



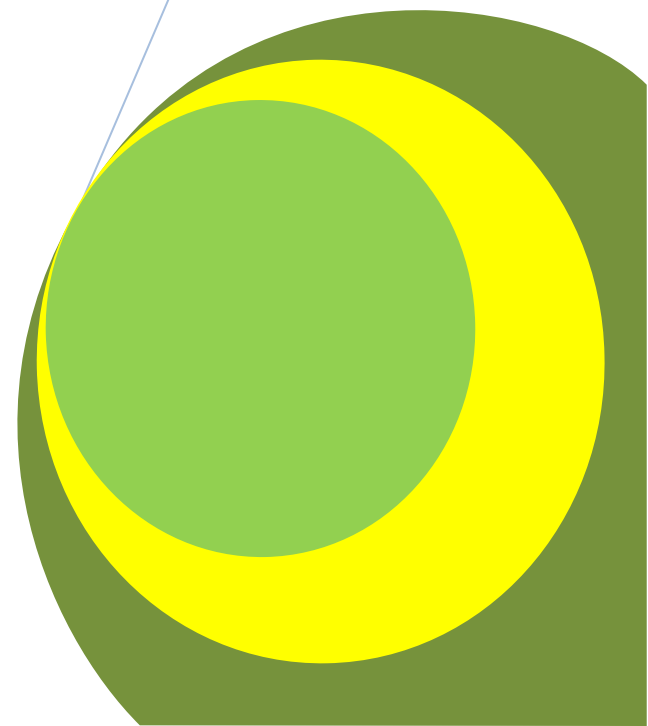
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## **An Electrically Operated Incubator for Household**

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*Research Article*

# An Electrically Operated Incubator for Household

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## ABSTRACT

A 120-egg capacity cabinet type incubator was designed and constructed using mild- steel as the construction material. It is lagged with the fibre material to avoid heat loss. Heat was supplied into the incubator by means of three 100 watts electric bulbs while the relative humidity was supplied by means of an appropriately loathed water pan. Incorporated with the incubator is a panel which consists of temperature and relative humidity sensors to control both the temperature and relative humidity within the incubator chamber. When tested with 20 eggs, the percentage fertility and hatchability rate of 75.2 and 64.8% respectively were recorded during an incubation period lasting for 20 $\frac{1}{2}$  days. These high efficiency values coupled with the cheapness of the construction materials and the improvisations employed in heat production are the principal features that recommend the incubator for rural application in Nigeria.

**Keywords:** Incubation, incubator design, incubator construction

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## INTRODUCTION

Incubation is defined as the process of keeping the fertilized eggs warm in order to allow proper development of the embryo into a chick. Further it is the management of a fertilized egg to ensure the satisfactory development of the embryo inside the fertilized egg into a normal chick (Oluyemi and Roberts, 1988). Also Komolafe *et al.*; (1981) defined incubation as the process of keeping the fertilized eggs warm in order to allow proper development of the embryo into a chick. Furthermore, an incubator is a machine or an apparatus for keeping fertilized eggs warm, as the embryo into a chick in the short space of 21 days.

The heat required for incubator is usually provided by coal, oil, gas, or electricity. For small incubator, about 58% relative humidity is kept at 102°F (38-39°C) up to the 18<sup>th</sup> day of incubation after which, the humidity goes to 90% and the temperature is lowered to 96°F (36°C) until the chick is hatched. Incubators are usually placed away from walls and corners of rooms so as to allow adequate ventilation and to provide sufficient work space for the incubator operator (Komolafe *et al.*, 1981); incubators can be divided into moisture and non-moisture types, one moisture type is equipped with a tray of water, the moisture prevents excessive evaporation of eggs while the air is continually changing within the machine. The non-moisture type reheats and redistributes the air, thus reducing the change of air and preventing excessive drying of the eggs. (Rice and Botsford, 1956).

Hatching eggs deteriorate with storage and should not normally be kept for longer than seven days before being set for incubation. The storage temperature should be 12.5°C; at which embryonic development is arrested. The relative humidity should not be less than 80% to prevent dehydration of the eggs. If the storage temperature is too low (-2°C) the blastoderm may freeze (Oluyemi and Roberts, 1988). Selected should be of normal shape, a minimum of 20z (56.7g) in weight, with good shell texture, and free from faults. Size does not affect the hatching of egg, however chicks tend to hatch too early from small eggs whole extremely large egg tend to hatch later. Colour of the eggs does not affect hatchability, although extremely light colouring may indicate calcium deficiency in the shell. (Oluyemi and Roberts 1988). The incubation of eggs, either naturally under a broody hen or artificially in an incubator cannot be supervised to the best advantage without some knowledge of the fundamental principles that are involved. The proper starting place for a study of the problem associated with incubation is the structure of the egg and the changes that take place within it as the embryo develops into a chicks in the short period of 21days (Anonymous, 1982). Akinsanmi (1977) says that during the first two weeks of incubation the temperature should be 38.3°C; during the last week it should be raised to 39°C and the humidity kept up to 60% in flat-type incubators, if however the humidity decreases, he recommended that the temperature may be raised.

Adoun *et al*; (1978) gave the following steps on how to hatch eggs in a table type incubator. Firstly, the water tray is filled to the indicated level, with the feet sheet spread across the ventilation hole with the edges dipping into a tray of water. The incubator lighted a day before setting the eggs so as to have a steady temperature of 39<sup>0</sup>C. The eggs are turned twice a day from the third day until the eighteenth day, with one side of all the eggs marked with a pencil to indicate which side has been turned. Eggs are candled on the seventh and fourteenth day of incubation all clear and addle eggs are removed. From the nineteenth day, some of the chicks begin to hatch; the chicks should not be removed immediately but should be left until their feathers are completely dried.

## MATERIAL AND METHOD

### Material Selection and Machine Description.

Materials that are locally and readily available were considered for use in the construction work to prevent the rigor of searching for scarce materials. Wood which is available with due regard inexhaustible was considered and no other material of construction have this sort of unique property.

### Design considerations

Reading the Environmental condition within which the incubator is to operate is an important factor in designing the incubator; the following environmental factors were taken into consideration: Temperature; Humidity, Ventilation and sanitation. Temperature: incubation temperature required ranges from 37<sup>0</sup>C to 39<sup>0</sup>C (Anonymous, 1982) and this is achievable by using three electric bulbs, each rated at 100watts. Two bulbs at the sides were connected at horizontal distance of 170mm and vertical distance of 100mm and 200mm from the glass inspection panel side while the third bulb is located underneath the glass inspection side at the horizontal distance of 450mm and vertical distance of 150mm from the floor. Humidity: The proper relative humidity for the best results should be 55% (Rice and Botsford, 1956) and this is achievable by placing three water bowls just immediately under the heating bulbs. Inside the bowl, water absorbent materials such as foam used in mattress were dipped into the water to increase the evaporating surfaces. Insulation: Environmental temperature can vary from a high temperature on a hot sunny day to a low temperature on a cold raining period especially at night or very early in the morning. To avoid undue fluctuations of temperature in the egg chamber, the special property of insulation of wood material was taken into consideration. The lid, floor and the four sides were covered with mild – steel with quarter inch (6.4mm) thickness and also, the frame and platform for water bowls were all made of flat bar. Water bowls and egg trays were made of plastic rubber which is also good insulating materials. Ventilation: Adequate ventilation rate. Inlet and outlet areas of 705.1 \* 76.2mm<sup>2</sup> were provided at low different elevations. Sanitation: After taking off the hatch, broken egg shells and membranes are usually left in the egg chamber. At times, unhatched eggs may be left in the incubator and all these leftover materials needs proper clearing and disinfection after each hatch, hence the lid is designed to be removable.

### Design Analysis of the Components of the Incubator

#### The Floor

It was made of ¼ in (6.4 mm) mild steel is supported by four beans so as to be able to carry the load that are to be imposed on it. The floor area is 23.5 x 35.5 m<sup>3</sup> (596.6 x 901.7 mm<sup>3</sup>).

#### The lid

It was made of 6.4 mm mild- steel which is lined at the four sides by 0.5 x 0.5 in<sup>2</sup> (12.7 x 12.7 mm<sup>2</sup>) plat bars. The area of opening covered by the lid is  $\frac{19^3}{4} \times \frac{31^3}{4} h^2$  (501.65 x 806.5 mm<sup>3</sup>). The lid is detachable for convenience of the incubator operator

#### The Slides

Two sides of area 23<sup>1</sup>/2 x 25<sup>1</sup>/2 in<sup>2</sup> (596.9 x 647.7mm<sup>2</sup>) were entirely covered with plywood (6.4mm thickness). The two other sides of area 25<sup>1</sup>/2 x 35<sup>3</sup>/4 in<sup>2</sup> (647.7 x 908.1 mm<sup>2</sup>). Located at these sides were the inlet and outlet areas for ventilating the incubator. Also at the ventral side was located the glass inspection panel.

## Beams and Colum

The incubator was made of  $2.0 \times 2.0 \text{ in}^2$  ( $50.8 \times 50.8 \text{ mm}^2$ ) beams and columns. The structure is supported by four columns of  $31 \frac{1}{2} \text{ in}$  ( $800.1 \text{ mm}$ ) in height. There are nine beams altogether supporting the structure, four of which is of span  $19 \frac{3}{4} \text{ in}$  ( $501.7 \text{ mm}$ ) while the remaining five beams were of span  $31 \frac{3}{4} \text{ in}$  ( $806.5 \text{ mm}$ ).

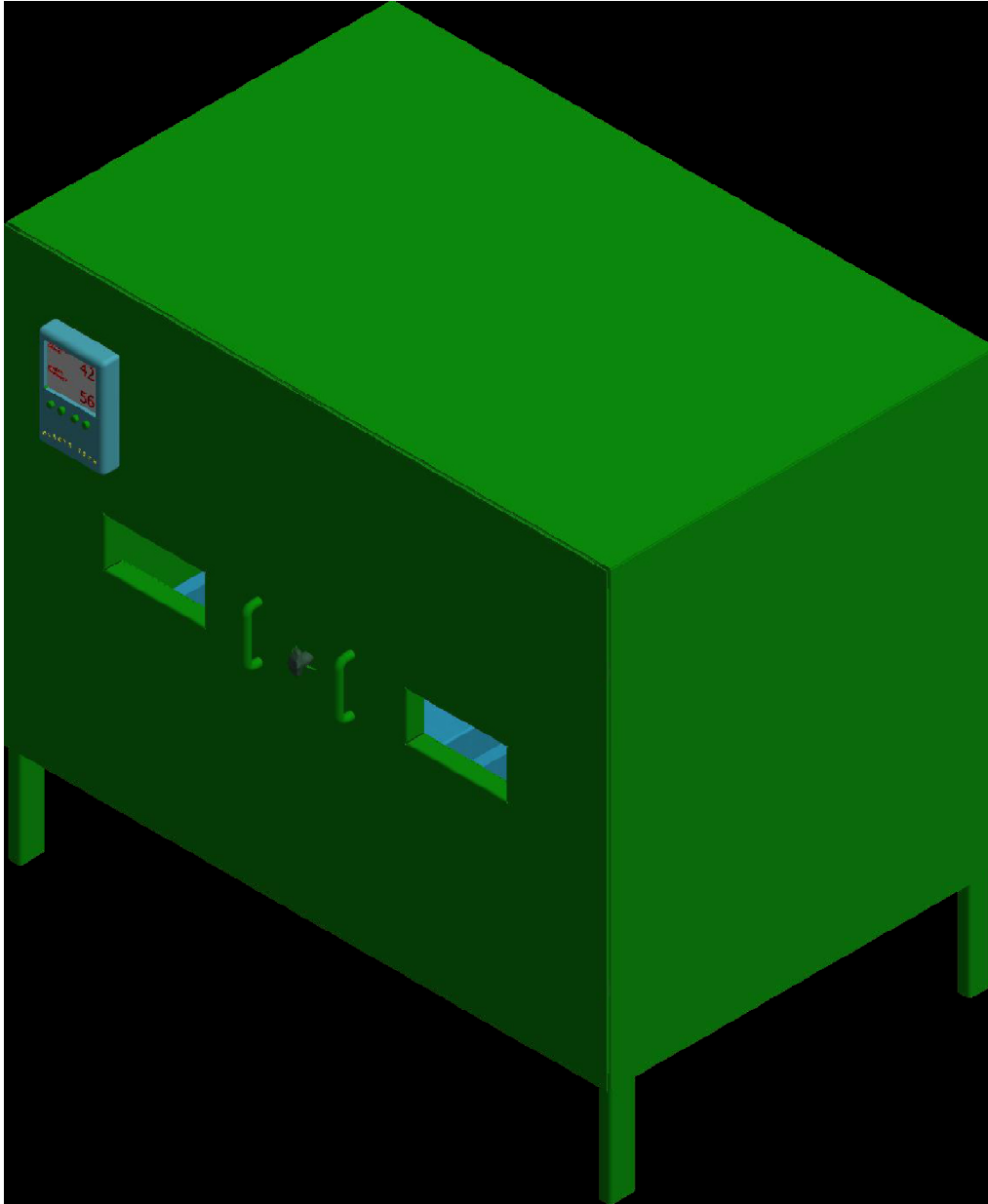


Fig 1: Isometric View of the incubator

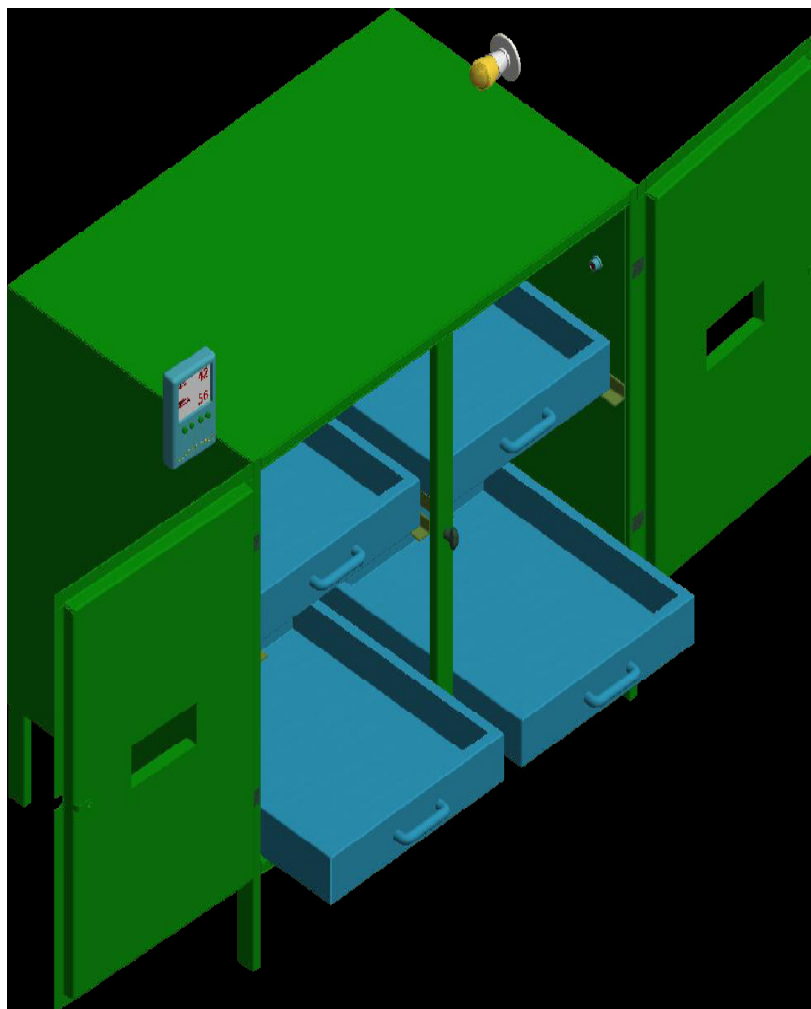


Fig 2: Exploded View of the Incubator

### Machine Testing

Three trial tests were carried out on the incubator before setting the eggs inside to determine the minimum and maximum temperature and relative humidity that may be reached during actual incubation. After the three pre-loading tests, an actual operational test was carried out with the incubator. The basic information about the parent stock and the eggs incubated are as follows:

#### (1) Type of Breed

The parent stock breed used was broiler Anak 2,000 which originated from Israel. It is reputable for table meat and early maturity.

#### (2) Age of the parent stock

The laying birds were age between 28 weeks and 32 weeks. The average age being 30 weeks.

#### (3) Storage temperature and humidity

The eggs were stored prior to incubation at 18°C and 75% relative humidity for 2 days at hatching.

Table1: operational test result

| Day | Average dry bulb temp °C | Average dry bulb temp °C | RelativeHumidity (%) |
|-----|--------------------------|--------------------------|----------------------|
| 1   | 38.4                     | 33.3                     | 69                   |
| 2   | 37.6                     | 33.1                     | 72                   |
| 3   | 38.2                     | 33.2                     | 70                   |
| 4   | 37.9                     | 33.3                     | 71                   |
| 5   | 37.8                     | 33.2                     | 71                   |
| 6   | 38.0                     | 33.4                     | 70                   |
| 7   | 37.8                     | 33.2                     | 71                   |
| 8   | 37.8                     | 33.3                     | 71                   |
| 9   | 38.0                     | 33.6                     | 70                   |
| 10  | 38.4                     | 33.2                     | 69                   |
| 11  | 38.5                     | 33.2                     | 68                   |
| 12  | 38.6                     | 33.3                     | 67                   |
| 13  | 38.6                     | 33.2                     | 67                   |
| 14  | 38.4                     | 33.2                     | 69                   |
| 15  | 38.5                     | 32.3                     | 68                   |
| 16  | 38.1                     | 34.0                     | 70                   |
| 17  | 37.7                     | 34.0                     | 72                   |
| 18  | 37.5                     | 34.0                     | 72                   |
| 19  | 37.3                     | 34.0                     | 73                   |
| 20  | 37.4                     | 34.0                     | 73                   |
| 21  | 37.6                     | 34.0                     | 72                   |

## RESULTS AND DISCUSSIONS

The minimum and maximum temperature recorded for the first 18 days were 37.7°C and 39.3°C respectively. After 18 days of incubation, the temperature was reduced from 37.8°C to 36.0°C until the chicks were hatched. Hence for the whole period of incubation, the temperature was maintained within the range of 36°C and 39°C as recommended by previous research workers (Oluyemi and Roberts 1988). The minimum and maximum humidity values recorded within 18 days were 52% and 62% respectively. After the 18<sup>th</sup> days, the relative humidity was increased from 55% to 71% until the end of the period of incubation as recommended in pervious works (Komolafe *et al*; 1981, oluyemi and Roberts 1988). Hence for the while period of incubation, the relative humidity was varied between 52% and 71%.

Out of 29 eggs set in the incubator, 27 (93.10%) were observed to have developed into an embryo by the 7<sup>th</sup> days when the first candling operations was performed, the remaining two being found to be infertile. At the second candling on the 18<sup>th</sup> days of incubation, the embryo had grown larger and more distinct for 25 of the 27 eggs (92.59%) while the remaining two eggs were infertile. The percentage fertility of the eggs therefore was 86.21%.

Hatching of the eggs commended on the 19<sup>th</sup> days, at the end of the incubation period on the 20<sup>th</sup> days, 19(76%) of the 25 fertile eggs were hatched to produce fully developed chicks.

The completion of embryonic development in the incubation took an average of 19.5 days (it commended on the 19<sup>th</sup> days and ended on the night of the 29<sup>th</sup> day). This period is slightly less than the 20-21 days average incubation period of chicken suggested by oluyemi and Roberts (1988), without the incidence of malformed chicks. The cause of this is most probably related to the genetic composition of the eggs used rather than the type of incubator as suggested again by oluyemi and Roberts (1988).

The high percentage fertility (86.21%) of the eggs used for incubation is an indication that the storage temperature and relative humidity condition prior to use were appropriate. The average age of the parent stock (34 weeks) was also optimum for fertile egg production as noted by walsh *et al*; 1995.

## CONCLUSION.

The conclusion drawn from the exercise is as follows:

- (1) The use of mild-steel as the construction material for the incubator is cheaper than using any other material in terms of relatively low production cost and minimal operational running cost.

- (2) The high percentage hatchability recorded during the test-evaluation of the incubator is an indication of the fact that the incubator is quite effective and could be employed for use in a profitable “day-old chicks” business.
- (3) The effective use of kerosene lanterns as a supplementary source of heat makes the incubator adaptable for use in rural areas by peasant farmers.
- (4) In term of maintenance of incubator, any pleasant farmer can avoid to maintain it.

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