CONSTRUCTION OF AN AUTOMATIC EGG HATCHING INCUBATOR SYSTEM

A Thesis

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DEPARTMENT OF MECHANICAL ENGINEERING

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DECLARATION

This is to certify that the thesis work entitled **''CONSTRUCTION OF AUTOMATIC EGG HATCHING INCUBATOR SYSTEM''** has been carried out by **MD SOHANUR RAHAMAN, MD SHIMUL HOSSAIN, MD ABU HAMJAL, CHOIN MIA** in the department of Mechanical Engineering, Sonargaon University, Bangladesh. The above thesis work or any part of this work has not been submitted anywhere for the award of any degree or diploma.

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ABSTRACT

The purpose of this project is to design and develop an egg incubator system that is able to incubate eggs from chicken, ducks, and goose. This system is called the Automated Egg Incubator (AEI). This project is eco-friendly, which uses as much as possible recyclable material is thrown away. AEI will control the temperature and humidity. AEI also has a sensor that can monitor the incubator conditions. For the heating element in this project. We use the light bulb to provide a suitable temperature to the egg.A thermostat will be used to control the temperature inside the incubator. Water will be used to maintain the humidity inside AEI. An air pump will be used to make sure the air circulates inside AEI, this will make the humidity inside the incubator evenly spread. If the eggs are hatched, the buzzer that is installed with an incubator circuit will sound to indicate that there is a movement of chicks or ducklings. The movement can be detected by using the ultrasonic sensor, Solenoid is used in order to turn the eggs. The purpose of moving the egg is to prevent the yolk inside the egg from attaching to the eggshell/skin. There is one element that will be controlled using a programmable integrated circuit (PIC), which displays the status condition of AEI on the LCK screen display. This project will be a user-friendly product because it is produced in small sizes and can be moved to other places with minimal user handling.

Keywords: Egg Incubator, Module temperature controller, XM-18

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CHAPTER I

1.1 Introduction

An incubator is a device simulating avian incubation by keeping eggs warm and in the correct humidity, and if needed to turn them, to hatch them. Modern incubators are electrically heated with a thermostat. The temperature within an incubator must be precisely maintained within certain limits for optimum growth of the egg. Also, the egg has to be periodically tilted every four hours to avoid the setting of the yolk. The industrial raising of farm animals indoors under conditions of extremely restricted mobility is commonly known as factory farming. It is done as part of industrial agriculture which is a set of methods that change as laws and technology change known as industrial agriculture which is designed to produce the highest output at the lowest cost, using economies of scale, modern machinery, modern medicine, and global trade for financing, purchases, and sales. An egg incubator is one of the inventions that provide opportunity especially for those who want to be excellent farmers. This invention is low cost and eco-friendly, which uses as much as possible recyclable material is thrown away. The construction of this project is used almost 99% of hardwood as the main material. The purpose of this project is to design and develop an egg incubator system that is able to incubate eggs from chicken and ducks. Because this livestock is often in high demand in this country. The systems will automatically control the temperature and humidity of the incubator. The function of the egg incubator is to take over the animal's job to incubate an egg until hatched. The mechanical design is based on the system size. It is consists of the development of incubator casing and a partition inside the incubator. Recycling stuff such as hardwood will be used for the project design.

1.2 Objectives

There are several objectives involved in this project that we need to achieve in order to design the project.

If you want an envelope, you can easily make it.

The price is relatively low and its design is very simple.

CHAPTER II

2.1 LITERATURE REVIEW

An egg incubator is a machine that creates the perfect conditions for an egg to incubate and hatch successfully. An egg incubator is designed to regulate incubation temperature and humidity at perfect levels. It recreates the role that the broody hen plays in nature [2].

There are two types of incubators:

1. Still Air Incubators

2. Circulating Air Incubators

2.2 Incubation Basics

Incubation is the term used to describe the process of applying heat to an egg so that the embryo contained within develops into a chick. Aviculturists of today have three options regarding the incubation of eggs and the procedure accordingly as compared to the other two.

2.3 Incubating Conditions

2.3.1 Temperature

Your electronic control should be set at 99.5° F (37.5° C). Leave it there for the entire incubation period for all species listed below. Before placing eggs in your incubator, turn it on for at least 24 hours to verify the temperature of 99.5°F (37.5°C) by placing your thermometer on the turning rack. It's better to under-heat (you'll get a somewhat delayed hatch) than to over-heat. Many factors account for reduced, early or late hatches. Temperature can be a starting point for making adjustments. An adjustment of one or more degrees may correct problems you suspect are temperature related. If eggs hatch a day or more early, the temperature may be too high. In the next setting, operate a one-degree cooler. If eggs hatch a day or more lately, the temperature may be too low. In the next setting, increase the temperature one degree. There can be a fair amount of variance from one thermometer to the next. Don't use a human fever thermometer, as they usually read too high in an incubator environment. For any particular thermometer, several egg settings may be required to determine the best temperature [3].

2.3.2 Humidity

Incubating eggs do have a surprising tolerance for variations in humidity. However, you should observe the following. Nature has provided that eggs should dry out to some extent during incubation. See Exhibit A. This loss under good conditions will be about 11% of the original weight. Nature provides for an air bubble to form in the large end. This is necessary for the chick to be able to pip through the shell and peck off the cap. Excess humidity will cause this air pocket to be too small. The chick will not be able to pip through the shell above the area containing fluid and may well drown. The chick may also be oversized from excess fluids if the humidity is too high. On the other hand, insufficient humidity during incubation can cause the chick to stick to the shell and also contribute to a delayed hatch. it will not be able to turn as it attempts to peck off the cap. Weather conditions affect relative humidity in the incubator. The amount of opening in the incubator also influences the level of humidity. The ideal moisture level is about 50 to 55% relative humidity (83°-87°F on a wet-bulb thermometer) for the first 18 days and about 75% (90°-94° wet bulb) for the last 4 days. Some variations above or below the ideal level usually will not affect hatchability drastically. Some experienced producers spray goose and duck eggs twice weekly and at least three times during the last ten days. Use 99.5°F (37.5°C) water when spraying. Don't spray water into the tower. Humidity is controlled by adding water to the outside of the tray. Check and fill the water ring twice a week. Be sure there is sufficient water during the last 3 days of incubation. Please also note that you should use only distilled water. This will reduce the amount of mineral buildup in your incubator. When you fill, use warm water. Finally, do not let the eggs come in direct contact with the water. Eggs under incubation will give off a certain amount of moisture. The environment of your incubator does have an effect on how you manage humidity. An incubator operated in a very damp cellar or room with a lot of natural moisture may require the addition of only a small amount of water. Remember to watch the air space in your egg. Perform candling when you test for fertility. If the air space is too large, provide more moisture. If the air space is too small, increase the ventilation (remove a plugin the cover) and do not add additional moisture. At the end of the seventh day, space should be no larger than a twenty-five cent piece. On the fourteenth day, there should be an air space no larger than a fifty-cent piece.

2.3.3 Air Ventilation

Incubator has air movement by natural convection and by a standard equipped fan. Air is heated in the center tower and evenly billows from the top of the tower over the eggs. There is no forced draft of a blast of air on any egg. This natural movement continues during the entire incubating period. Most tabletop incubators with circulating air have fans which operate only when the heating element is on. This causes a lot of variation in how eggs are subjected to air blast.

2.3.4 Turning the Eggs

Egg turning is done for three reasons. First of all, turning reduces temperature gradients within the egg. Secondly, turning prevents embryos from sticking to the eggshell membranes during early incubation. Thirdly, and most importantly, egg turning is required to allow the proper utilization of growth nutrients in the inner white. If eggs are not turned, such nutrients cannot easily move to accessibility by the embryo. The embryo does emit wastes and those wastes are moved away from the embryo by turning to allow the embryo to access the nutrients it needs for development. The most popular small incubators in Europe all roll the eggs and European research confirms that hatch percentages between rolling and tilting eggs are statistically identical. When eggs are turned is the most important decision. The critical period is three to seven days. Eggs not turned in this period but at all other times have lower hatchability than when turned in the critical period of three to seven days. Top Hatch Incubator comes with a rack designed for protected rolling of the egg. Thus, eggs roll back and forth and not continuously in one direction. Try to place eggs of the same size and type in each section of the turning rack. Stop turning eggs 3 days before they hatch. Do this by lifting the tray slightly and rotating the tray so that the motor crank cannot engage the lug on the bottom of the tray. This will prevent turning but the turning rack can remain in place.

2.4 Monitoring of Eggs

Eggs need to be monitored during incubation to determine embryo progress and where incubation adjustment may be necessary.

2.4.1 Candling

Figure 2.1: Candling the eggs

Candling lamps are lights with a concentrated beam that may be shone through the shell of the egg to illuminate the egg contents. This allows the size of the airspace to be determined which offers a guide to the weight loss rate. If the air space is larger than expected too much water is being lost and the humidity in the incubator should be increased to reduce the rate of water loss. If the air space is smaller than expected, then the opposite applies. Candling also allows the development inside the egg to be observed so that eggs that are infertile or have died may be safely removed from the incubator. There are a lot of commercial egg incubators out there in the market been designed to hatch eggs. However, they are high in cost and not environmentally friendly. Alternatively, the Automatic Egg Incubator (AEI) is designed to overcome this problem. Besides, AEI also to improve the available eggs incubator in order to change the traditional farming method to advance and modern farming method. By introducing the Automated Egg Incubator may help our country achieve a food trade balance surplus. The scope of this project is categorized into three parts such as software, hardware, and mechanical design. There are several hardware components and circuits used in this project. A thermostat is used to control the temperature inside AEI. The outputs for thermostat are light bulbs for the heating element and air pump. A water level sensor is used to detect the water level inside the AEI. The output for the water level sensor is a water pump. Then, the ultrasonic sensor is used to detect any movement inside the AEI. The output for this sensor is a buzzer.

With a bit of research, we determined it would be the best course of action for several reasons:

a) The incubator will help farmers produce products in a short time with a large number of eggs.

b) An egg incubator can be considered a replacement for incubate session of animal

c) The incubator will be large enough to avoid problems of less production.

Hygrometers are electronic or mechanical devices that measure humidity by a physical change of a substance. Hair hygrometers have a dial indicator connected to a fine filament of a material that changes length according to the humidity and moves the dial indicator across a graduated scale. Electronic hygrometers measure the change in electrical resistance of a small chip of moisture sensitive material and tend to be more accurate than mechanical hygrometers.

Figure 2.2: Automated Egg Incubator Top view

The Brinsea Humidity Management Module uses this type of sensor to display the humidity and to control a pump system to add water to maintain the desired humidity. Warning: cheap, inaccurate hygrometers can be worse than having no hygrometer. The ideal humidity level for the egg, which can be affected by variation in shell thickness and porosity, is always best monitored by checking the egg weight loss. In contact incubation, the embryo temperature tends to fall at later stages of incubation as a result of the embryo's own blood circulation which becomes significantly more important than embryonic metabolism in determining temperature distribution and heat flow within the egg, quite contrary to previous understanding which assumed metabolism to be dominant and cause egg temperature to rise. The inevitable fact that the embryo grows larger and must move from its original position on top of the yolk sack downwards in the egg to cooler regions also tends to reduce the embryonic temperature as

incubation progresses. These important findings emphasize surprising differences between natural and artificial incubation, but there are others.

Figure 2.3: Automated Egg Incubator front View

Eggs in nature are certainly subjected to a cycle of warming and cooling coupled with ventilation as the parent bird leaves the nest to feed and defend territory, etc. The first manufactured contact incubator, Brinsea's 'Contaq' incubator should be viewed as replacing the natural Bird and Nest combination. The lid with the attached 'skin' mimics the functions of an incubating parent; providing warmth by contact with the tops of eggs, but also the facility to lift from the eggs periodically and in doing so, causes a substantial influx of fresh air in the manner of a bird standing of leaving the nest. The skin is gently but firmly pressed against the eggs by a low positive pressure of air, ensuring good thermal conduction. The egg chamber substitutes for the 'nest' in providing a safe, protected environment for the eggs, with provision for air to be induced through the nest material which enables the operator to exercise control over the degree of ventilation of eggs. Nests of different species have very different characteristics, particularly with respect to gas permeability. This, in turn, affects water loss from eggs, so it is necessary to adjust the amount of nest material accordingly. Where required, additional humidity is introduced to the egg chamber automatically. The ideal combination of nest material and humidity setting is best determined by weighing eggs and monitoring water loss. The egg chamber is not directly heated.

CHAPTER III

3.1 Required Materials

- Module temperature controller,XM-18
- Humidifier
- 12VDC Fan
- 220V, 100W light
- Wood Box (size: H-35",L-31",W-16") inch
- Plug
- Plastic Box

Figure 3.1: Module temperature controller

The XM-18 is an incredibly low cost yet highly functional thermostat controller. With this module, you can intelligently control power to most types of electrical device based on the temperature sensed by the included high accuracy NTC temperature sensor. Although this module has an embedded microcontroller no programming knowledge is required. 3 tactile switches allow for configuring various parameters including on & off trigger temperatures. The onboard relay can switch up to a maximum of 220V AC at 5A or 12V DC at 10A. The current temperature is displayed in degrees Centigrade via its 3 digit seven segment display and the current relay state by an onboard LED [4].

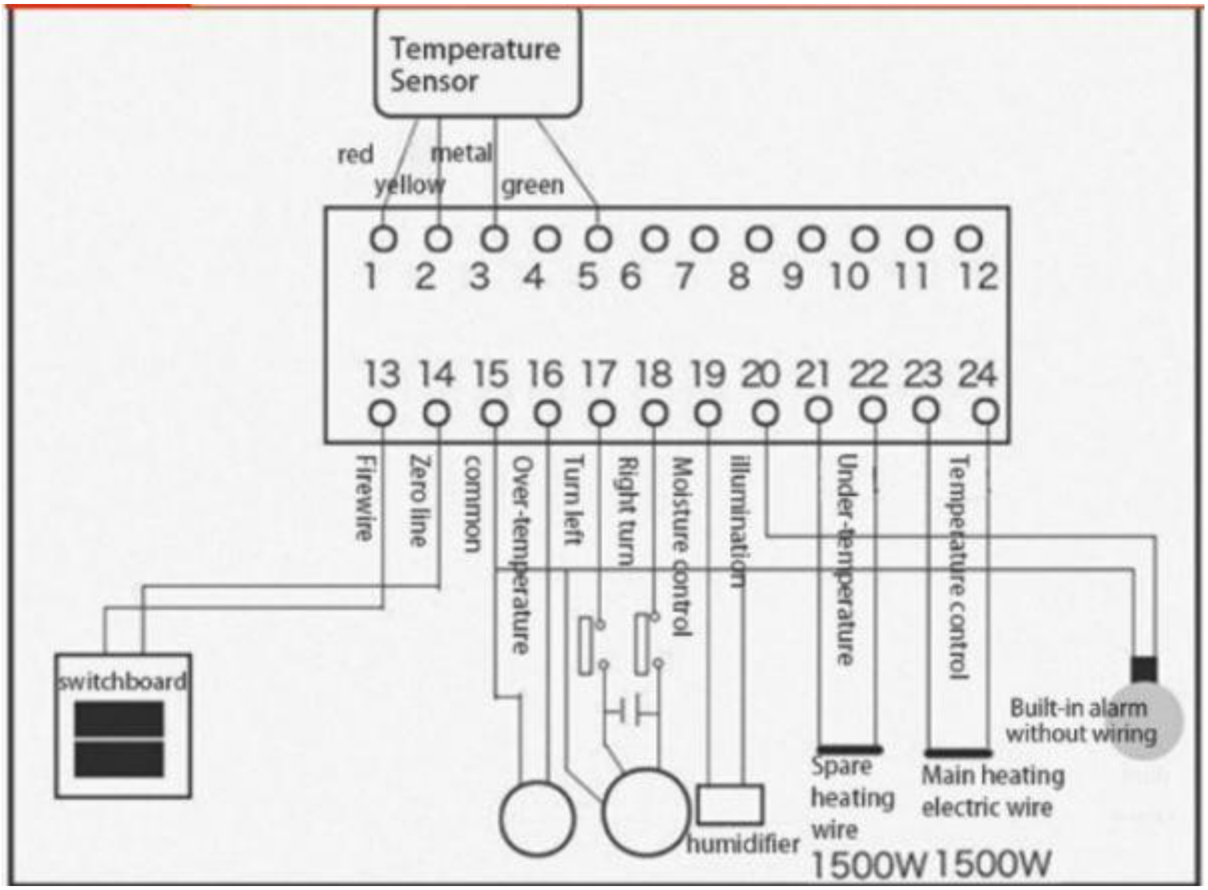

Figure 3.2: Schematic-diagram XM-18

3.1.1 Specifications

- Temperature Control Range: -50 ~ 110°C
- Resolution at -9.9 to 99.9: 0.1°C
- Resolution at all other temperatures: 1°C
- Measurement Accuracy: 0.1°C
- Control Accuracy: 0.1°C
- Refresh Rate: 0.5 Seconds
- Input Power (DC): 12V
- Measuring Inputs: NTC (10K 0.5%)
- Waterproof Sensor: 0.5M
- Output: 1 Channel Relay Output, Capacity: 10A

3.1.2 Power Consumption

- Static Current : <=35mA
- Current: <=65mA

3.2 Construction:

As we wanted it quick and cheap, rather than using wood, we opted to use a wood box and it insulated with syntax polymer insulation. Simply put a fitting plate on the bottom, against the sides and then add one as a lid. Make sure the lid fits well. If you can get your hands on a Styrofoam cool box of the proper size, use that one. As a heater weare using a lamp, so needed to mount a lamp fitting. it is attached to screws in wood, we sunk the screws into a piece of wood on the outside that also functions as a handgrip. I then bolted a small fan with spacers on the top sidewall, aimed at the lamp. This fan is purely for internal circulation. Make 2 holes, 1 to lead the wire of the Moisture sensor through and one to lead the wire of a temperature sensor through Make 2 or 3 extra holes (about 1.5 cm diameter) near the bottom for ventilation. Eggs need oxygen.

Figure 3.3: The Case

The Thermostat will control the temperature. The Hygrometer will not control the humidity but at least give info about it and the 1/240 RPM motor can be left on continuously as it will slowly turn the eggs so they make a full turn every 1 hour. This thermostat is basically an NTC with an 8-bit microprocessor, a display, and a relay. The sensor of the Xm-18 is a 10k NTC. The Thermostat needs 12 Volt, mainly for the relay and has a 5 Volt regulator for the rest of the circuit. The thermostat was mounted on a piece of cardboard that was attached to the box at an angle for easy reading. The XM-18 thermostat can be used to cool as well as to heat. The SETbutton was pressed for 2 sec. The measured temperature will start flashing and you can set that to the desired switching temperature with '+' and '-' keys. Press SET again to accept the setting.In the factory setting, the device is most likely set as a cooler rather than a heater. P2 Highest temperature

- P3 Lowest temperature
- P4 Calibration
- P5-Delay starting time: In this step, you set the start delay in minutes 1-10 min.
- P6-High Temperature Alarm

The menu P6 initially turns OFF to ON and press the SET, then set the temperature at which the alarm is activated.

Figure 3.4: The Electric Connection

CHAPTER IV

4.1 Egg Inspection

The Egg Inspection program is responsible for enforcement of the Bangladesh Egg Law enacted to provide Bangladesh consumers with wholesome, high-quality eggs. The law also provides fair trading practices for the egg industry as all sellers of eggs must comply with the requirements. All wholesalers and egg packers selling eggs in Bangladesh are required to register with MDA annually. Packers are required to submit the information that qualifies their flock as meeting a Salmonella enteritidis (SE) risk reduction requirement such as originating from a National Poultry Improvement Plan SE monitored flock of participation in an approved Egg Quality Assurance Plan. The registration also serves as a method for traceability in the event of an egg-related foodborne illness such as Salmonella enteritidis. Inspections are performed at the wholesale, foodservice and retail level to ensure eggs sold in our state originate from an approved packer and meet the standards established for quality, size, refrigeration, microbial and physical contamination, labeling and record-keeping. Portions of the labeling, record keeping. Portions of the labeling, record keeping, and registration requirements were developed to provide traceability in the event any problems with the eggs. Eggs found to be out of compliance with the established standards are removed from sale and violation notices are issued to the responsible person. Repeated or severe violations of the Bangladesh Egg Law can result in civil penalties. Eggs are inspected at retail and wholesale stores to ensure quality, wholesomeness, and proper labeling. Inspectors verify that eggs are properly refrigerated and rotated. A special light, called a Candler, is used by the inspectors to illuminate the interior of the egg, allowing them to ascertain that the eggs meet the Grade (quality) labeled on the cartons.

Necessary documentation for the inspection:

- Egg license
- Wholesaler name
- Any other supporting information

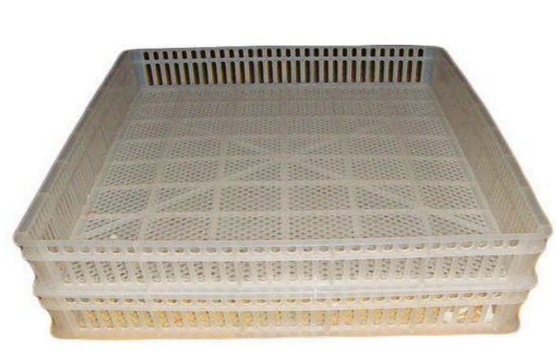

Figure 4.1: Hatching Egg Incubator

4.2 Inspection Data

Days	Temperature	Humidity
1	37.9°C	50%
2	37.9°C	50%
3	37.9°C	50%
4	37.9°C	50%
5	37.9°C	50%
6	37.9°C	50%
7	37.9°C	50%
8	37.8°C	55%
9	37.8°C	55%
10	37.8°C	55%
11	37.8°C	55%
12	37.8°C	55%
13	37.8°C	55%
14	37.8°C	55%
15	37.5°C	65%
16	37.5°C	65%
17	37.5°C	65%
18	37.2°C	70%
19	37.2°C	70%
20	37.2°C	70%
21	37.2°C	70%

Table 4.2: Inspection data for egg hatching pattern in temperature and humidity levels

CHAPTER V

5.1 DISCUSSION

The eggs were candled alongside the incubation process as the experimentation continues. This was to determine the air space size in order to have a guide to the weight loss rate of the egg content. Also, to observe the development of the embryo so that infertile or dead embryo can be safely removed from the machine. Finally, on the 21th-day, the hatching process took place. During this process, close observations were made and the necessary data were taken.

5.2 CONCLUSION

In conclusion, this study has been able to successfully develop an incubator that can accommodate about 50 eggs at a time. The aim and objectives of this project have been achieved. An automatic egg incubator and hatchery has been developed and it could be used to incubate various types of eggs. It is expected that further studies should focus on ensuring adequate access to power supply since constant power supply would be the cornerstone for the efficient functioning of a microcontroller-based bird-egg incubator. Other areas of further development such as the inclusion of the telecommunication module to inform the farmer about the current status of the incubator and give alerts for emergency actions. Also, the inclusion of stepper motor for better angular movements of egg trays and the inclusion of a DC heater avoid the use of alternating current (AC) can be considered. Furthermore, the inclusion of an inverter as a backup power supply can also be considered as well as the possibility of establishing a solar-powered system.

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