Conceptual Development of Conical Flourmill

Ramesh B R[1], Raghavendra Reddy N V[2], Ashok R Banagar[3]
[1,2]*Asst. Professor, Department of Mechanical Engineering, Jain Institute of Technology, Davangere, Karnataka, India*
[3]*Asst. Professor, Department of Mechanical Engineering, PES Institute of Technology and Management, Shivamogga, Karnataka, India*

***Abstract*- Flour is a powder made by grinding cereal grains or other seeds with the help of grinding wheels. Flourmill is a machine used to break solid grains into smaller pieces. Milling of flour is accomplished by grinding grains between revolving stone or steel wheel which rotates over a stationary wheel vertically or horizontally.**

The aim of the paper is to present a conceptual CONICAL shaped grinding wheel, comparatively with more efficient than the conventional grinding wheels. In conventional flourmill, the flat surfaced or circular disc type wheels are held vertically or horizontally in order to make the grains in to powder, there are two wheels one is stationary and another is rotating and movable. The shaft is coupled to the rotating and movable wheel which is driven by the motor.

In conical flourmill, the two wheels of conical shape are held together in order to make the grains in to powder. In this type two conical shaped grinding stones are used, one is non-rotating movable and another is rotating non-movable, the stones are held vertically, the rotating non-movable wheel is coupled with the motor. With these modifications the advantages of conical flourmill over conventional flourmill are found to be load can be varied easily, less power consumption, efficiency is high and increased contact surface area.

***Index Terms*- Flourmill, Circular, Conical, Grinding Wheel or Stone, Grains, Flour.**

I. INTRODUCTION

Flourmills are among the most traditional units. Taking into consideration the local needs and market requirement, flourmills can be established at different levels – domestic flourmills, commercial flourmills, bakery / mini flourmills and roller flourmill. The most useful out of these flourmills is the flourmill on commercial levels because not only can these be established at a lower cost but versatile as well.

Flourmill is an electrical appliance used to grind flour from grains like wheat, corn, millet, rice etc. The appliance has gained acceptance as which can produce pure and good quality flour of a desired size at very economical rate. It is a very safe and user-friendly appliance and does not produce any dust and the entire operation is automatic. [1]

In flourmills, the grain undergoes crushing or breaking into flour. In pursuing the need for efficient milling, the fundamental engineering disciplines like fluid dynamics, aerodynamics, mechanical engineering has to be described.

In this work, the machine is modified from the old design of circular type of grinding stones to conical grinding stones. This modified machine uses the electric motor as means of speed reduction and involves a drive shaft, and is being directly driven by electric motor. The machine is plugged directly to electricity (AC supply) and can be driven at variable speeds easily.

From these arrangements, the gear box and pulley system is unnecessary because of the speed reduction of the motor itself. The modification of design will yield less power consumption, reduced installation and maintenance cost.

II. SURVEY

Flour milling is as old as human history. Ancient farmers used saddle stones or querns to grind their grains into flour. In the middle ages, gristmills were developed that could grind larger amounts of grain into flour. These original mills were powered by wind, water, animals or even humans. [1]

Flour is produced by rocking or rolling the hand stone using parallel motions (i.e., pushing and pulling the hand stone). These are the most ancient and widely used type of quern-stone.

Before the introduction of the mechanical flour milling machine, concave stones known as saddle stones were used by many cultures and numerous fine examples exist today. Grain placed on the stone like bowl would be pulverized by manually moving the second stone backward and forward. Experimentation with the shape of the top crushing stone eventually led to the development of a round stone used in a circular motion and the development of the quern. [2]

At about 1000BC various civilizations had developed quern mills. A quern mill consisted of a flat circular stone which crushed grain between its two flat surfaces. As querns became refined, holes were made in the top stone to introduce grain or to hold a handle that could be used to turn a stone easily. The small early hand mills were enhanced in size by some organized societies such as the Romans who used donkeys and slaves to provide the power to turn large scale stones. [2]

The Greeks harnessed streams and rivers for the first water powered mills. Observing the apparent power of running water led to the development of water mills known as Norse mills. Horizontal paddles placed in moving water turned a vertical shaft which would be connected to mill stones for grinding. Early records showed that Norse mills was working in Asia in 65BC and their success led to the wide spread development of water mills. [2]

Windmills were used in Europe in the 11th and 12th centuries. The roller milling with the increase availability of power, the industrial revolution and demand for good white flour, the speed roller mills and refining system were developed towards the end of the 19th century, originally designed by a Swiss named Heifenburger in 1874. This newer method of milling crushed the grains between a series of fluted metal rollers using a reduction process. The fine flour articles sifted out at each pass, returning the residue to the next set of steel roller. The development of roller mills enables greater quantities of white flour to be made at high speed. [2]

Modern flourmills typically use electricity to spin heavy serrated and flat surfaced wheels made up of steel or cast iron or stone, where one is fixed and another will be rotating one and held vertically or horizontally in order to make the grains in the form of powder. The shaft is coupled to the rotating wheel which in turn connected to motor by means of pulley and belt drive systems.

Horizontal types are most reasonable and competitive price ranges to provide complete satisfactory experience to the large number of customers. It is capable to use in domestic as well as industries. These are vastly used in the industries of pulses, grains, tobacco, dry chemicals, herbs, cereals, non abrasive material and many more. All the entire range of horizontal type is available in various designs and dimensions to cater distinct requirements of customers.

But, the kinds of flourmill available are flat surfaced circular rollers. Our work concentration is to modify the existing circular roller flourmill into conical roller flourmill to achieve less power consumption, reduced installation and maintenance cost.

III. DESIGN ANALYSIS AND MATERIALS

A. Design Calculation

Conventional Type:

Diameter of the circular type flourmill = 0.40m

Hence,

Lateral surface area of circular flourmill stone = $\frac{\pi \times d^2}{4}$ - (1)

$= \frac{\pi \times 0.4^2}{4} = 0.1257 m^2$

Conical Type:

For conical type flourmill, considering same lateral surface area of circular flourmill and taking sizes as major diameter [D] = 0.15m and minor diameter [d] = 0.10m. We have –

Lateral surface area of conical flourmill stone = A x L - (2)

$0.1257 = \pi [D + d] s$

Therefore; Slant height of the conical flourmill [s] = 0.16m

B. Power Requirement

To find the power required to drive the inner cone the following parameters were considered-

1. Weight of the inner cone, w = 2180 grams.
2. Speed of conventional grinding wheel, N = 1000rpm
3. Acceleration due to gravity, g = 9.81m/s
4. Length of shaft, L = 0.105m

Therefore; Net force acting on the motor, F =

$\frac{w}{g} = \frac{2180}{9.81} = 222.2$ N

Torque = F x L = 222.2 x 0.105 = 23.3 N-m.

Power required of the motor to be used $= \frac{2\pi NT}{60000} = \frac{2\pi \times 1000 \times 23.3}{60000} = 235.149$ watts

C. Materials Selection:

Table 1: Description of Components

Sl No.	Particulars	Description
1	Frame	Material : Mild Steel H x L x W = 0.375m x 0.315m x 0.315m
2	Inner Cone	Material : Mild Steel Density : 7.85 kg / m^3 Major diameter = 0.10m Minor diameter = 0.066m Height = 5cm Tapered angle = 18°
3	Outer Cone	Material : Mild Steel Density : 7.85 kg / m^3 Major diameter = 0.12m Minor diameter = 0.07m Height = 0.075m
4	Collar	Material : Mild Steel Density : 7.85 kg / m^3 Thickness = 0.025m Major = 0.185m Minor = 0.145m
5	Shaft	Material : Mild Steel Length of the shaft = 0.105m Dia of shaft = 0.025m
6	Motor	Type: open. Horse power (hp): ½ hp. Phase: single phase. Speed: 1725 rpm. Amps @ 110v/220v: 8A/4A

IV. ASSEMBLING OF THE MACHINE

The base frame is a structure which accommodates all the components. To have smooth drive, the motor mounting frame was welded on the base frame along with its motor. The motor is mated with inner cone through a drive shaft. The drive shaft, both ends were machined to accommodate the bearing, key ways, bolts and nuts. The collar is mounted on to the frame with the help of bolts and nuts which houses outer cone and provides linear motion.

A. Equipment for the Assembling Operation

1. Welding machine
2. Electrode
3. Nut and bolt
4. Spanner

The parts are welded together with the use of electric welding machine and electrode, which fuses two parts to be joined together, causing it to be permanently joined.

Some of the parts are also coupled with nuts and bolts so that they can be easily dismounted and remounted repeatedly.

B. Reasons for Using Welding Operation [6]

1. Provides very rigid joints.
2. Welded joints exhibit great strength.
3. The tension member is not weakened.
4. Smooth in appearance and looks pleasing.

C. Painting

The machine is painted to prevent rusting of the parts and to avoid corrosion of the frames.

D. Testing and Valuation

Before testing, grease is applied to the rotating mechanical parts. Then the system is connected to the power source and tested.

V. RESULTS & DISCUSSIONS

The conventional flourmill of circular type which is made up of stone, the power of motor which is required to drive the mill is 3 to 3.5 hp. But in case of conical flourmill shown in fig.1, the power requirement to drive the conical mill is less than 2hp. Hence the power consumption in conical flourmill is comparatively low.

The transmission losses have been reduced by direct mounting of motor to the grinding wheel and removing gear or belt and pulley systems. It was been noticed, a considerable level of reduced vibrations in conical flourmill.

Ease of controlling, the speed of grinding wheel is controlled by controlling the speed of motor itself by varying the voltage supplied. In case of conventional flourmill, to vary the speed of grinding wheels every time belt as to be changed from one pulley to another pulley manually, but before doing this the motor as to be switched off. It same for gear drive system also. This problem is eliminated in conical flourmill due to direct mounting of grinding wheel to the motor as we can vary the speed of the grinding wheel without switching off the motor.

Figure 1: Conical Flourmill

For the same lateral surface area of grinding stones, the size and construction of the flourmill is small and simple for conical type than the conventional type. This reduces overall space required and cost of the flourmill.

VI. CONCLUSION

This work is quite an engineering construction of flourmill involving application of all the principles of construction which includes: measurement, marking, machining, cutting, joining, fitting, fastening and painting.

Finally, it can be conveniently concluded that with this improved design the following improvements were found for conical flourmill over conventional flourmill:

1. Load can be varied easily.
2. Ease of handling.
3. Less power consumption.
4. Efficiency is high due to reduced transmission losses.
5. Contact surface area is more
6. Simple in construction.
7. Space required is less due to reduced size.
8. Ease of controlling.
9. The electric motor is able to transmit power through the drive shaft with reduced vibration.

REFERENCES

[1] John Storck, Walter Dorwin Teague, Flour for man's bread: a history of milling, University of Minnesota Press.

[2] Nwogu, Uchenna Celestine and Ikebudu, Kingsley O "Improved Design of a Flour Milling machine", Proceedings of the World Congress on Engineering and Computer Science 2013 Vol II WCECS 2013, 23-25 October, 2013, San Francisco, USA.

[3] Petr Alekessvīch Koz′mīn, Flour Milling: A Theoretical and Practical Handbook of Flour Manufacture for Millers, Millwrights, Flour-milling Engineers, and Others Engaged in the Flour-milling Industry, D. Van Nostrand Company.

[4] V B Bhandari, Design of Machine Elements, Third Edition, Tata McGraw-Hill Education, 2010.

[5] Mahadevan K and Balaveera Reddy K, Design Data Hand Book, Third Edition, CBS Publishers and Distributors, Delhi.

[6] Hajra S K., Chaudhari, , Elements of Workshop Technology, Volume 1 & II, Asia

[7] Publishing House.