

Development and Implementation of a Proto-type Pop-Corn Machine with Aluminium and Glass for Nigeria

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Article Info

Article history:

Received 25 October 2016

Received in revised form

20 November 2016

Accepted 28 November 2016

Available online 15 December 2016

Keywords:

Element, Compartment, Heating, Power

Abstract

This paper involves designing the system and also constructing a unit that can be used to pop cereals. In the olden days, crude and tedious methods were used for popping corn until this machine was discovered, its operation is simple, it does not waste energy or time, and it can pop large quantities of corn within a short time. And lastly, it can be operated automatically. The popcorn-making machine is constructed with locally made materials at a reduced cost. The con popcorn machine is one of the fastest means of converting corn into another substance in a faster way than using kerosene stove, firewood or other primitive sources. The Bill of Engineering Measurement and Evaluation was estimated as (N 51,300 or \$ 213.75) with the choice of materials used, the cost of production and maintenance of the machine is considerably fair and the durability is reliable.

1. Introduction

Economy has suffered a terrible setback over the years, the common man finds it difficult to make up for his livelihood, and the ultimate aim of Engineers in any society is to embark on projects which will facilitate efficient processing in any area of life. Scientists' development and technological growth have to do with invention, discoveries and design of new modern equipment and machines which were developed in form of craft and more mathematical properties, supports of physical sciences have led to a great improvement in the use and operation of the equipment and machines [1]. Corn is one of the popular cereals in West Africa which can be made or prepared in many ways for human consumption like boiling, roasting or by making it into paste. The electrical popcorn machine is a device for preparing popcorn for the human consumption (<https://afribary.com>).

A pop-corn machine is made specifically for popping of corn. In the olden days, crude and tedious methods were used for popping corn until this machine was discovered, its operation is simple, it does not waste energy or time, and it can pop large quantities of corn within a short time. And lastly, it can be operated automatically and with locally made materials at a reduced cost.

In 17th century colonist popped corn using a device formed of a thin sheet of metal shaped into a cylinder, with a handle attached. The implement was rotated in front of the fire on an axle, much like a squirrel cage. (Akinoso and Awaoliyi, 2004). The first automatic popcorn popper was a steam-powered machine invented by Charles Cretors in 1885; before Cretor's invention, street vendors popped corn in wire baskets over open fires. By about 1890, the glass-sided popcorn machine with its gasoline burner became a popular feature of the circus, carnival, slideshow, local fair, and small town streets where popcorn vendors would sell bags of popcorn as dusk fair. In order to test his machine, it was necessary for Charles to operate it on the street as the customer. Street vendors use to follow crowds around pushing as dusk fair. In order to test his machine, it was necessary for

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Charles to operate it on the street as the customer. Street vendors use to follow crowds around pushing stream or gas powdered poppers through fairs, park and exposition. The first automated popcorn machine with an electric motor became a new investor for human consumers and the electric popcorn machine poppers soon took to market and electricity quickly became the choice of power [2]. Fuse is the simplest and often the cheapest form of excess current protection, it's active part fusible element consist of short length of conductor often a single strand of wire with cross-sectional area much smaller than the cable it is protecting. It is connected in series with the circuit to be protected under normal operation condition; fuse element is at a temperature below its melting point, therefore, it carries the normal load current without over-heating. However, when a short circuit or overload occurs, the current through the fuse, increases beyond its rated capacity, this raises the temperature and the fuse element melts (or blows out) disconnecting the circuit protected by it. Therefore a fuse protects the machine and equipment from damage due to the excessive current. It should be noted that for this project, a 13 amp fuse is used and where accuracy in fuse rating is required, the required fuse become unreliable due to usage of wrong size of wire. The result is that, it will not protect the circuit. The cartridge type of fuse is more reliable since the fusible element is produced under the strict manufacturing control. The fuse plug therefore serves a dual purpose. It is sited with a 13A plug [5]. A fuse is a current interrupting device which breaks or opens the circuit by fusing the element when the current in the circuit exceeds a certain value (Gupta, 2009).

2. Design Analysis of the Pop corn Machine

The design and construction of a standard popcorn machine involves several components of which the following factors were considered, in order to have a good design are:

- i. The source of power
- ii. The efficiency of the machine
- iii. The nature of the product to be produced by the machine
- iv. The mechanical strength of materials to be used for the construction this will involve the abrasion, strain and the stress level of the material.

The various component parts of the pop corn machine are divided into modules for easy designing and fabrication.

3. The Modules of the Popcorn Machine

3.1 Aluminium Frame

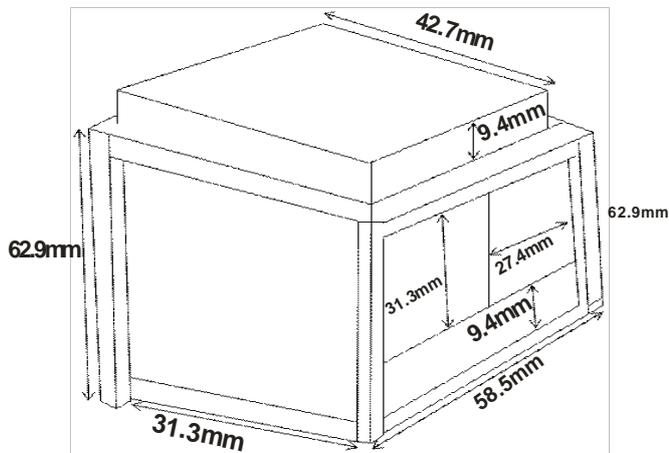


Fig. 3: Aluminum Frame

The aluminium frame forms the main casing. It is rectangular in shape. It measures 62.9mm x 58.5mm x 31.3mm. It was made of strong electroplated metal in order to prevent rusting and also to elongate the life of the popcorn machine. It has stainless base on which the popcorn will be poured. On top of the frame is a cover which is used to cover the motor and other connections. The main function of the aluminium frame with the glass cover is to house the popping chamber, which is suspended and attached to the upper part of the frame.

3.2 Glass Cover

The glass cover formed major part of the casing and has a thickness of 4mm with 49x31mm at two equal sides while its front was 49x38mm for the door. It is advisable to use glass of high thickness to avoid unexpected cracking due to effect transparency of the popped corn and as well as to reduce heat losses to the surrounding. It also Allows for maximum visibility and is a great experience for the whole family. Who can resist hot, buttery, fresh Popcorn? (<http://www.popcornmachine.ca>).

3.3 Stirring Unit

The popping chamber was made of aluminium having a cylindrical shape of 26.8mm in diameter and 14mm in height. It has a hole in the middle through which the stirrer was passed to the popping chamber. The stirrer was suspended in such a way that it always touches the bottom of the popping chamber for effective turning of the corn during popping operation. The use of aluminium metal is due to its ability to conduct heat readily. The popping chamber was made double layer with the heater attached to the lower part of it. The main function of the popping chamber is to absorb the heat energy produced by the heater and the stirrer to turn round the corn for even popping.

3.4 Heating Unit

This unit comprises the heating element. The element used in the project is a ring type which produces heat energy needed for the popping. It was fixed to the lower part of the popping chamber used for popping the corn. For this design, a ring type element was used because of its high quality property and its low cost rate.

Fig. 4: The Popping Chamber

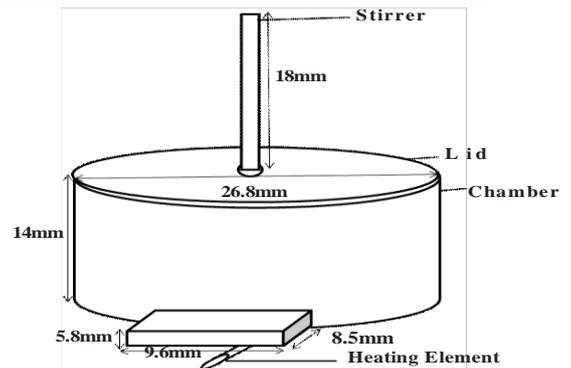


Fig. 5: The Stirrer

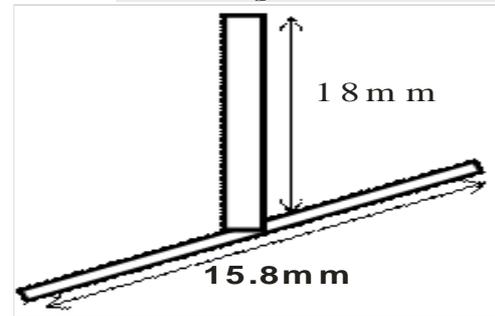


Fig. 6: Heating Element



3.4 Heater Design Calculations

The power rating of the element is 1500W and the A.C supply is 240V.

$$Power = 1500W, Power = IV$$

$$I = \frac{P}{V} = \frac{1500}{240} = 6.25A$$

3.5 Heat Transfer

Transfer of heat can be determined by the property of matter and temperature. It is governed by the second law of thermodynamic, which dictates that for a free flow of heat is possible only from a body of higher temperature to a lower temperature (Gupta, 2003). The principles of heat transfer are based on the energy sources and the heat energy transportation to the system (movement of molecules within fluids). Fluids consist of liquids and gases. The three mechanisms modes of heat transfer are conduction, convection and radiation. The heat energy transfers between a solid and a fluid when there is a temperature difference between the fluid and the solid. This is known as "convection heat transfer". Generally, convection heat transfer cannot be ignored when there is a significant fluid motion around the solid. However, convection is one of the major modes of heat transfer and mass transfer. In fluids, both convective heat and mass transfer take place through diffusion. A common use of the term convection leaves out the words "heat" but nevertheless refers to heat convection: that is the case in which heat is the entity of interest being advected (carried) and diffused (dispersed). In one of the two major types of heat convection, the heat may be carried passively by fluid motion, which would occur without heating process

(a heat transfer process termed loosely as “force convection”). In the other major type of heat convection, heating itself may cause the fluid motion (via expansion and buoyancy force), at the same time cause heat to transport by this motion of the fluid (a process known loosely as natural convection, or “free convection”.



Fig 7 (a): Machine with Aluminium and Glass Compartment



Fig 7 (b): Developed Pop-corn Machine

3.6 Insulator

Any material that offers opposition to flow of current is called insulator but in pop-corn machine the case is different. The wire used in pop-corn machine have to be protected or insulated because of the heat generated by the heater in the process of popping corn, if these wires are not properly protected can melt. So to avoid melting, thermal and electric insulators were used. The following practices and techniques were put in place during the construction of the popcorn machine.

3.7 The Compartment

In order to have a good design of the construction certain condition must be check and to obtain an approximate desirable design, there is a need to consider the choice of materials to be used in the construction of the compartment. In the construction of compartment the most commonly used materials are:

- (i) Aluminium compartment
- (ii) Wooden compartment

In the case of this project an aluminium compartment type is used because of its durability, strength and efficiency.

3.7.1 Aluminium Compartment

This type of compartment is made from aluminium metal and stainless sheet of various sizes; it has two different layers, the top layer where with the circuit configuration is placed, also the lower layer is meant for the popped corn when done is poured on. The following steps were taken in the construction of the compartment for the popcorn. A good metal sheet was chosen and selected in place of wood because of the following reasons:

- (i) It has an excellent corrosive resistance.
- (ii) It can stand the test of time.
- (iii) It is strong and durable.
- (iv) It has high strength.

The required size and shape was measured on the sheet using tape rule and marker and the shape was cut out using hack saw.

A good iron rod was selected to hold the stirrer for the following reasons:

- (i) It has the strength to withstand heat.
- (ii) It is durable and strong.

The required size was marked and cut out from the length. The appropriate size and shape of metal sheet for constructing the top cover was marked and cut out. The metal sheet for the top cover that was earlier cut into size which was welded by electrodes. The stainless metal sheet of the second layer was cut and folded to required size and screw to the frame. The top layer where the component was arranged on was folded into the required size and screwed to the frame with the aid of an electric drilling machine. Electric heating element was used because of the following reasons:

- (i) It is cheap in cost.
- (ii) It does not consume much energy.
- (iii) It is durable.

The top cover was grinded after welding to remove attached and bumpy electrode. Spray paint was selected to beautify the top cover for the following reasons:

- (i) It is durable and permanent
- (ii) It prevents the metal from rusting.
- (iii) It has a long life span.

(iv) The top cover with spray painting has color brilliance than the ones painted with emulsion. Holes were made beside it to convey wire for the main supply. The diagram of the compartment was shown in figure 3.3.

3.7.2 Incorporation of the Circuits

After the compartment has been completed, the choice of circuit configuration was put together on the top layer to test the functionality of the circuit. After testing it was soldered together and all connections were made.

4. Performance Analysis and Results

A performance analysis test was carried out after the design and construction of the project was completed. The popcorn machine was connected to supply mains and was switched on. The switch was turned on and the following results were gotten;

- (i) The connecting cable is able to withstand the power consumed by the unit.
- (ii) The switch was able to control the intensity of the heating element.
- (iii) The intensity of the light keeps the popcorn warm in the compartment.
- (iv) The heat from the chamber was evenly distributed, while the stirrer stirs the popcorn.

Table 1. Bill of Engineering Measurement Evaluation (BEME)

S/N	Description of Item	Quantity	Rate #	Total Price #
1	DC Stepper Motor	1	8,000	8,000
2	Heating Element	1	2,000	2,000
3	Step-down Transformer	1	800	800
4	Rectifier	1	700	700
5	Switch	3	150	450
6	Casted pot	1	1,200	1,200
7	13A plug	1	300	300
8	Cable connector	1	100	100
9	Aluminium Frame	2	5,000	10,000
10	Glass	1	6,000	6,000
11	Lamp holder	1	50	50
12	Bulb 100W	1	50	50
13	Indicator	1	200	200
14	Screws	1Packet	250	250
15	stainless sheet		4,000	4,000
16	Stirring	1	400	400
17	Supply cable	2m	150/ m	300
18	Paint	1	500	500
19	Fibre Door		1,000	1,000
20	Transport			5,000
21	Workmanship			10,000
	Total			51,300

5. Conclusions & recommendations

The construction of a popcorn machine is one of the fastest means of converting corn into another substance in a faster way than using kerosene stove, firewood or other primitive source. The Bill of Engineering Measurement and Evaluation was estimated to be (N51300 or \$213.75). After the project has been constructed, it is obvious that the objective of the paper was achieved, that is the electric popcorn machine is an efficient means of producing popcorn for commercial purposes. With the choice of materials used, the cost of production and maintenance of the machine is considerably fair and the durability is reliable. Based on this concept, the following recommendations were made:

(i) Since the popcorn machine (prototype) was designed for small scale production, it is necessary to increase machine capacity and develop similar type based on same principle of designed for commercial purpose.

(ii) It is recommended that slow electric motor should be used in subsequent construction to avoid high turning speed.

(iii) The source of heat for the popcorn machine was electric heater; it will be interesting to investigate heat transfer in further research.

(iv) The procedure for mass production of the popcorn machine should be worked upon with particular concerned organization.

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