# DEVELOPMENT OF AN AUTOMATED SOLAR-DRIVEN HYBRID EGG INCUBATOR

**V. Divagar*[1], N. Kannan[1] and T. Thiruvaran[2]**
*[1]Department of Agricultural Engineering, University of Jaffna*
*[2]Department of Electrical and Electronic Engineering, University of Jaffna*
**Corresponding author (email: divagarva@gmail.com)*

## Introduction

**Poultry farming is popular in Sri Lanka in order to supply eggs and meat for consumption. Natural hatching could not meet the ever increasing demand for egg and meat. Therefore, artificial incubators and hatchers started to satisfy this requirement. However, the available artificial incubators are high cost, not affordable for rural poultry farmers, low efficient, non-ecofriendly, and operation of those are not user friendly. Further, viable chicks are the base for better productivity.**

**Temperature of around 37.4 $^{o}$C should be maintained for all days for chicken, whereas this condition is variable for different species (Wilson and Tulett, 1990). Relative humidity is also another factor to be monitored and controlled systematically for achieving high hatching percentages. Around 60% of relative humidity has to be maintained for first 18 days, whereas last 3 days require 70% of relative humidity for efficient hatching. Early development of embryo is usually under stressful condition, which leads to embryo death. Therefore, proper turning is done in artificial incubators to eliminate such effect.**

**To have high hatching rate for better production, it would be a best option as such incubator consumes no electricity for its operation and no harmful effect is exerted to environment. As world seeks for low-energy solutions, this attempt would definitely be a best solution for energy crisis and high manufacturing cost of presently available artificial incubators. Hence, this research aims to design an automated solar driven hybrid lower energy egg incubator for egg hatching. This incubator was developed by using low cost materials with an egg holding capacity of 120. Maintaining proper temperature, relative humidity and performing the proper turning of eggs were automated by controlling positive thermal coefficient heater, fans and motor with Arduino programming. The study was conducted to design, fabricate and evaluate the automated solar driven incubator for egg hatching and to compare the effectiveness of such design with commercially available incubators in terms of hatching percentage and cost effectiveness.**

## Methodology

### *Setting up of Parameters for Hatching of Eggs*

**Temperature of 37.5 $^{o}$C was maintained inside the incubator for obtaining high percentage of hatchability, whereas it was kept at 36.2 $^{o}$C inside the hatcher. Relative humidity of 55% to 65% was kept inside both incubator and hatcher. All the values were controlled automatically by programming with Arduino.**

### *Experimental Setup*

Experiment was designed in CRD (complete randomized design) such that chamber was able to be investigated. Two different loops were developed in isolation for incubator and hatcher. Command was directed to both intake and exhaust from Arduino to operate such fans systematically. Total cycle time of 20 minutes was selected for both fans. This loop was continued to operate for 2-hour duration.

Figure 1. Solar driven egg incubator

*Statistical Analysis*

ANOVA analysis is to check for significant differences in on and off times of positive thermal coefficient heater (PTC heater) during incubation and hatching.

Table 1. Incubation and Hatcher trail

| Treatment | Treatment setup | | | |
|---|---|---|---|---|
| | Intake fan operation | | Exhaust fan operation | |
| | On time (minutes) | Off time (minutes) | On time (minutes) | Off time (minutes) |
| T 1 | 1 | 19 | 1 | 19 |
| T 2 | 2 | 18 | 2 | 18 |
| T 3 | 3 | 17 | 3 | 17 |

## Results and Discussion

Table 1 shows the scenario of the ON and OFF times of the PTC heater during incubation and hatching of eggs as of the activation of three different treatments T1, T2 and T3. On and off times of the PTC heater during incubation and hatching exhibited significant differences among different treatments T1, T2 and T3 at $\alpha = 0.05$. Highest on time of minutes of PTC was recorded as T3 treatment during incubation and hatching, while lowest was recorded as T1 becomes active and T2 lies in between. Mixing larger volume of air does stimulate PTC heater to be on for long duration to keep temperature profile of chamber compared to a situation where smaller volume value of air it mixed.

Table 2. Operational profile of PTC heater

| Treatments | Incubator | | Hatcher | |
|---|---|---|---|---|
| | PTC on time (min) | PTC off time (min) | PTC on time (min) | PTC off time (min) |
| T1 | $36.70 \pm 2.88^{c}$ | $63.30 \pm 2.88^{a}$ | $34.49 \pm 1.16^{c}$ | $65.51 \pm 1.16^{a}$ |
| T2 | $44.24 \pm 1.36^{b}$ | $55.76 \pm 1.36^{b}$ | $43.10 \pm 0.66^{b}$ | $56.90 \pm 0.66^{b}$ |
| T3 | $48.28 \pm 1.49^{a}$ | $51.72 \pm 1.49^{c}$ | $45.58 \pm 0.17^{a}$ | $54.42 \pm 0.17^{c}$ |

*Data represented as mean ± SE (n=3). Mean values in the column superscripted by different letters were significantly different at $p < 0.05$.*

It can be used for incubating eggs for first 18 days with an automatic temperature profile of 37.4 ± 0.2 $^0$C and relative humidity of 60 ± 5% suitable for embryo development. It has further been automatically directed to change its temperature down to 36.2 ± 0.1 $^o$C for last three days with relative humidity profileof 60 ± 5 %. It performed well and yielded 81.72% of hatchability during experimental trails.

Intake and exhaust fans have been operated with different on and off times. As on time of both fans increase the volume of air mixed in the chamber increase which in turn increase on time of PTC heater to keep the temperature profile of temperature inside the chamber and vice versa. The on time of PTC heater is influenced by on time of intake fans and such values are significantly different between them at $\alpha = 0.05$ according to Duncan's grouping.

T3 was maintained required relative humidity and temperature profile for incubation and hatching in designed incubator. It has an ability to maintain the required temperature of 37.2± 0.3 $^0$C for incubator and 36.2 ± 0.1 $^0$C for hatcher. It is good for having reasonable percentage of hatchability. Relative humidity profile of incubator and hatcher were between 60 ± 5% in T3 for efficient hatchability percentage (81.72%). Total power consumption was 15 watts both in incubation and hatching condition. As on time of fans increases, total power, total current consumed also increases.

## Conclusions and Recommendations

Designed incubator is ecofriendly as it is driven by solar energy input and it produces no pollutes during operation. Designed incubator is suitable for commercialization as it gives reasonable percentage of hatchability of 81.72%, low power of 15 watts and total cost of designed incubator is around 29250 Rupees without solar and battery. It is therefore cost effective and ecofriendly incubator. Rural farmers should be made aware about this invention to make their economic profile viable.

## References


Barott, H. G. (1937). Effect of temperature, humidity, and other factors on hatch of hens' eggs and on energy metabolism of chick embryos, US Dept. of Agriculture.

Robertson, I. (1961). The influence of turning on the hatchability of hens' eggs I. The effect of rate of turning on hatchability. The Journal of Agricultural Science, 57, 49-56.

Slack, J. M. W. (1991). From egg to embryo: regional specification in early development, Cambridge University Press.

Wilson, H. & Tulett, S. Physiological requirements of the developing embryo: temperature and turning. Avian incubation., (1990). Butterworth (Publishers) Ltd, 145-156.