Construction and Characterization of Solar Powered Micro-Base Incubator

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Abstract : In this work, micro based solar incubator was designed and constructed. It consist of a solar collector which heats water that in turn heats an incubating chamber for the process of fowl hatching. It is designed to work for 24 hours and has a built-in heat storage facility that supplies heat to the incubating chamber when there is no solar energy. Our micro based solar incubator was able to hatch egg within 20-21 days.

1.1 Introduction

An incubator is a device used to grow and maintain microbiology culture or cell culture or maintain temperature of the egg equivalent to that of mother fowl until it hatches. The incubator maintains optimal temperature, humidity and other conditions such as carbon dioxide (CO_2) and oxygen content of the atmosphere inside. More elaborate incubators have the ability to lower the temperature or ability to control humidity or CO_2 level. Incubators can vary in size from table top to the size of small rooms. A solar powered micro base incubator is all about using energy from the sun to power an incubator. A solar panel connected to the battery with charge controller assures 24 hours supply of power. The battery is provided for power stability through storage of energy and distributing it inside the chamber. The maximum temperature sterilization is 200^{o}C. An incubator should be resistant to corrosion and can easily be cleaned. A devote chamber or two incubator stacked, one above the other independently regulated, is preferable to one large incubator because it can accommodate more culture with better temperature control.

1.2: MATERIAL SELECTION

Materials used in this work were sourced from local market. The various components of this micro-base solar incubator were fabricated according to their respective size and where fitted. The solar powered micro-base incubator is made up of the following components:

1. The Reflector
2. The Transparent plexy glass
3. The Egg chamber
4. The cover
5. The Body
6. The Heat retention material (sand)
7. Angle bar
8. Plumbing tape

1.2.1: REFLECTOR

The reflector is made in the form of a rectangle focused unto the incubator for solar rays to fall on it. It is of dimension 45cm x 37cm, this dimension was chosen to increase the amount of rays that fall on it. The reflector is adjustable by the aid of a rope that is fasted to the wood by a nail.

1.2.2: THE TRANSPARENT PLEXY GLASS:

The glass is a clear glass of 4mm thickness. Glass is preferred to plastic because of its high transitivity and higher resistance to heat buildup.

1.2.3: THE INCUBATOR

The incubator is a rectangle box made of wood to reduce cost of insulation. The top of the box is grooved for the cover to sit on as to reduce heat leakage due to convection at the openings. The top is made of a clear glass that allows the rays that fall directly on the incubator to be transmitted, hereby increasing the amount of rays that enter the incubator.

Fig 1.3: Incubator

1.2.4: THE EGG CHAMBER

The egg chamber is made of aluminum. Aluminum is a good conductor of heat. It is made spacious enough to contain 20eggs and it is suspended at the middle of rectangular box to allow for the ventilation of the eggs.

Fig 1.4: Egg Chamber

1.2.5: THE HEAT RETENTION MATERIAL (SAND)

The sand is poured inside the rectangular box (incubator) the sand is porous. The wet sand is used to regulate the temperature and humidity.

1.3: TEMPERATURE

During the warm-up period, the temperature was adjusted to hold a constant 101^0 f for still air, 99^0 – 100^0 F for forced air. We obtained reliable readings by keeping the bull of the thermometer at the same height as the tops of the eggs and away from the source of heat.

Incubator temperature was maintained between 99^0 and 100^0 f. the acceptance range is 97^0 to 102^0 F (lifeway solar, 2000). According to literature, mortality is seen if the temperature drops below 97^0 F of rises above 103^0 F for a number of hours. If the temperature stays at either extreme for several days, the eggs may not hatch.

The incubator was operated in a location from grafts and direct sunlight. The sand in the incubator was socked with water. We did this as to stabilize its internal temperature or humidity before fertile eggs where set.

1.4: HUMIDITY

Before relative humidity of the air within an incubator should be about 60 percent, we made sure that during the last 3 days (the hatching period) the relative humidity was between 65-70 percent. If moisture is too much in the incubator, it prevents normal evaporation and results in a decreased hatch, but excessive moisture is seldom a problem in small incubators like ours. Too little moisture result in excessive evaporation, causing the chicks to stick to the shell, remains in the piped shells and something hatch crippled.

During the hatching period, we increased the humidity in the incubator by using an atomizer to spray a small amount of water into the ventilating hole.

Incubator temperature	Thermometer Readings					
100^0 F	81.3	83.3	85.3	87.3	89.3	90.7
101^0 F	82.2	84.2	86.2	88.2	90.0	91.7
102^0 F	83.0	85.0	87.0	89.0	91.0	92.7
Percent Relative Humidity	45%	50%	55%	60%	65%	70%

Table 1.1. The table shows the reading we obtained from the thermometer while investigating the relative humidity.

1.5: VENTILATION

To obtain the best hatching result we maintained a normal atmospheric air, which usually contains 20-21 percent oxygen. It is difficult to provide too much oxygen, but a deficiency is possible. That is why we made sure that there was enough ventilation by allowing a normal exchange of air.

It is possible to suffocate the eggs and chicks in an air-tight container. However, excessive ventilation removes humidity and makes it difficult to heat incubators properly.

1.6 RESULT AND OBSERVATION

The experiment/test was conducted in the month of September, 2011. It was carried out at the premises of New Education Trust Fund (ETF) hall. We started by first pouring a reasonable amount of sand in the lower chamber of the incubator with little water. No water was drawn off from the system throughout the experiment. During the experiment, the recorded temperatures included the incubator temperature, the reflector temperature and the temperature of the surrounding where the incubator was sited. During the experimental period (12^{th} to 15^{th}) the weather was clear some days and cloudy other days. The experimental results/values obtained were as follows.

Day 1:12^{th} September 2011

Initial incubators temperature = 27^0 C

Time (hr)	Incubator temperature (^{0}C	Reflector temperature (^{0}C)	Ambient temperature (^{0}C)

9.00-10.00Am	27	30	29
10.00-11.00Am	28	29	30
11.00-12.00Am	30	32	31
12.00-13.00Pm	32	34	30
13.00-14.00Pm	33	40	27
14.00-15.00Pm	36	46	28
15.00-16.00Pm	35	38	27
4.00-5.00Pm	32	30	26

Table 1.2. The table shows the reading we obtained from the thermometer while investigating the relative humidity on the first day.

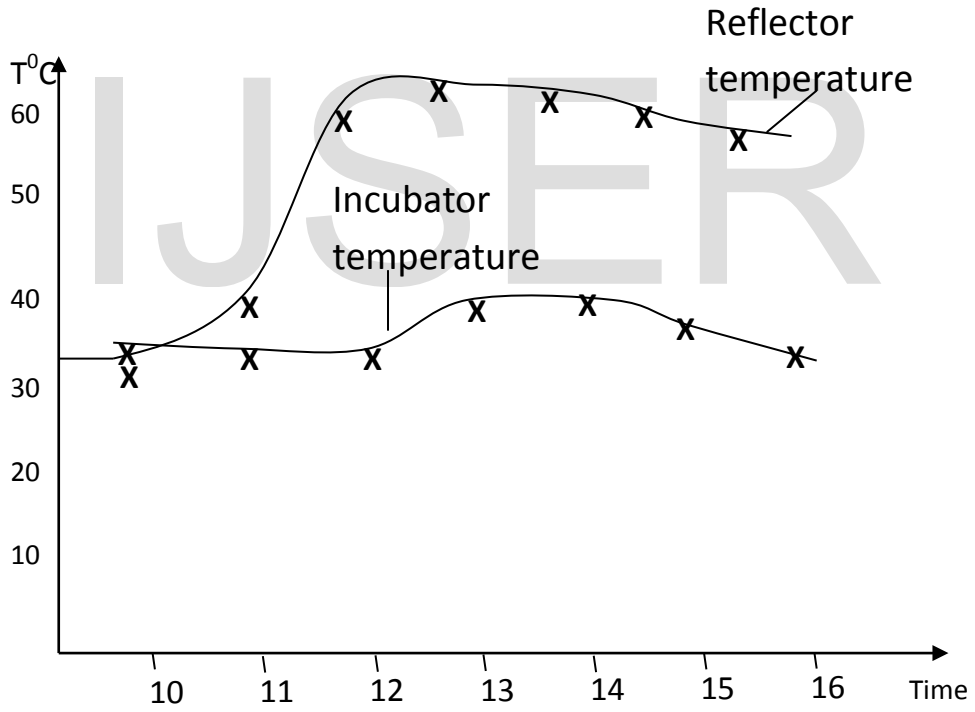

Fig. 1.1 Graph of incubator temperature and reflector temperature against time for the first day.

DAY 2: 13TH SEPTEMBER 2011

Initial incubator temperature = 27^0C

Time (hr)	Incubator temperature (^{0} C)	Reflector temperature(^{0}C)	Ambient temperature (^{0}C)
9.00Am-10.00Am	32	30	25
10.00Am-11.00Am	33	36	28
11.00Am-12.00Pm	33	56	31
12.00pm-13.00Pm	35	58	33
13.00Pm-14.00Pm	36	53	33
14.00Pm-15.00Pm	34	53	31
15.00Pm-16.00Pm	33	48	28

Table 1.3: table showing the observation made on the second day.

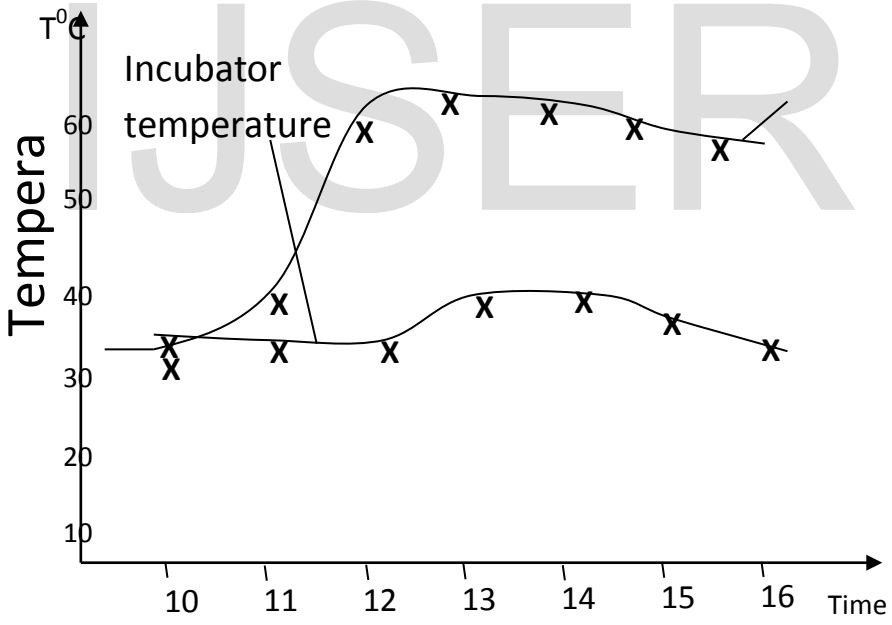

Fig. 1.2 Graph of incubator and temperature and reflector temperature against time for the second day.

Day 3:14th September 2011.

Initial incubator's temperature =260^{0}C

Time (hr)	Incubator Temperature(^{0}C)	Reflector Temperature(^{0}C)	Ambient Temperature (^{0}C)
9.00Am-10.00Am	34	30	26
10.00Am-11.00Am	35	38	30
11.00Am-12.00Am	36	46	32
12.00Pm-13.00Pm	37	46	32
13.00Pm-14.00Pm	33	50	30
14.00Pm-15.00Pm	33	52	31
15.00Pm-16.00Pm	32	44	30

Fig. 1.4: Table showing the observation made on the 3rd day.

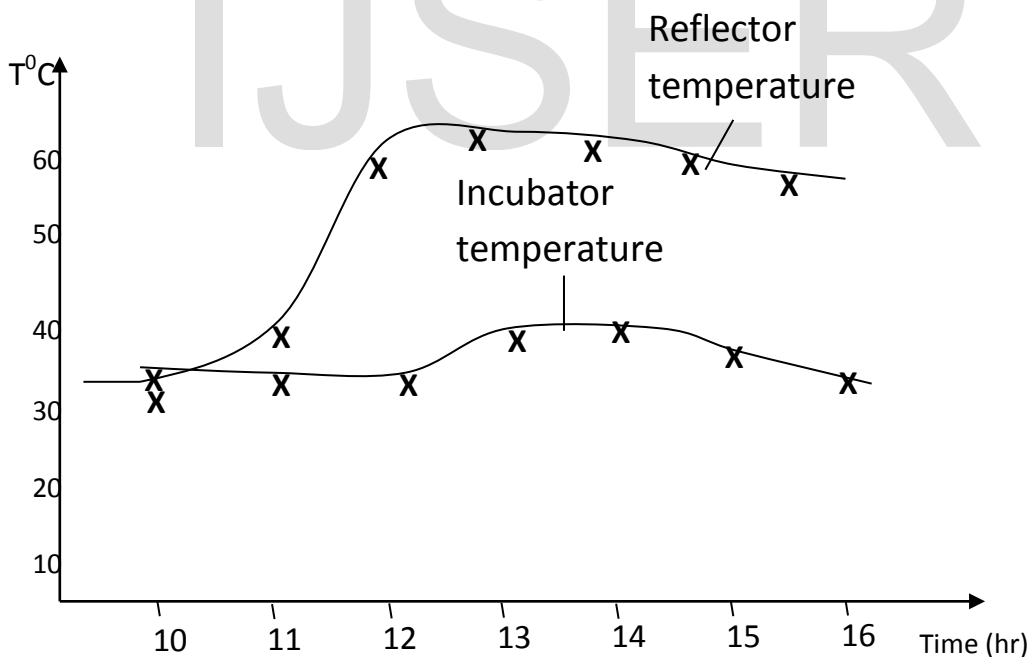

Fig. 1.3 Graph of incubator temperature and reflector temperature against time for the third day.

DAY 4: 15TH SEPTEMBER 2011

Initial incubator's temperature = 27^0C

Time (hr)	Incubator temperature (^{0}C)	Reflector Temperature (^{0}C)	Ambient Temperature (^{0})
9.00Am-11.00Am	33	30	27
10.00Am-11.00Am	34	38	29
11.00Pm-12.00Pm	35	46	30
12.00Pm-13.00Pm	36	49	32
14.00Pm-15.00Pm	37	50	33
15.00Pm-16.00Pm	34	53	30
	32	44	30

Fig. 1.5: table showing the observation made on the 4th day.

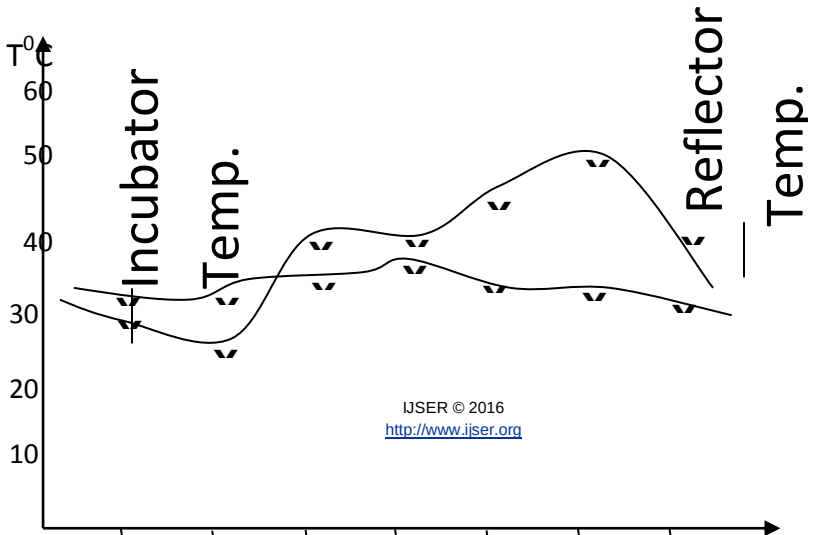

Fig. 1.4 Graph of incubator temperature and reflector temperature against time.

Concurrently, incubators temperature gradually increases as the reflectors temperature increases and decreases and vice versa. The observation was made between the hours of 9am and 6pm. This is because before 9am the sun is still rising and beyond 6pm the sun set. A decline in temperature of both (incubator and Reflector) were observed sometime in the afternoon time throughout the days the test was carried out. From the doubt that the incubator/system is highly sufficient.

1.7. CONCLUSION

The foregoing exercise has demonstrated the possibility of incubation of eggs using solar energy. The design, construction and testing of this solar powered incubators has established the possibility of using readily available solar energy to increase chicken production to satisfy the protein need of the masses. Though the experiment was carried out in the month of September (during rainy season) it was purely application of physics and we were able to achieve good results. This shows that the system constructed is efficient.

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