Design and Implementation of Flour Mixing Machine with Water Heater in Rwanda

Vincent NIYONSABA
Email: vincentniyo4@gmail.com

ABSTRACT

Nowadays, the world improves very fast in technology in order to increase the productivity and reduce the work done by human being and save human being energy consumption. People across the world consume goods that comes from mixed flours such us breads and cakes. Many years ago, and in some instances, people mix flours by using their own hands and adding hot water as well as using unimproved cooking methods for proper mixing. And these traditional methods consume human energy and time consuming. After analyzing all the above situation that comes from the research carried out; these above problems could be solved by introducing a new combined machine entitled “Design and implementation of Flour mixing machine with water heater in Rwanda.” This machine will serve to increase productivity and to satisfy the people’s needs of breads.

Keywords: Flour mixing machine, Design, Rwanda, water heater

INTRODUCTION

Most of the population in cities even in rural areas consumes flour derivatives in daily life. Still the problem to both government and entrepreneurs is what can we do to increase the productivity of flour derivatives without destroying the environment and consuming the human being energy and satisfy the local market as well as common market. This is only achieved by fabricating the machine which has a high efficiency at low operation and maintenance cost.

The aim of this project is to design and implementation Flour mixing machine with water heater which will contribute in reducing pollutants to the environment, it will be used in all region of the country, I will be operated and maintained easy and It will be at affordable price.

METHODS

Modelling Design

Many years ago, flour and water had been mixing manually and water was cooked by using woods or charcoal in many regions of world including my country
(Rwanda). After introduction of new technology, in developed countries, the flour and water were mixed by 3 phases voltage mixing machine and water was cooked separately. After research carried out, I found that cooking water with charcoals or woods contaminants the environments and take longtime. Also, to use 3 phases voltage mixing machine, the operation cost is high and it can’t be used in all region where there is no three phases voltage supply. I decided to introduce a combined flour mixing machine with water heater which will be used in household and in bakeries. The users of this new machine will be benefited in its low-cost operation and maintenance with high efficiency and It will help the government in its policies to mitigate the pollutants against environment.

Process of Design

The process of design is a subchapter that intended to give full explanation to every reader of this dissertation on the processes followed once manufacturing this machine, there are various processes carried out during manufacturing this machine, I cannot develop all of them but for making it easy to one who is reading my dissertation to understand how this machine was manufactured I can list some such as selection of materials, marking, measuring, cutting, preparation of edges to be welded, welding and finishing.

Basic concept of machine design

Design and implementation of this machine is based on different concepts, we as designers there, are a lot of factors to consider for getting an optimum design. Firstly, once conduct a market survey this gives a picture of really what people around need and according to what we learnt in entrepreneurship course a successful business is created based on customer’s needs. All designer’s consideration should meet the desired design because once mistaken lead to poor design.

As I am focusing on design and implementation of flour mixing machine with water heater, which is a machine used to mix different forms of flours with water not only that only but also heating
water to the desired temperature for getting mixed flours needed in bakeries.

Let us see some ideas and basic concepts from various authors concerning some parts of flour mixing machine with water heater.

**Theoretical perspectives**

This Flour mixing machine with water heater can be described as a household, industrial and institution machine used for kneading large quantity of flours and heating a given quantity of water. It is an electromechanical machine and may have different controls to suit the users’ needs.

This machine uses standard mechanism. Motor torque is at required speed to mix large quantity as well as small quantity of flours, even the stating torque is enough for starting to produce the rotation to the dish.

Fundamental goal in design and implementation of this machine is to meet the required production, operate competitively but all this being affordable to the population at low price.

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**Brock Diagram of Flour Mixing Machine with Water Heater**

Figure 3. 1Block Diagram of flour mixing machine with water heater

![Water Heating System](image1)

**Water Heating System**

**Electric Water Heater**

Electric heating is a process in which electrical energy is converted into heat. Common applications include space heating, cooking, water heating and industrial process. An electric heater is an electrical device that converts electric current to heat. The heating element inside every electric heater is an electrical resistor and works on the principle of Joule heating. An electric current passing through a resistor will convert that electrical energy into heating energy. Most modern electric heating device use nichrome wire as the active element, the heating element depicted on the right, uses nichrome wire supported ceramic insulators

![Figure 3. 2 Water heater](image2)
Water Reservoir

It is a container manufactured in aluminium for avoiding problems of rust, and increasing corrosion resistance, it is a container just for holding water to be used with in mixing flours and it has a hole at the bottom just for allowing water to be distributed within the machine up to the dish. The capacity is approximately 10 liters.

Water Distributing System

This is a system we inserted in the project just for allowing water heated to circulate from the water reservoir to the dish where flour to be mixed is placed. This system is constructed by two materials:

Pipes: A pipe is a tubular section or hollow cylinder, usually but not necessarily of circular cross section, used mainly to convey substances which can flow, liquids and gases (fluids), slurries, powders and masses of small solids

Pipes used are made in Galvanized steel because it is used in high temperature and pressure piping in process and power facilities and drinking water and in our project because we use hot water, we used pipes made in Galvanized steel.

Control System

3.5.2.1 Control and Power Circuit of Flour Mixing Machine with Water Heater

Meaning of acronyms used in the circuit:
P  Live
N  Neutral
KM1  Main contactor1
M  Motor
S0  Normally closed switch
S1  Normally open switch
FLOUR MIXING SYSTEM

Design of Cover for flour mixing machine with water heater

After manufacturing, collecting and assembling main parts of flour mixing machine with water heater we had to design the cover of this machine, means the outlook of the machine, because in order to allow and facilitate the users of this machine to use this machine there must be an outlook designed in a way that it will be easy for users to access this machine. The cover is manufactured in mild steel sheet metal of 2mm thick and welded in corners with mild steel angle iron of 40mm*40mm*60mm as specification as it is illustrated bellow it has complex form and looks like below.

Figure 3. 8 cover
The machine cover supports the component of the flour mixing machine such as: water heater, DC motors, helix mixer, dish and a set of pipes used. The material used to fabricate this machine are made from Mild Steel.

Even though there are lots of metals (like Aluminium, cast iron) available for fabricating different kinds of object, Mild Steel is the most widely used in fabrication of materials. Following are the major reasons behind this.

- It is highly ductile.
- Moreover, Mild Steel can be recycled easily.
- It can be easily welded.
- It is widely and cheaply available compared to other ductile metals.
- It’s Youngs modulus

1. Shielded Manual Metal Arc Welding is the simplest of all the arc welding processes.
2. The equipment can be portable and the cost is fairly low.
3. This process finds innumerable applications because of the availability of a wide variety of electrodes.
4. A big range of metals and their alloys can be welded.
5. Welding can be carried out in any position with highest weld quality.
6. The simplicity and portability of SMAW equipment allow use of this process in a wide variety of applications from refinery piping to cross country pipelines.
7. SMAW can be used in any position or location that can be reached with an electrode.

**Fabrication and Metal Joining Methods**

Fabrication is a process of producing something or product from row material in which to adding the value of these material. In this project we fabricate many things like machine frame, sieve holder by using shielded metal arc welding and using difference type of metal forming. I have chosen the above welding type because it is more advantageous type.

The following are advantages of shielded metal arc welding.

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**Helix Mixer Design**

Forging is often classified according to the temperature at which it is performed: cold forging, warm forging, or hot forging, for us as the picture above demonstrate it, we used hot forging where a small cylindrical tube was heated until it looks red like the above right picture looks and then we hammered it to form a shape similar to a coil shape for forming the helix mixer. We fixed the bottom plate of the helix mixer and the hammered the tube to form the below shape designed in Solidwork software.
Design of Shafts

A long, narrow part or section forming the handle of a tool or club, the body of a spear or arrow, or a similar implement. A shaft is normally a mechanical component for transmitting torque and rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them. We used in our project three shafts of specifications:
- One had 25mm as diameter over 300mm of length.
- Second had 25mm as diameter over 900mm of length.
- Third have 20mm of diameter on 300mm of length.

The last shaft has a hallow cylindrical bore of 25mm as internal diameter, 50mm of external diameter and 200mm of length to be used for making a wheel hub. The shaft is fixed to the stand by two journals bearing and is shown on the figure above. Properties of material used for the above shafts:

- High wear resistance.
- Good machinability property.
- Ductility and malleability.
- High tensile strength.

Key

In mechanical engineering, a key is a machine element used to connect a rotating machine element to a shaft. The key prevents relative rotation between the two parts and may enable torque transmission. For a key to function, the shaft and rotating machine element must have a key way seat, which is a slot and pocket in which the key fits. The whole system is called a keyed joint. A keyed joint may allow relative movement between the parts.
Mixer Shaft

This is normally a shaft that has at its top a plate with threaded holes and this plate is fixed on the plate also welded at the bottom of the dish, and the shaft pass through or inserted in mixer bearing (Ball bearing) and the shaft pass through up to the bottom pulley to allow for the rotation of the dish, once the bottom pulley rotates, it rotates together with that shaft and the plate at the bottom of the shaft also rotate together with the dish and this the needed rotation of the dish.

Figure 3. 12 Shaft pulley with its upper plate mounted on the dish.

The key way we see on the shaft as discussed before it helps to lock the shaft together with the pulley in order to transmit properly the motion.

Dish

It is a tool similar to a source pan that we use in our house, it is made in aluminium as its property due to the reason we will discuss about letter and its role is in mixing, it is where flours are disposed and mixed. Briefly during the operation, it is where flour and hot water are mixed.

Why dish is manufactured in Aluminium?
It is because Aluminium:

- Not get rust
- Has excellent corrosion resistance
- Is easy machined
- It has superior malleability.
- It has good thermal and electrical conductivity
- It is very easy to recycle

This dish we have shown the isometric view of it but once we look on its bottom view there is a plate welded on it that contains threaded holes too where the mixer shaft is fixed.

Working Principal of Flour Mixing System

Electric water heater is placed in water reservoir so that the resistance makes physical contact with water in the reservoir, the cable of electric water heater once connected in single phase supply this resistance change electric
energy into heat energy and by convection there is a heat exchange between this resistance and cold water, from this water acquire temperature and get hot. Once water get hot because at the bottom there is a hole, water descends via pipes and if the operator wants to allow this hot water to flow to the dish, he/she raise or lower the internal gate of the valve. Flours are mixed by rotation of dish and helix mixer in counter directions, dish must be in opposite direction to that of helix mixer, both helix mixer and dish are connected to DC motors by means of shafts and bearings. One motor is placed at the bottom and another at the top and then fixed in machine cover, they are then coupled by shafts and these shafts are fixed to the ball bearing so that both shaft and ball bearing rotates together. and dish as well as helix mixer are fixed too to this ball bearing one at bottom bearing and another at the top ball bearing so that once the shaft rotates, it rotates together with the dish and helix mixer the difference is how polarities of motors are connected in order to give opposite direction.

**Assembling of Flour Mixing Machine with Water Heater**

After manufacturing the cover of this machine, we fixed the ball bearing on the stand and inserted the mixer shaft then we placed the dish on its appropriate plate then locked with bolts and nuts. And then we fixed helix mixer to the shaft inserted in ball bearing to allow rotation and hollow square tube called arm tube to the stand which are perpendicular to the dish. At the accomplishing of the above processes, we brought DC motors and fixed it to the machine and fixed the transmitting shaft to the machine with journal bearing. And after we coupled those motors through journal and ball bearings to dish and helix mixers.

![Figure 3. 14 Assembly of flour mixing machine with water heater](image)

Motors are supplied by DC supply (Battery) as discussed before and also water heater is connected to single phase supply, but also contactor is supplied by Ac supply to allow the coil of contactor for holding its normally open contacts (Auxiliary contacts).
Working Principal of Flour Mixing Machine with Water Heater

My project named Flour mixing machine with water heater can be explained as a tool that will be used for mixing flours for forming dough used in production of breads, cakes and other flour derivates and simultaneously heating water used in that production. Its working principal is based on the rotation of DC motors. We have two (2) rotating parts for proper operation of this machine which are Dish and helix mixer. These DC motors are given what we call transmission shafts to transmit the motion from one place to another place. Dish and helix mixer are coupled to the DC motors via shafts and bearings and from this system dish and helix mixer are given motion. We should keep in mind that for proper mixing, dish and helix mixer should rotate in opposite direction and this is achieved by reversing polarities of one DC motor, in order to mix well flours, fixed hallow square tube is there for barring the flours passing through the corners of the dish. So once motors are supplied by DC supply by pressing on start button, it starts to rotate together with all shafts coupled to them, and the dish and helix mixer also rotate but the dish due to the fact that its polarities are reversed, it rotates in opposite direction to the helix mixer.

There is a reservoir at the top of the helix mixer containing water heater, the reservoir is filled with water and the wire connected to the water heater is connected to a single phase supply too and water in the reservoir starts to boil, once it attains the desired temperature around 75 °c there is a vane compared to a governor called in this book Control valve that the operator rotates and water pass from the reservoir to the dish for proper mixing of flours.

RESULTS

This machine named flour mixing machine with water heater after being manufactured were tested for the following purposes:

1. To check the capacity of flours this machine is able to mix a day.
2. To determine its function ability and effectiveness through some items like breads and cake.
3. To check its resistance in operating whole day.

After conducting the test, we have seen that for each of the products while measurement was taken with respect to corresponding added products in flour like oil, sugar, water and also depending on the form and kind of
bread to be produced, the machine can mix 144kg per day. This was measured from the fact that this machine mix 1kg in 5 minutes and it can work properly the whole day without any problem or obstacle. The following results were obtained:

During the various experiment conducted.
1. The flours were properly mixed.
2. Quantity of water needed was properly added and dough was as required.
3. Water in the reservoir was boiled up to 75°C

CONCLUSION

Briefly this flour mixing machine with water heater is a machine composed of three parts i.e. electrical part, heating system and mechanical part when the three parts are combined together, they form flour mixing machine with water heater which serves in mixing various types of flours and spinning on bakery sites and can also be applicable in homes and in industries producing mixed flour derivatives. This machine will increase the productivity of mixed flour derivatives, it will not require muscular forces as it is in traditional method because it will be electrically operated. by using this machine, no emission of pollutants includes fine particulate, nitrogen oxides, sulfur oxides, carbon monoxide and volatile organic compounds which are harmful to human being and deforestations will be reduced.

This machine is cheap because its total cost is 567300 Rwf compared to the other types which may value 700000 rwf without electrical motor, economical in terms of electricity because it uses the single phase alternating current for water heating and dc voltage for running motor instead of using three phases alternating current which is costly, less time and manpower will be less used.

Limitation

During the implementation of the project, the proper materials like aluminum sheet metals and the price of materials cannot be affordable and the theoretical research was not easy as some online books must be paid for being accessed.

LIST OF ABBREVIATIONS

IST BURKINAFASO Institut superieur de technologies de Burkina Faso
MINICOM Ministry of trade and Commerce
L Length
O Diameter
Fig Figure
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REFERENCES


• C.L. Wadhwa, (2007), Basic electrical engineering, 4th edition

• Toussaint-Samat 2009, p.204 gives a date of 168 for "a considerable influx of craftsmen bakers (pistores)

• Alexander Gray (1913), Electrical machine design


Stuart W. Gibson; project advisor: Bernard K. Amoako-Awuah

• London: Macmillan, (1994), Practical welding

• Sham Tickoo, (2016) Technologies. Schererville, Indiana: CADCIM Technologies

• Larry Jeffus, 2012,” Welding and metal fabrication”


• The army institute for professional development (1988), lathe operations, 8th edition