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# A Thermo Electric Heating Based Solar Powered Egg Incubator For Remote Areas

[1]VinuSankar[2]Rani Chacko[3]Anish Benny
[1]Student [2]Assistant Professor[3]Assistant Professor
Department of Electrical and ElectronicEngineering
Amal Jyothi college of Engineering ,Kanjirapally,
[1]vinusankar9@gmail.com [2]ranichacko@amaljyothi.ac.in [3]anishbenny@amaljyothi.ac.in

***Abstract:*----Incubators are devices which provides virtual atmosphere for egg hatching. Many conventional egg hatching mechanisms are existed in the early days and in nowadays electrical incubator become a replacement for conventional egg incubators. Due to high initial and operating cost it is not accessible for small scale poultry farmers. In this thesis a new thermo electric heating based solar powered egg incubator with closed loop temperature and humidity control, egg turning mechanism, effective ventilation is introduced. The cooling feature of thermo electric module can be utilized for refrigeration applications.**

***Keywords:*** **Incubator-Poultry-Ventilation-Humidity- Peltier effect-Solar energy**

## I. INTRODUCTION

A mother hen performs hatching function at low efficiency [1]. Incubator is a system which simulates the environmental conditions required for egg hatching within a specific temperature and relative humidity range. These ranges are between 36 to 39 $^0$C & 50 to 70 % respectively [1][2]. 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.

They often use a collection of bush lamps and kerosene stoves to achieve the heating requirements of the small hatcheries and brooders [3]. But there are many problems for these systems. The use of fossil fuels produces toxic gases which are harmful to eggs and poultry attendants. Electricity based egg incubators are known to produce clean energy without harmful effects on the environment but they are however limited in operation due to high initial cost, high cost of electric bill and frequent power outages where grid electric exists. And thus it becomes a dream for people in rural areas to get into poultry business. Due to this reason the proposed solar poultry incubator has its importance. It can operate even in the absence of power from grid, it works from the solar power and need power from grid only in the extreme cases.

## II. LITERATURE SURVEY

Incubators are machines, which artificially provide the egg with the correct, controlled environment for the developing chick. Incubators are mainly classified into two based on the source used for heat generation method. They are electrical incubators, nonelectrical egg incubators and solar thermal hybrid incubators. Electrical incubators may be classed as Still Air, Forced Draft and Contact types according to how air is circulated [4]. Still air incubators are the most basic form of incubator. A still air incubator is basically an insulated box consisting of a heating element, temperature controller, egg tray and water tray. Due to still air inside the chamber a temperature gradient is formed. In a forced draft incubator a fan is used to circulate the air inside the box, thereby temperature gradient can be avoided. Contact incubators are a new generation of machines designed to mimic natural incubation much more closely. The lid with the attached skin mimics the functions of an incubating parent. In non-electrical incubators the sources used for heat generation for maintaining the incubator temperature difference was different. Solar thermal incubator uses solar thermal energy for egg incubation [6].

## III. PROPOSED SYSTEM

The important parts of the proposed system was the thermo electric heater, closed loop humidity control, closed loop temperature control and the egg turning mechanism

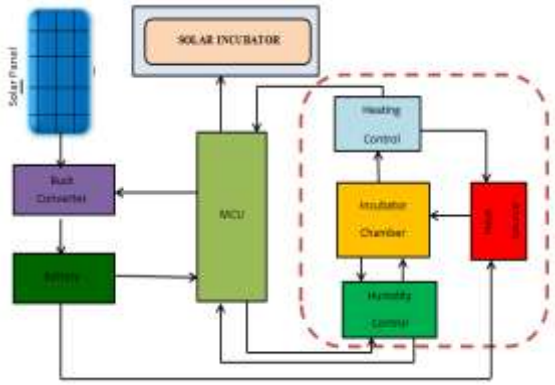


*Fig.1 Block diagram of the proposed system*

These systems are implemented in order to meet the necessary conditions for egg hatching. A buck converter is used for charging the battery from solar panel. Fig.1 shows the block diagram of the proposed system. The entire action is under the control of a micro controller based system. PIC 16F877A is the micro controller used here.

### *I. Egg Turning Mechanism*

Egg turning prevents the sticking together of egg yolk with the egg shell. So periodic turning is needed Egg turning automatically stops after 18'th day of incubation. Eggs in the incubator chamber must be turned at least 4 times a day. A moving floor mechanism used here. The main parts are a moving floor and egg tray with fixed divider. The main elemental part of the egg turner was the low rpm gear motors, L293D motor driver, chassis, gear and track. Egg turning should be at low speed so two 12V, 10 rpm gear motor is used. The egg turning plate is mounted over a chassis which is moved with the help of gear motors, gear wheels and toothed track.

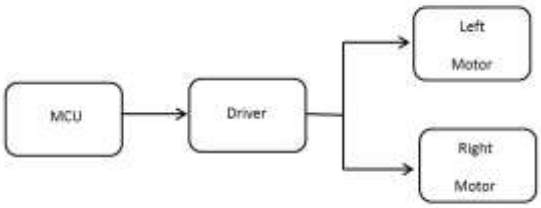


*Fig.2 Block diagram of the egg turner mechanism*

Fig.2 shows the block diagram of egg turning mechanism. Operation of gear motor was controlled by the PIC microcontroller. The motors were driven by the motor driver L293Dwith the help of control pulses from PIC microcontroller.

*Fig.3 Hardware of the egg turner mechanism*

The moving floor is made from a thick steel sheet covered with jute. Fig.3 shows the hardware developed for egg turning mechanism. A divider is made but cutting a steel wire meshes with 16 egg holding capacity.

### *B.Heating Source For Incubator*

For a conventional forced draft incubator incandescent lamp was the heat source and for a thermo electric based incubator the TEC module coupled with an aluminum heat sink acts as a heating source. TEC module works on the principle of peltier effect [7]. Both of these two systems are under closed loop temperature control.

*Fig.4 Heating mechanism for the proposed system*

Fig.4 shows a TEC1-12706 module used in thermo electric incubator which is coupled with aluminum heat sink and a cold chamber. A steel cylindrical vessel filled with water is attached to the cold side of TEC module in order to maintain a cold temperature.

### *C. Closed Loop Temperature Control System*

In grid mode the incandescent lamp is the heating source, and in thermo electric mode TEC module coupled with aluminum heat sink acts as the heating source. LM 35 based closed loop temperature control was implemented for the proposed system. When the temperature reaches the desired value in thermo electric mode the module is disconnected from the power source and in grid mode the incandescent lamp is disconnected from its source. Fig.5 shows the block diagram representation of closed loop temperature control system.

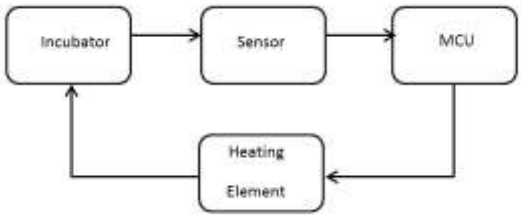


*Fig.5 Block diagram of closed loop temperature control system*

### *D. Humidity control system*

Active humidity control mechanism is used for the proposed study. In a conventional forced draft incubator passive humidity controlling within a desired level is a complicated task. Fig.6 shows the proposed humidity control system. The important part of the proposed active humidity system consists of a humidity sensor (DHT11), water sprayer and a fan. The sensor used in humidity control is the DHT 11. The DHT 11 is a basic, ultra-low-cost digital temperature and humidity sensor. A 12 V DC sub immersible pump is used for spraying the water, 12 V DC

fan is used to blow air into the humidity controlling chamber. Figure shows the different components used in humidity controlling. When the humidity level falls below certain value the circuit activates and regulates the humidity.

*Fig.6 Humidity controlling mechanism*

A buzzer is used to alert the user in case of extreme low humidity level. This will occurs due to low water level inside the water sprayer.

***E. Buck Converter For Battery Charging***

For operating thermo electric incubators in remote isolated areas, an electric power source is needed. Solar energy can be used for this application with the help of dc-dc converter. A 500 w panel is used so a buck converter is used to step down the dc voltage to 16 V for battery charging. A 64 Ah, 12 V battery is used. A charging current of 6 A was available at the output terminal of buck converter. The buck converter has an open loop control. It regulates the output voltage to 16 V irrespective of the varying irradiance. A charge controller facility is available i.e., when the battery voltage exceeds 14.8 V the battery is disconnected from the converter. Fig.7 shows the block diagram of open loop buck converter used for battery charging with charge controller.

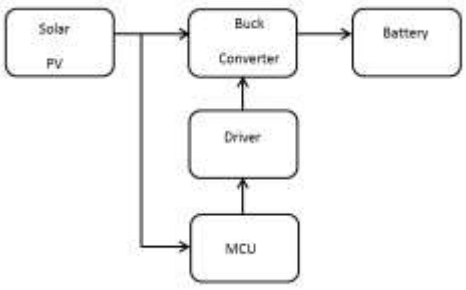


*Fig.7 Block diagram of the buck converter*

Fig.8 shows the hardware of buck converter.TLP 250 is the driver used in this buck converter.

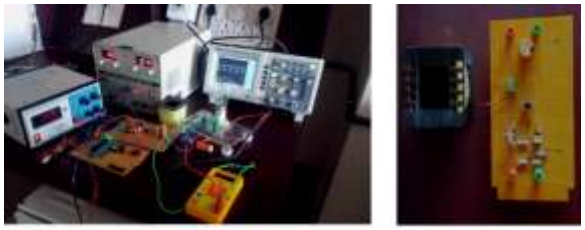

Fig.8 Hardware setup of the buck converter

***F. Hardware Analysis***

A set of data obtained from thermo electric incubator is compared with the readings of a forced draft incubator. Fig.9 shows the final hardware setup of thermo electric egg incubator.

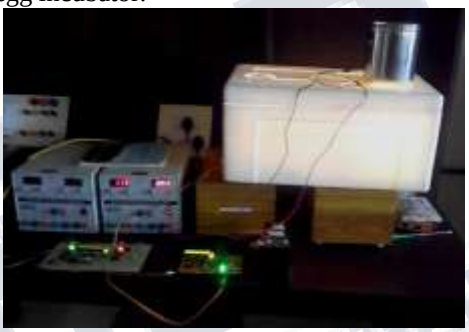

*Fig.9 Hardware of thermo electric egg incubator*

The important characteristics taken in this analysis are the temperature versus time plot, humidity with time plot and weight loss factor with time plot. For doing the experimental analysis both thermo electric and forced draft incubators were constructed. The experiment was conducted over a time period of 450 minutes.

***G.Comparison Oftemperature-Time Characteristics***

Fig.10 shows the variation temperature with respect to time in these two incubators. The incubators have closed loop temperature control. It always tries to maintain the temperature in a specified range. While analyzing the graphs it is clear that the thermo electric incubator have the ability to maintain the desired temperature as that of a forced draft incubator. This is the vital thing needed for egg incubation. In forced draft incubator the incandescent lamp was turned on and off for temperature control while in thermo electric incubator it was done by switching the TEC module on and off. So thermo electric heating can be used for maintaining a constant temperature in the incubator.

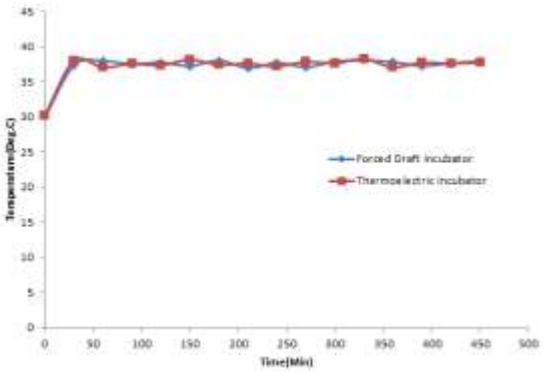


*Fig.10 Comparison plot of temperature v/s time*

### *H. Comparison Of Humidity - Time Characteristics*

The humidity was the hardest factor to control. In a forced draft incubator a water tray was used for humidity control and in a thermo electric incubator a water spaying mechanism was used. Humidity level can be controlled by increasing or decreasing the tray area in case of a forced draft incubator and that in case of a thermo electric incubator it was done by controlling the time for water spraying.

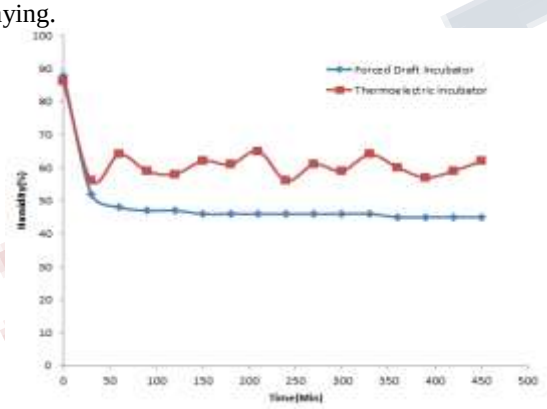


*Fig.11 Comparison plot of humidity v/s time*

It is evident from the fig.11 that forced draft incubator used here can maintain a humidity level of 45% and that in case of a thermo electric incubator was around 60%. A humidity level of 60% was good for incubation than 45 %. So the thermo electric incubator can have the advantage of maintaining any humidity level.

### *I. Weight Loss Factor Characteristics*

Weight loss factor is a significant term used in egg incubator. An egg losses its weight while going through its incubation period. Weight loss factor is dependent to humidity. If humidity is too high the weight loss will be less and incubation gets delayed. If the humidity is low the egg will become dry and losses a considerable amount of weight. The table given below shows the weight loss chart of eggs in a forced draft incubator for a period of 14 days. An ideal weight loss is about 4 grams in 21 days[5]. This is what an incubator needs. The fig.12 shows the weight loss factor of the forced draft incubator. As it is clear from the above section that the humidity level is low in case of forced draft incubator and in 14 days an average weight of 4 gram was lost. The table given below shows the weight loss of different eggs in a thermo electric incubator during its incubation period. Fourteen days are taking here for the analysis due to the unavailability of a reliable power supply for testing procedure.

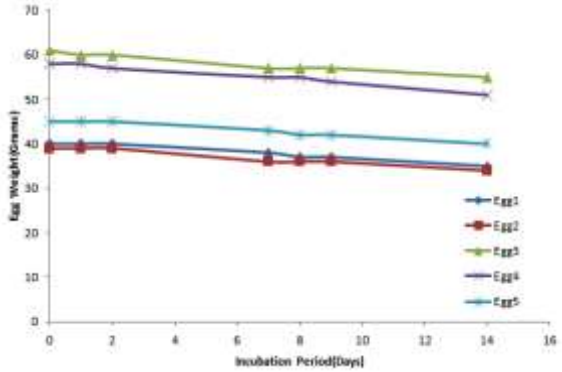


*Fig.12 Weight loss characteristics of a forced draft egg incubator*

Fig.13 shows the weight loss characteristics of a thermo electric egg incubator. The weight loss characteristic of thermo electric incubator is very much similar to the ideal weight loss characteristics of a conventional incubator.

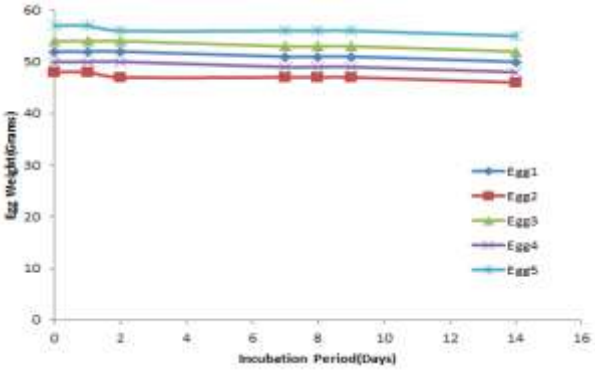


*Fig.13Weight loss characteristics of a thermo electric egg incubator*

## III. CONCLUSION

Electrical incubators have high installation and maintenance cost. Due to this reason it is not preferable for remote area use and it is not affordable for small scale poultry farmers. In this paper a new incubator which uses

thermo electric heating for egg incubation was presented. Advanced egg turning mechanism, closed loop humidity control, closed loop temperature control were the attracting features of this incubator. In this paper an open loop buck converter and an efficient egg turner were designed. The temperature time curve and humidity time curve of thermo electric incubator shows its effectiveness in performance over conventional forced draft incubator. The weight loss factor of thermo electric egg incubator was similar to that of an ideal incubator.

## FUTURE SCOPE

By effectively controlling the current flow through the thermo electric module this incubator can be used for heating as well as cooling simultaneously.

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