help sustain their flock over a period of time. This user's manual is designed to assist those who wish to incubate small number of domestic poultry eggs. A mother hen performs hatching function at low efficiency and artificially in an incubator a system which simulates the environmental conditions required for such operations is used by poultry farmers to do this operation within specified temperature and relative humidity range. These ranges are between 36-39°C and 50-70% respectively. So as to maintain this temperature range sustained heat supply is required.

In the most developing countries, the vast majority of poultry farmers in the rural communities operate their farms on small scale or even subsistence level. In traditional poultry husbandry, the hens lay their eggs in odd corners of the house or under cover outside the house. In their free range they mate at random and hatch their fertile eggs by natural incubation, producing about 3-10 chicks per hatch. Therefore, a laying hen can produce at best between 12 and 30 chicks per year, whereas under modern methods of artificial incubation, a laying hen with no brooding disposition can produce up to 150 chicks a year .Hatching involves the production of day–old chicks from parent stock through natural or artificial incubation of fertile eggs. Incubation is the process of aiding the development of a fertilized egg from the embryo inside to a live chick at appropriate time by providing such factors as heat, humidity, ventilation, and turning of eggs. Eggs can be hatched naturally by getting a hen to sit on her fertile eggs or those of other hens, or by artificial means which represent a stimulation of the necessary factors of the natural process.

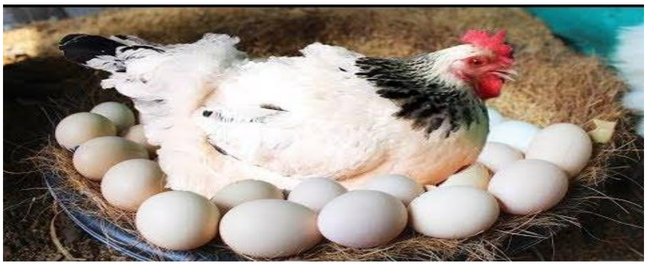

FIG 1: Hen with Eggs

2.3 PROPOSED SYSTEM

The aim of this project is to hatching the eggs with the temperature and humidity controller. The PV panel which is used to produce DC power from sunlight and the output power from the panel is fed into the charge controller and from there to the battery. The charge controller is used so as to prevent the battery from getting overcharged and it has got a blocking diode inside which prevents the flow of current from battery to panel when the panel is not producing any power and Relay is employed to interface the circuit with the grid so it is essential to have grid supply as to continue the incubation process even when the panel is not able to produce power due to lack of solar irradiation. The Temperature controller is employed so as to control the temperature inside the incubator and it is a prototype temperature control of hatchery incubator using microcontroller, the nature of hatching process takes place 21 days with a temperature of 37-38°C, with proper humidity and the eggs must be moved several times for certain hour for optimum performance. In the incubator the lamps are used as heater to give suitable heat temperature for the eggs and also by using water and co1ntrolling fan, it is can make sure the humidity and ventilation in good condition and the health of eggs is very important for development of embryo within the eggs.

2.4 PRINCIPLES

In fixity of purpose heat load of the PV poultry egg incubator, the following reckon were made: steady state condition exists, one dimensional heat flow prevails, incubator materials have persistent thermal conductivity, and the incubator is a closed system at constant temperature.

Table I shows the wet bulb reading at numerous incubator temperatures. The heat balance equation of the incubator chamber was appraised by

$$Q_{load} = Q_{pv} + Q_{egg} - Q_{cnd} - Q_{cnv}$$

Q_{load} = Heat load of the incubator, W

Q_{pv} = Heat supplied by PV panels, W

Q_{egg} = Heat supplies due to metabolic actions of egg, W

Q_{cnd} = Heat loss by conduction through incubator walls

Q_{cnv} = Heat loss through air convection

Table-1: Wet Bulb Reading at Various Temperatures

Incubator Temperature	Wet Bulb Readings					
100^0F	81.3	83.3	85.3	87.3	89.0	90.7
101^0F	82.2	84.2	86.2	88.2	90.0	91.7
Percentage Relative Humidity	45%	50%	55%	60%	65%	70%

2.5 IMPLEMENTATION

An incubator for chicken eggs was constructed to test and evaluate its performance. The incubator box's dimensions were 61cm (depth), 36.5cm (width), and 62cm(height).It was made from 12mm thick plywood, the incubator has four stands, the insides of the cabinet were covered with insulation foam to minimize heat losses by absorption and transmission through the walls to the atmosphere. The door of the incubator is made from plywood and glass, plywood was because of the insulating properties, ease in fabrication, durability and availability in the local market. Likewise, glass was chosen for the visibility of the eggs inside. schematic diagram, structural design shows in figures

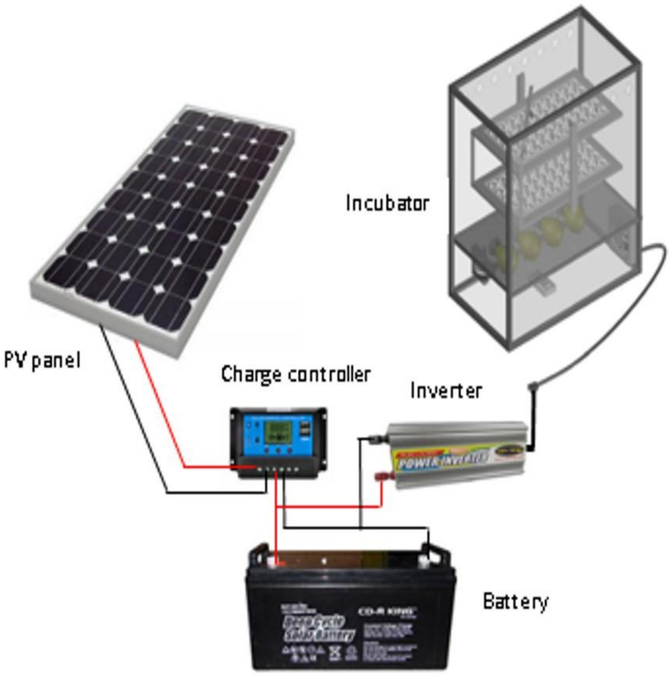

FIG 2: Schematic diagram

The incubator should provide the following conditions. They are, Constant maintenance of a certain temperature and ventilation, automatic turning of trays with eggs (in nature the chicken itself turns the eggs with its break), and maintaining a certain level of humidity in the incubator. The structural design of incubator shown in below:

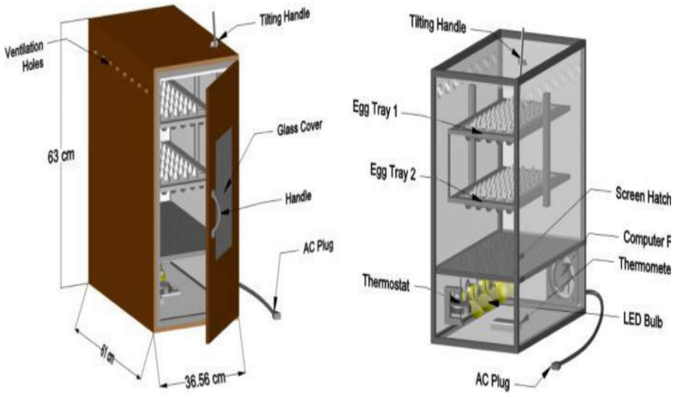

FIG 3: Structural Design

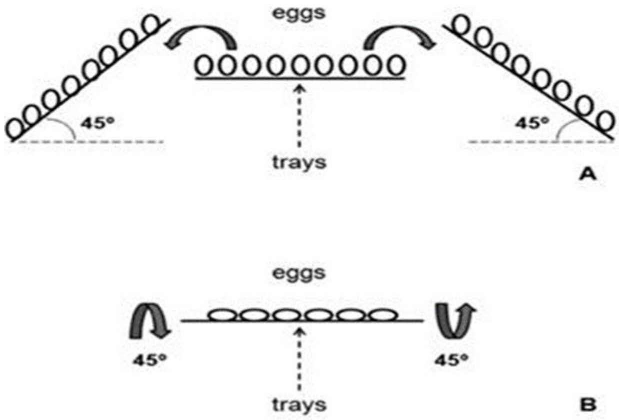

FIG 4: Turning of egg tray a) Vertical and b) Horizontal

The trays for egg turning are very important for the positioning of the eggs. The egg incubation chamber is composed of two egg trays that have the capacity of 100eggs spread in the two trays. The distance between the trays was enough to prevent the base of the upper tray from touching the eggs that may be set at the lower tray.

In this egg incubator the eggs were turned at least three times per day for normal embryonic development to take place. The gap between the trays, when turned to an angle of 45°C is 35.5mm. Manual turning of eggs was not required. Egg-turning failures may reduce the formation of embryonic fluids, as well as hinder the formation and growth of embryonic annexes, thereby hindering embryonic and fetal development.

From 2 days towards the end of the twenty-one days incubation period the eggs started hatching. The hatched day-old chicks are shown as in the incubator chamber in figure.

FIG 5: Solar hatched day old chicks inside incubator

3.1 IMPORTANCE OF PROJECT

Solar powered egg incubator is designed to increase production by 200% for rural based small-scale poultry farmers by increasing number of eggs hatched, and hatching efficiency from 40% to 95%. The solar poultry incubator there will not be any power shortage or breakdown, also there will be no recurring expenditure to run the incubator. The solar incubator can save up to 50% electricity, so that hatching expenses will be less. Another aspect is that it is possible to plan when to hatch the chicks unlike with the hen one may not know when it can sit for the eggs. Artificial incubation can't spread parasites and diseases to the small chicks and lastly there is no cost for feeding a broody hen since an incubator is used. There are no chances of the hen damaging eggs through pecking, common occurrence with natural incubation, generally for poultry humidity level is between 60-70% and last 3 days 70-80%.The main advantage of solar incubator is when comparing with conventional one, it will work in three options that is grid, battery and solar. The additional benefit is it will conserve energy, an Eco friendly product and also to use and the environmental protection is, according to the calculation, during the ten years each solar incubator will reduce the coal discharge into the atmosphere of 12tons of carbondioxide,656 tons of carbon dioxide, 520 tons of dust,162 tons of Sulphur dioxide, 350 tons of hydrogen nitrogen compounds, this is not a small number, so the solar energy incubator is green environmental protection an effective measures.

3.2 EXPLANATION

Many The block diagram of the proposed solar poultry incubator is given below in figure 5. It consists of a PV panel which is used to produce DC power from sunlight and the output power from the panel is fed into the charge controller and from there to the battery. The charge controller is used so as to prevent the battery from getting overcharged and it has got a blocking diode inside which prevents the flow of current from battery to panel when the panel is not producing any power. Relay is employed to interface the circuit with the grid. It is essential to have grid supply so as to continue the incubation process even when the panel is not able to produce power due to lack of solar irradiation. Temperature controller is employed so as to control the temperature inside the incubator. It is very essential to control the temperature inside the incubator. It is a prototype temperature control of hatchery incubator using microcontroller, the nature of hatching process takes 21days with a temperature of 37-38°C, with proper humidity and the egg must be moved multiple times for certain hour for optimum performance. In this project, lamps are used as heater to give suitable heat temperature for the eggs, by using water and controlling fan, it is can make sure the humidity and ventilation in good condition.

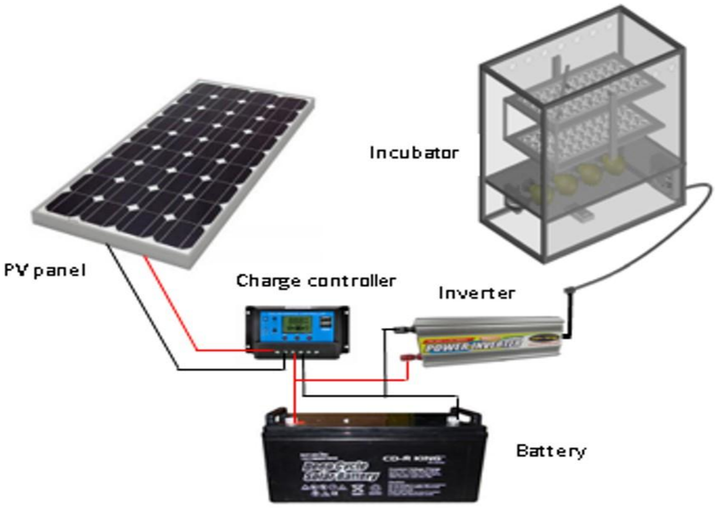

FIG 6: Schematic diagram

While egg positioning and turning were done manually at 45°C rotation, using a lever handle at six hourly intervals. This prevents the sticking of egg yolks on the shell. Eggs set on their sides must be orientated 1/2 turn at least 3 times daily. Eggs set with the air cell end up should be chambered in the opposite way of direction for 3 times daily. This keeps the embryo centered in the egg and prevents it from sticking to the shell membrane. If hand turning, to ensure proper turning, mark each side of the egg with a pencil. Put an "x" on one side and an "o" on the opposite side. Stop orienting the position of eggs for the last three (3) days of the incubation cycle (at 18 days for chickens, 25 days for waterfowl, etc.) and do not open the incubator until the hatch is completed to ensure that a desirable hatching humidity is maintained.

Four factors are of major importance aspects in incubating eggs artificially: temperature, humidity, ventilation and turning. Of these factors, temperature is the most critical. However, humidity tends to be overlooked extensively and causes many hatching problems. Extensive research has shown that the optimum incubator temperature is 100°F when relative humidity could be 60 percent. Concentrations of oxygen should be maintained at above 20 percent, carbon dioxide should be below 0.5 percent, and air movement past the egg should be 12 cubic feet per minute. At two days towards the completion of the twenty-one days incubation period as the eggs started hatching.

Table 2: Incubation Periods of Other Species

Incubation Periods (species and days required to hatch)			
Bobwhite Quail	(23-24)	Guinea	(27-28)
Chicken	(21)	Muscovy Duck	(35)
Chukar Partridge	(23-24)	Pheasants	(24-26)
Coturnix Quail	(16-18)	Ostrich	(42)
Ducks	(28)	Swan	(35)
Geese	(28-33)	Turkey	(28)

4.1 COMPONENTS REQUIRED WITH THEIR SPECIFICATION

COMPONENTS	RATING
Solar Panel	: 18 Volts,3.33 Amps, 80 Watts
Battery	: 24 Volts. Lead Acid Battery
Charge Controller	: 12volts,520w
Dc Fan	: 12v
Inverter	: 220v
Led Bulb	: 40w
Synchronous Motor	: 150 To 1800 Rpm
Incubator	: Fridge Type Incubator

4.2 CONSTRUCTION

The incubator was built as show in Figures 7 to 8. Figure 7 shows solar PV system connects whilst Figure 8 shows connections in Figure 8 show between the PV module, controller or regulator and the battery. The casing of cover was made from foam material. It was preferred because it was to susceptible to sudden change of temperatures and humidity and was easy and cheap to acquire. However, to make the casing durable, a thin hardboard was used to enclose the foam in between other components connection are as shown in Figure 8. Figure 9 shows the assembly and connection of dehumidifying fan which is used for regulating relative humidity in the incubator.

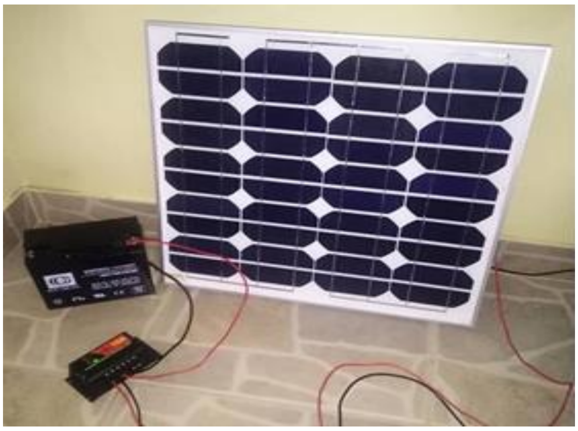

FIG 7: PV system components connections

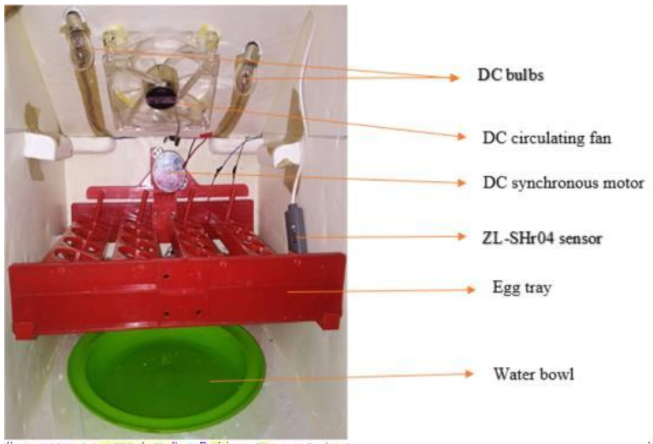

FIG 8: Experimental setup of the incubator

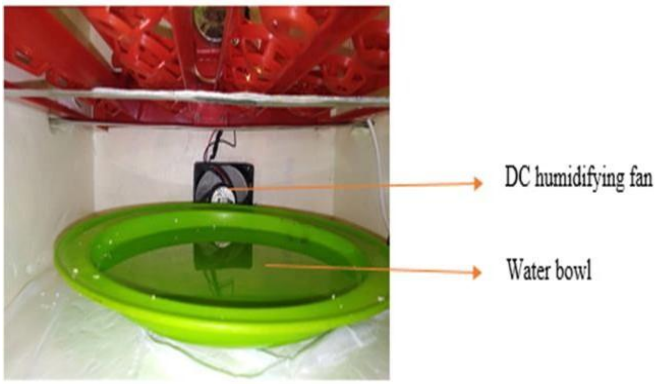

FIG 9: DC humidifying fan and corresponding water reservoir

4.3 WORKING

Small Machines are semi-automatic having automatic heat control and manual egg turning, this machine can be powered through 3 power sources they are first option is solar power with 24V/250Wp photo voltaic module, then 12V/200Ah battery is provided to charge and reserve power. Second option is grid in which we have given a Switched Mode Power Supply (SMPS) option for AC/DC conversion, and the third is input grid power of solar power fails. The nature of hatching process takes 21days with a temperature of 99-102°F or 37 to 38.9°C, with proper humidity and the egg must be moved several times for certain hour for optimum performance. It will fill with the clean water or distilled water in to the plastic bowl, the water level is sufficient to develop 50% humidity/moisture inside the incubator during setting time (18days), By using water and controlling fan, it is can make sure the humidity and ventilation in good condition. Freshly collected eggs without dirt on shell keep on the tray, the trays for egg turning are very important for the positioning of the eggs, so the distance between the trays was enough to prevent the base of the upper tray from touching the eggs that may be set at the lower tray, in this egg incubator, the eggs were turned at least three times per day for normal embryonic development to take place, the gap between the egg trays when turned to an angle of 45°C is 35.5mm. The relative humidity in the existing incubator dropped in the afternoon due to the frequent opening of incubator door during the manual turning of the eggs. At night ana early morning, the eggs were not turned, thus opening of the incubator was not required, unlike during daytime when the incubator operator turned the eggs. During daytime, water was added to the water pan, and it affected the relative humidity. When water levels increased, the relative humidity increased and when water levels dropped, the relative humidity also dropped. The temperature display unit reading shoes 34.1 degrees Celsius and a relative humidity reading of 24.4%, when the temperature reading was 39.2 degrees and the lights went off, the relative humidity reading was 18.7% regarding the turning of egg tray on either side of the axle. The bulbs are ON when the temperature is below 36.5°C.

4.4 OPERATION

There are three key parameters important for the incubation of eggs. These are relative humidity, temperature and egg turning defined in terms of angle of inclination of egg tray as it swings on either side of the axis. The schematic diagram showing a cross section of the incubator with features for the control of such parameters is show in figure 10. The bulbs are using to provide heating to raise temperature to the required range. The fan is used speed water evaporation from the water reservoir to increase humidity to the required level. The motor which is equipped with actuator mechanism is used to tilt egg tray at an angle of 45 degrees on either side of the axle at predetermined intervals. The incubator has electronic displays showing balance of days left before hatching. They also show the internal ambient temperature and relative humidity. The incubator components are powered from solar photovoltaic (PV) energy system. The system has the option of powering the circuits directly from the panel. Alternatively, when there is not enough power from the panel the system is powered from a battery which is used as energy storage.

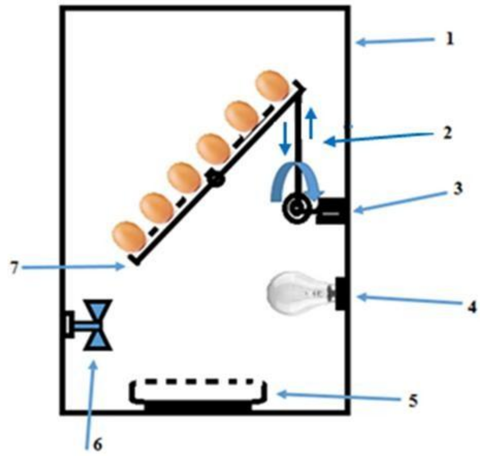

FIG 10: Cross sectional view of the egg incubator

4.5 SOLAR PANEL

Electrical energy can be harvested from solar power by means of either photovoltaic or concentrated solar power systems. Photovoltaic directly convert solar energy into electricity. They work on the principle of the photovoltaic effect. When certain materials are exposed to any kind light, they absorb photons and release free electrons. This phenomenon is called as the photoelectric effect. Photovoltaic effect is a methodology for producing direct current electricity based on the principle of the photoelectric effect.

The solar panel was based on the principle of photovoltaic effect, solar cells or photovoltaic cells are made. They convert to sunlight into direct current (DC) electricity for mechanical purpose. But a single photovoltaic cell doesn't produce enough amount of electricity. Therefore, the no. of photovoltaic cells was mounted on a supporting frame and are electrically connected to each other to form a photovoltaic module or solar panel. Commonly available solar panels range from several hundred watts (say 100 watts) up to few kilowatts (ever heard of a 5kW solar panel?). They are available in different sizes and different price ranges. Solar panels or modules are designed to supply electric power at a certain voltage range (say 12v), but the current they produce is directly dependent on the incident light rays. As of now it's clear that photovoltaic modules produce DC electricity.

FIG 11: Solar Panel

4.6 BATTERY MODEL

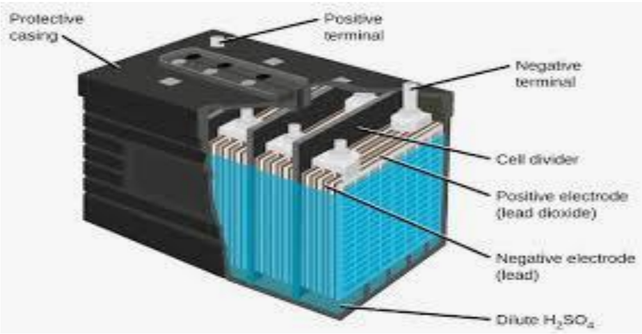

FIG 12: Battery Model

4.7 BATTERY FUNDAMENTALS

Batteries operate by converting chemical energy into electrical energy through their electrochemical discharge reactions. Batteries were composed of one or more cells, each containing a positive electrode, negative electrode, separator, and electrolyte. Cells can be divided into two major classes: primary and secondary. Primary cells are not rechargeable and must be replaced once the reactants are depleted. Secondary cells are rechargeable and require a DC charging source to restore reactants to their fully charged capacity state. Examples of primary cells include the following carbon-zinc (Leclanche or dry cell), alkaline-manganese, mercury-zinc, silver-zinc, and lithium cells (e.g., lithium-manganese dioxide, lithium-sulfur dioxide, and lithium- thionyl chloride). Examples of secondary cells include the following parts lead-lead dioxide (lead-acid), nickel-cadmium, nickel-iron, nickel-hydrogen, nickel-metal hydride, silver-zinc, silver-cadmium, and lithium-ion. For aircraft applications, secondary cells Plays the most prominent part, but primary cells are sometimes used for powering critical avionics equipment (e.g., flight data recorders).

Batteries are rated in terms of their nominal voltage (V) and ampere-hour (amp) capacity. The voltage rating is based on the number of cells connected in series and the nominal voltage of each cell (2.0 V for lead- acid and 1.2 V for nickel-cadmium). The most commonly used voltage rating for aircraft batteries is 24 V. A 24-V lead-acid battery contains 12 cells, while a 24-V nickel-cadmium battery contains either 19 or 20 cells (U.S. military rates 19-cell batteries at 24 V). Voltage ratings of 22.8 V, 25.2 V, and 26.4 V are also common with nickel-cadmium batteries, consisting of 19, 20, or 22 cells respectively. Twelve-volt lead-acid bat-terries, consisting of six cells in series, are also used in many general aviation aircraft.

The ampere-hour (Ah) capacity is available from a fully charged battery depends on its temperature, rate of discharge, and age. Normally in the aircraft batteries are rated at room temperature (25°C), the C-rate (1-hour rate), and beginning of life. Military batteries, however, often are rated in terms of the end-of- life capacity, i.e., the minimum capacity before the battery is considered unserviceable. Capacity ratings of aircraft batteries is vary widely, generally ranging from 3 to 65 Ah.

The maximum power obtainable from electric battery depends on its internal construction. High rate cells, for instance, area unit designed specifically to possess terribly low internal electrical phenomenon as needed for beginning rotary engine engines and auxiliary power units (APUs). sadly, no universally accepted customary exists for outlining the height power capability of associate craft battery. For lead-acid batteries, the height power usually is outlined in terms of the cold-cranking amperes, or CCA rating. For nickel-cadmium batteries, the height power rating usually is outlined in terms of this at most power, or Imp rating. These ratings area unit supported totally different temperatures (—18°C for CCA, 23°C for Imp), creating it troublesome to check totally different battery varieties. what is more, neither rating adequately characterizes the battery's initial peak current capability, that is particularly necessary for engine begin applications. additional rigorous peak power specifications are enclosed in some military standards. for instance, MIL-B-8565/15 specifies the initial peak current, this once fifteen s, and therefore the capability once sixty s, throughout a 14-V constant voltage discharge at two totally different temperatures (24 and —26°C).The state-of-charge of electric battery is that the proportion of its capability obtainable relative to the capability once it's totally charged. By this definition, a completely charged battery includes a state-of-charge of 100 percent and electric battery with 2 hundredth of its capability removed includes a state-of-charge of eightieth. The state-of-health of electric battery is that the proportion of its capability obtainable once totally charged relative to its rated capability.

4.8 BATTERY CONSTRUCTION

Lead-acid batteries area unit made exploitation injection-molded, plastic monoblocs that contain a bunch of cells connected nonparallel. Monoblocs generally area unit manufactured from plastic, however ABS is employed by a minimum of one manufacturer. Normally, the monobloc is the battery case, the same as a traditional automotive battery. For a lot of strong styles, monoblocs area unit assembled into a separate outer instrumentation manufactured from steel, aluminum, or fiberglass-reinforced epoxy. Cases sometimes incorporate Associate in Nursing electrical receptacle for connecting to the external circuit with a fast connect/disconnect plug. 2 generic kinds of receptacles area unit common: the "Elcon style" and also the "Cannon style". The Elcon vogue is resembling military sort MS3509. The Cannon vogue has no military equivalent, however is created by Cannon and alternative connective makers. Batteries typically incorporate thermostatically controlled heaters to boost coldness performance. The heater is steam-powered by the aircraft's AC or DC bus. shows Associate in Nursing assembly drawing of a typical lead-acid craft battery; this explicit example doesn't incorporate a heater.

4.9 CHARGE CONTROLLER

A charge controller, charge regulator or battery regulator limits the speed at that electrical phenomenon is additional to or drawn from electrical batteries. It prevents overcharging and will defend against overvoltage, which might scale back battery performance or life and will cause a security risk. it's going to conjointly stop utterly debilitating ("deep discharging") A battery, or perform controlled discharges, looking on the battery technology to guard battery life.

A star charge controller is essentially a voltage or current controller to charge the battery and keep electrical cells from overcharging. It directs the voltage and current hailing from the solar battery setting off to the electrical cell. Generally, 12V boards/panels place go into the ballpark of sixteen to 20V, thus if there's no regulation the electrical cells can broke from overcharging. Generally, electrical storage devices need around fourteen to fourteen.5V to induce utterly charged. The star charge controllers ar offered altogether options, prices and sizes. The vary of charge controllers ar from four.5A and up to 60A to 80A.

FIG 13: Charge Controller

4.9.1 TYPES OF SOLAR CHARGE CONTROLLER

There are three different types of solar charge controllers and they are:

- Simple 1 or 2 stage controls
- PWM (pulse width modulated)
- Maximum power point tracking (MPPT)

4.9.2 FEATURES OF SOLAR CHARGE CONTROLLER

- Protects the battery(12V) from over charging
- Reduce system maintenance and increase battery lifetime
- Auto charged indication
- Reliability is high
- 10amp to 40amp of charging current
- Monitors the reverse current flow

4.9.3 FUNCTIONS OF SOLAR CHARGE CONTROLLER

Generally solar power systems utilize the 12V of batteries. Solar panel can convey much more voltage than is obliged to charge the battery. The charge voltage could be kept at a best level while time needed to completely charge the electric storage device is lessened. This permits the solar systems to work optimally constantly, by running higher voltage in the wires is diminished fundamentally. The solar charge controller can also control the reverse power flow. The charge controllers can distinguish when no power is originating from the solar panels from the battery devices and halting the reverse current flow.

4.10 12V DC FAN

A mechanical fan is a machine used to create flow within a fluid and typically a gas such as air. The fan consists of a rotating arrangement of vanes or blades which acts on the fluid. The rotating assembly of blades and hub is known as an impeller or a rotor, or a runner. The major function of a fan in an incubator is to cool or circulate heat in the system (Steve 2010; & Shittu et al., 2017). This egg incubator used a 12V, 1.8 W DC fan mounted at the back portion to ventilate the air inside the incubator for machine cooling.

FIG 14: DC fan

A DC motor uses an internal arrangement of their magnets with opposing polarity. As current passes through the coil around this arrangement, a strong magnet field is produced. This magnetic field then creates a torque that causes the motor to orient.

4.11 LED BULB

In the developed incubator, the source of heat was a 44 W (4 x 11 W) LED bulb powered by a solar PV system. The heat in the egg incubator was 34.47 W. Light bulb emits heat energy if this energy is controlled it is more than enough to incubate the eggs. Light has no apparent side effect on chick development during incubation. Incubator is an electric device which is use to give a maintained temperature and humidity along with aeration to hatch eggs.

FIG 15: LED Bulb

4.12 HUMIDITY & TEMPERATURE CONTROLLER

Our humidness and Temperature Controller, HTC96 could be a ON-OFF management designed for relative humidness ratio & temperature control applications with a humidity vary from zero to 100 percent RH and a temperature vary of -20 to 100° C.

FIG 16: Humidity and Temperature Controller

4.12.1 TEMPERATURE

Heat energy is a major requirement for successful hatching of eggs into chicks and eventual growth of the young chicks in the brooding house to maturity (Ahiaba et al., 2015). Temperature is a very important factor in egg incubation. The best hatch is obtained by keeping the temperature at 37°C may be tolerated, but should not vary more than a total 1°C. Total heat generated was 3.08 watts. The summation of all calculated heat loss around the incubator was 6.45 watts. The actual heat required for the incubator was 9.53 watts. Having a total heat generated by the LED bulb which was 44 watts, the remaining heat in the incubator was 34.47 watts. The incubator required 3.81 system amperage, 100 W solar panel, 10 A solar charge controller, and a 12V 100Ah/20h lead acid rechargeable battery in order to function.

4.12.2 HUMIDITY

Humidity was carefully controlled to prevent unnecessary loss of egg moisture. The relative humidity in the incubator between setting and three days before hatching was at 58%-60%. Humidity is the amount of water vapor (water that has turned from a liquid to an invisible gas) in the air. Humidity is measured by placing two thermometers inside the incubator. One of the thermometers (the wet bulb) has a wet wick around it, and the wet-bulb thermometer reads a lower temperature than the normal (dry-bulb) thermometer (Van der Pol et al., 2013; Umar et al., 2016). The difference in the temperature readings given by the dry-bulb and the wet-bulb thermometers is a direct measure of the relative humidity. If the relative humidity inside the incubator is too low or too high, there is a hatching problem called red hocks. These chicks may suffer from weak legs. In this egg incubator, a water tray was placed at the bottom FL floor of the egg incubator cabinet to increase and maintain the humidity in the incubator during the experimental period.

4.13 TEMPERATURE VS TIME OF INCUBATION

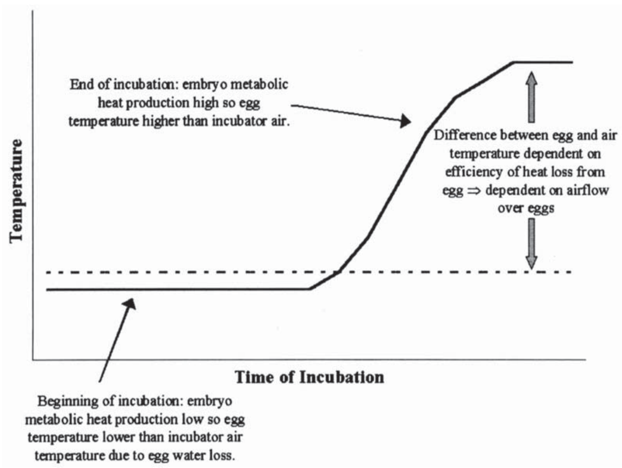

FIG 17: Relation between temperature and time of incubation

The temperature knowledgeable about by associate degree embryo throughout incubation depends on

- The metabolic heat production of the embryo itself that successively depends on the scale of the embryo.
- The slight cooling impact of water lost from the egg throughout incubation.
- The temperature of the setup and
- The ability of the warmth to transfer from embryo to setup air. many authors have created thermal energetic models describing however these four factors move to work out the temperature inside the egg throughout inside incubation.

4.14 AIR VENTILATION

Ventilation plays a role in cooling an overheated egg incubator, as well as making sure that the oxygen-carbon dioxide exchange is maximized (Umar et al., 2016). The air ventilation in this research work was provided and installed from the rear side, as well as the upper end of the incubator, to ensure proper distributions of temperature and humidity. The volume and total mass of the incubator were 0.1403 m and 0.1725 kg respectively.

5.1 BLOCK DIAGRAM

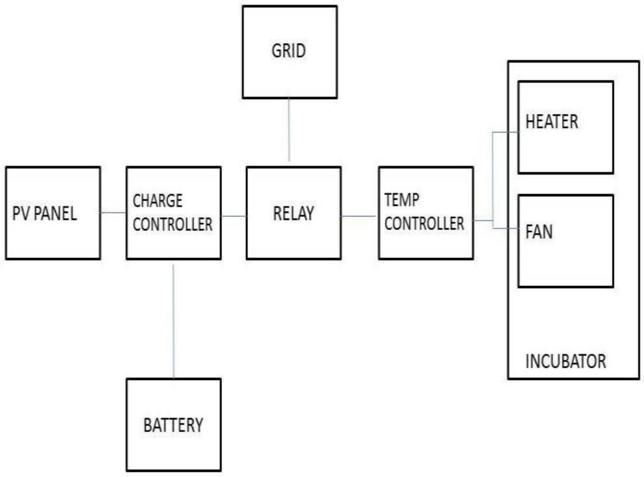

FIG 18: Block Diagram

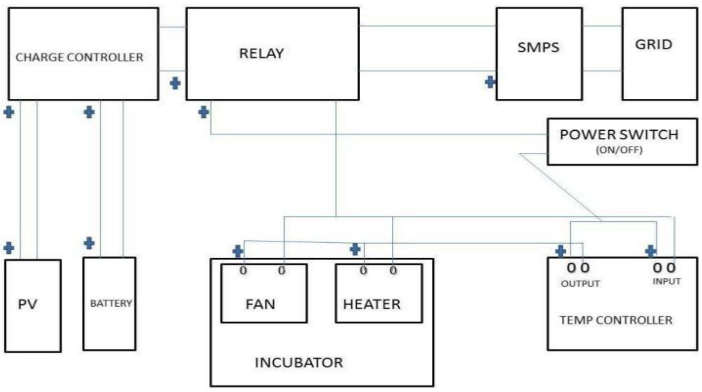

FIG 19: Circuit Diagram of Solar Poultry Incubator.

The block diagram of the proposed solar poultry incubator is above in figure 18. It consists of a PV panel which is used to produce DC power from sunlight and the output power from the panel is fed into the charge controller and from there to the battery. The charge controller is used so as to prevent the battery from getting overcharged and it has got a blocking diode inside which prevents the flow of current from battery to panel when the panel is not producing any power. Relay is employed to interface the circuit with the grid. It is essential to have grid supply so as to continue the incubation process even when the panel is not able to produce power due to lack of solar irradiation. Temperature controller is employed so as to control the temperature inside the incubator. It is very essential to control the temperature inside the incubator. If the temperature is less or more it will affect the hatching efficiency. The temperature controller senses the temperature inside the incubator and puts on the heater or the fan according to the need.

6.1 SPECIFICATIONS OF CHICKEN EGG INCUBATOR

Working voltage	: 220-240V AC
Electric power	: 500 watts
Range of temperature control	: 35°C to 39°C
Precision of humidity control	: 2% relative humidity
Angle of eggs	: 41-45 degrees
Setting time of egg-turning	: 0-190

6.2 ADVANTAGES

- Increased potency is hatching from four-hundredth to ninety fifth and improved productivity of chicken by two hundredth at intervals 6months.
- Many chicks are often hatched at a time in a very twinkling of an eye.
- Another issue is that it's attainable to arrange once to hatch the chicks not like with the hen one might not recognize once it will sit for the eggs.
- Artificial incubation cannot unfold parasites associate degreed diseases to the chicks and last there's no price for feeding a brood hen since an brooder is employed.
- Chances of eggs spoilage area unit decreased since all eggs area unit subjected to the optimum hatching temperatures.
- There aren't any possibilities of the hen damaging eggs through pecking, common incidence with natural incubation.

6.3 DISADVANTAGES

- It is expensive to buy an incubator. Most of the incubators are highly priced and not affordable to small scale farmers.
- The incubator requires power source to work. In most rural and remote areas, reliable source of power is a major challenge.

RESULTS

The result below were obtained when operating the incubator under different environmental or weather conditions. In Figure 16 the temperature fell below the normal operating temperature range. The temperature display unit reading shows 34.1 degrees Celsius and a relative humidity reading of 24.4%. This triggered, through temperature sensor, the bulbs to switch on as on the figure. When the temperature has reached the upper value of the temperature range, 39 degrees Celsius, the lights switched off as shown in Figure 20 where the temperature reading was 39.2 degrees and the lights went off. The relative humidity reading was 18.7%. Regarding the turning of egg tray on either side of the axle, Figure 8 shows such turning. When it was supplied with power. Figure 9 shows the countdown of days (balance of days), starting with 21days, before hatching. The counter enables the user to make prior preparation form the small chicks before hatching. Figure 7: Bulbs are ON when temperature is below 36.5°C.

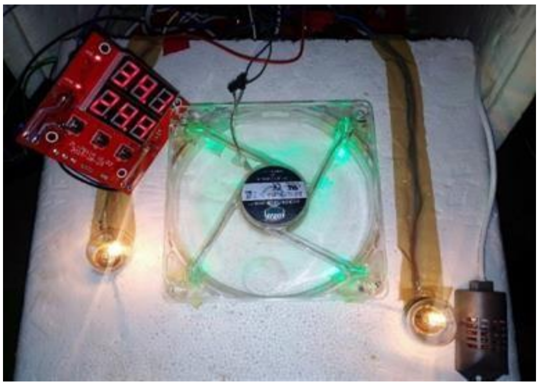

FIG 20: Bulbs are on when temperature is below 36°C

Bulbs are off when temperature increases beyond 39°C as shown below:

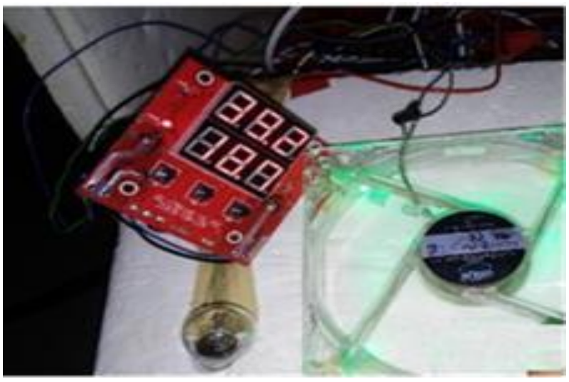

FIG 21: Bulbs are off when temperature increases beyond 39°C

TABLE-1: Trend for the number of days required to hatch chicks in the existing and developed incubators

NUMBER OF HATCHED CHICKS	EXISTING	DEVELOPED
18TH DAY	2	19
19TH DAY	23	6
20TH DAY	42	21
21ST DAY	29	34
22ND DAY	0	3
23RD DAY	0	0

TABLE-2: Temperature Readings of The Existing and Developed Incubators

TIME OF THE DAY	EXISTING	DEVELOPED
MORNING	99.6	100.64
AFTERNOON	100.5	100.8
NIGHT	100.3	100.32

TABLE-3. RELATIVE HUMIDITIES OF THE EXISTING AND DEVELOPED INCUBATORS

TIME OF THE DAY	EXISTING	DEVELOPED
MORNING	60	60
AFTERNOON	60.3	58.32
NIGHT	60.3	59

1. TREND FOR THE NUMBER OF DAYS REQUIRED TO HATCH CHICKS IN THE EXISTING AND DEVELOPED INCUBATORS

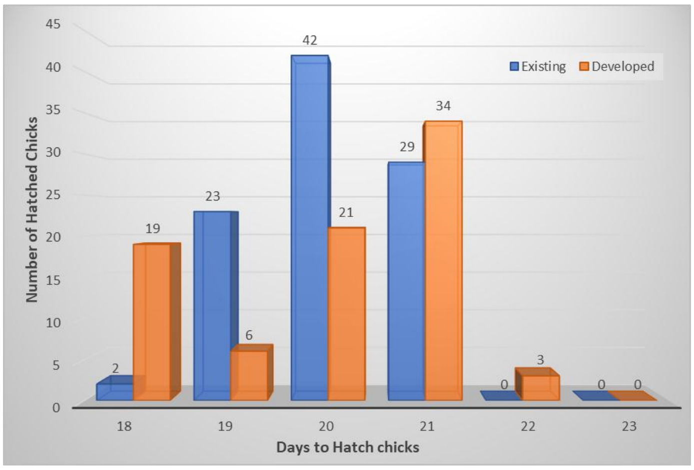

CHART 1: Hatch of Chicks

2. TEMPERATURE READINGS OF THE EXISTING AND DEVELOPED INCUBATORS

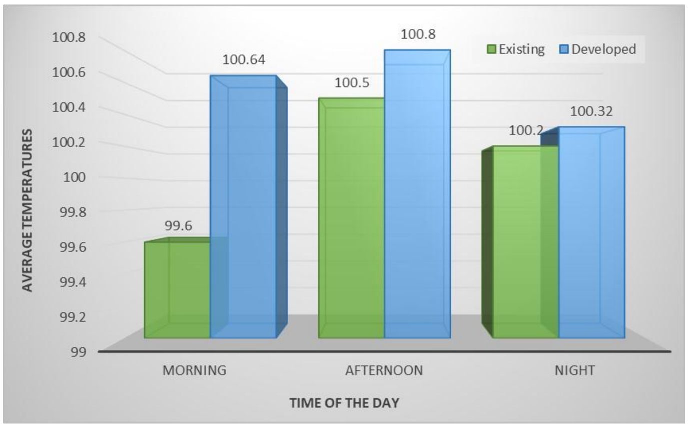

CHART 2: Temperature Readings

3. RELATIVE HUMIDITIES OF THE EXISTING AND DEVELOPED INCUBATORS

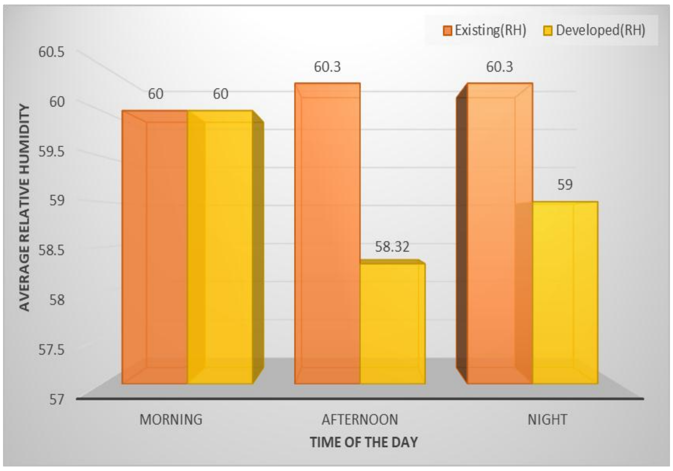

CHART 3: Relative Humidity

CONCLUSION

The results show that the setup is functioning consequently of course. In was responding to temperature variations that fell outside set temperature vary. identical was determined whereby it responded well to the wetness ratio readings outside the set humidity vary. The egg receptacle was additionally turning on either aspect to the shaft or pivot with most angle not prodigious 45 degrees. Also, the star PV system provided enough power to control the electric motor and additionally to supply power to different electronic gadgets within the system, and every one the in operation mechanism like egg receptacle turning operated of course. For any work the setup packaging is to be improved and be tested underneath traditional operating atmosphere with eggs within.

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