Design and Implementation of Solar PV Poultry Incubator

Nithin T Abraham, Shaema Lizbeth Mathew, C.A Pradeep Kumar

Abstract—***Incubation of poultry egg is very important these days as the demand for chicken is increasing day by day. But the process of hatching eggs by the conventional method is very difficult as well as it consumes much power. In short conventional method of egg hatching requires continuous supply of power. In this paper 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. By implementing this method of solar poultry incubator we will be able to reduce the power consumption of the incubator by 75% and the cost involved in the design also yields profit and hence could bring out a revolution in this field.***

Index Terms**—*****Battery, Charge Controller, Hatching, PV panel***

I. INTRODUCTION

Many domestic bird growers incubate eggs to help sustain their flock over time. This user's manual is designed to assist those who wish to incubate small number of domestic poultry eggs. The words "fertility" and "hatchability" are often used incorrectly by small producers. A mother hen performs hatching function at low efficiency [1]. And artificially, in an incubator, a system which simulates the environmental conditions required for such operation is used by poultry farmers to do this operation within specified temperature and relative humidity range. These ranges are between 36 – 39oC and 50–70% respectively [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 and/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 for day-old chicks [3]. But the problems with these systems are enormous. If we use fossil fuel, it produce 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 the initial cost of procuring such equipment coupled with the high cost of electric bill, frequent power outages where grid electric exists. And thus it becomes a dream for people in rural areas to get into poultry business. That is why the proposed solar poultry incubator comes into play. It can operate even in the absence of power from grid, it works from the solar power and we need power from grid only in the extreme cases.

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II. DESIGN OF POULTRY INCUBATOR

The block diagram of the proposed solar poultry incubator is given below in figure 1. 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.

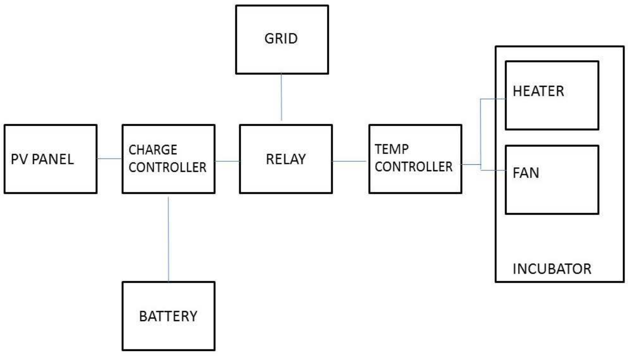

Figure 1. Block diagram of solar poultry incubator

The circuit diagram of the solar poultry incubator is given below in fig 2. The circuit is designed in such a manner to maximize the efficiency of the incubator.

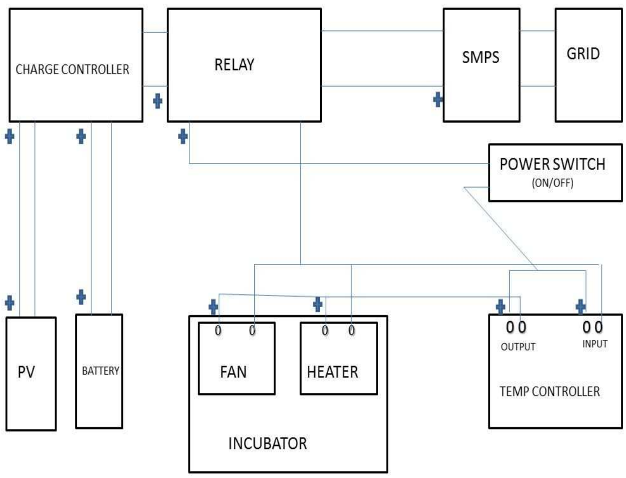

Figure 2. Circuit diagram of solar poultry incubator

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III. MATERIALS REQUIRED

Equations involving heat and mass balances were used to estimate the components elements of the incubator. The physical and biological elements of the egg incubator were conducted. The physical measurements involved the use of thermometers to measure the ambient and incubator temperature while temperature-relative humidity sensor was used to monitor the ambient and incubator chamber conditions. A sliding device as a provision for regulating the degree of ventilation rate through openings ensured that proper ventilation was maintained within the incubation chamber.

While egg positioning and turning were done manually at 45o 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 rotated 1/2 turn at least 3 times daily. Eggs set with the air cell end up should be tilted in the opposite direction 3 times daily. This keeps the embryo centered in the egg and prevents it from sticking to the shell membrane.

If hand turning, to insure 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 turning the 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 insure that a desirable hatching humidity is maintained.

Four factors are of major importance in incubating eggs artificially: temperature, humidity, ventilation and turning. Of these factors, temperature is the most critical. However, humidity tends to be overlooked and causes many hatching problems. Extensive research has shown that the optimum incubator temperature is 100°F when relative humidity is 60 percent. Concentrations of oxygen should be above 20 percent, carbon dioxide should be below 0.5 percent, and air movement past the egg should be 12 cubic feet per minute.

IV. HEAT LOAD OF POULTRY INCUBATOR

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

Table I shows the wet bulb reading at various incubator temperatures.

The heat balance equation of the incubator chamber [4] was estimated by

$$\mathbf{Qload = Qpv + Qegg - Qcnd - Qcnv}$$

Qload = Heat load of the incubator, W
Qpv = Heat supplied by PV panels, W
Qegg = Heat supplies due to metabolic actions of egg, W
Qcnd = Heat loss by conduction through incubator walls
Qcnv = Heat loss through air convection

V. RESULTS AND DISCUSSIONS

The performance evaluation of the photovoltaic (PV) powered incubator was conducted. The incubator was initially run empty without eggs. This was done so as to ensure that the level of the operating micro elements- temperature and relative humidity of the incubation chamber were right. The incubator was then loaded with fertilized poultry eggs for a period of twenty one days and replicated three times. The eggs were turned periodically and manually. This was to no sticking of the egg yolks on the shell. Before loading the eggs candling was conducted to ascertain the condition of the eggs. This was repeated on the seventh, fourteenth and eighteenth days of the incubation period.

TABLE I.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
102^0F	83.0	85.0	87.0	89.0	91.0	92.7
Percentage Relative Humidity	45%	50%	55%	60%	65%	70%

At two 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 fig 3.

Figure 3. Solar hatched day old chicks inside incubator

Table II gives the incubation period required for hatching eggs of other species. Energy has always been an important issue among scientists and policy makers. Seeking a viable alternative energy source has always been the center of attention particularly in the agricultural sector. Harnessing solar energy has been gaining significance as a new and continuous supply of alternative power source, which seems to have an answer to frequent power constraints faced by farmers.

Continuous power supply is a boon to riots, especially in regions affected with frequent electricity failure. So far solar energy has been used for lighting lamps and for cooking food. Recently it has also been utilized in the poultry sector. The cost of these incubators may vary between Rs.50, 000 and Rs. 60,000.

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)

TABLE II.INCUBATION PERIODS OF OTHER SPECIES

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VI. CONCLUSION

A solar poultry incubator design is proposed in this paper which can make a revolution in the field of poultry agriculture mainly in rural areas and can bring down the usage of power made from conventional method and is replaced by renewable energy based source and is found to be economically viable than the conventional poultry incubator.

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