Design And Analysis of End Runner Mill for Multipurpose Work

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***Abstract*- End Runner Mill is a great choice for grinding in front of traditional method which was grinding with help of small sized mortar and pestle operated by human power. This milling equipment may consist of two heavy wheels made of either stone or metal, connected by a shaft. Nowadays, the pharmaceutical companies use the end runner mill machine for preparing Ayurvedic medicines. In this, components of machine mainly are mortar and pestle which are normally made up of steel and pestle of rock. The raw material used for preparation of Ayurvedic medicines in suspension or powder form or cream, this conversion of raw material into final medicine there are some acidic chemicals are produced, these were reacted with the steel mortar and forms the holes on its surface, causing the leakage of suspension. The pestle is made of wooden material which is directly rest on mortar. The pestle is hold by the chain. The speed of the machine is more which tends to make a non- homogeneous mixture of medicine. We have used Granite material in the formation of mortar. Because granite material reacts slowly against acids during preparation of medicine as compared to other like steel. The advantage of using granite is, it has zero chemical. Its weight and slightly irregular surface make our work easy, such as crushing and grinding of herbs and even fibrous ingredients such as Kaffir lime leaves and lemon grass. Good mortar and pestles are must be hard enough to crush the substances rather than be worn away by it. The rotating speed of mortar is reduced according to application. We increased the size of mortar for preparation of large quantity in minimum time. We have designed mechanism for easy lifting of pestle.**

***Index Terms*- Granite, Runner, Suspension etc.**

I. INTRODUCTION

End Runner Mill is a great choice for grinding in front of traditional method which was grinding with help of small sized mortar and pestle operated by human power. This milling equipment may consist of two heavy wheels made of either stone or metal, connected by a shaft. The wheels rotate at its axis in a shallow circular pan. The material to be milled is fed into the centre of the pan and is worked outwards by the action of the wheels. Or it may be another method which consist of grinding between vertical surfaces of mortar and pestle. These surfaces of mortar and pestle are in continuous contact with each other while rotating and the ingredients to be crushed is fed between these surfaces. This can add a special feature of adjusting the coarseness of ingredients by varying different parameters like speed and time of operation. Scrapers are employed for scraping the material constantly from the bottom as well as from side surfaces of mortar after which it is feed to the pestle where it gets crushed to powders. This machine can be used for both dry as well as wet grinding. These may be equipped with different drive mechanisms like gearbox, couplings and pulleys and belts, etc. This may be operated with variable or fixed speed gearbox according to requirements. It can have a great future scope in food and pharmaceuticals industries.

The principles of the project is to size reduction applied by these mills are crushing due to heavy weight of the stones or metal and shearing force which is as a result of movement of these stones or metal. In the End-runner mill, a weighted pestle is turned by the friction of material passing beneath it as the mortar rotates under powder. The End-runner mill has the paste equivalent mounted horizontally and rotating against a bed of powders.

II. Literature Review

Sud Sushant, Gujarat [1] has concluded that Sono-crystallization is effective means of size reduction and controls size distribution of active pharmaceutical ingredients. Spray drying is common method of drying a liquid feed through a hot gas. This improves dissolution rate and also viscosity. It provides bioavailability and uniform mixing.

Dr. Bhawana Bhatt Prof S.S. Agarwal, New Delhi [2] has worked on size reduction operation can be divided into two major categories depending on whether the material is a solid or a liquid. If the material is solid, the process is called grinding requirements .and cutting, if it is liquid, emulsification or atomization. All depend on the reaction to shearing forces within solids and liquids. Different raw materials vary in their size, shape, brittleness and toughness and the product required may vary from a coarse powder to a powder of the micron size. Different types of machinery are available to suit the specific process.

V.G. Haach, etc. all USA [3] has worked on well-known that unreinforced masonry behaves as a quasi-brittle material when subjected to seismic loading. The construction in unreinforced masonry is usually not allowed in regions with moderate to high seismic hazard. The alternative to unreinforced masonry and even to reinforced concrete and steel construction is reinforced masonry, which appears to perform adequately under seismic loading. This work deals with the challenging issue of contributing to the

definition of a fast and simples construction system using reinforced masonry, by replacing the grout by a general-purpose bed mortar, capable of being used also to fill vertical cells with vertical reinforcement. The major difficulty is to find a mortar that is also suitable to fill vertical hollow cells of concrete units.

Mortar Grinder RM 200, Retch, Germany [4] has worked on the Mortar Grinder RM 200 comminutes mixes and triturates by pressure and friction. The function of the scraper is to feed the sample material into the area between the mortar and pestle. This forced feed ensures that the whole of the sample is continuously subjected to the grinding and trituration process and is also intensively mixed. The grinder pestle is not located in the center of the mortar but is offset; contact with the rotating mortar and the sample causes it to rotate automatically. The necessary grinding pressure is achieved by the weight of the pestle itself combined with the adjustable spring pressure acting on its axis.

Intech GmbH, Russia [5] has worked on edge runner mills (also referred as edge runners) are the grinding machine. Their main components are bowl and two (or three) grindstones making the complicated motions around horizontal and vertical axes. Edge-runners grind a material by crushing and grinding the pieces by massive grindstones, which roll along cast iron bowl. There are two main types of edge-runners one is with fixed bowl and moving grindstones; and the other is with rotating bowl and fixed (relative to vertical axis) grindstones. Grindstones of both edge-runners are rotated around the horizontal axis. Edge-runners with fixed bowl and moving grindstones are used to grind all-lump materials, i.e., those that were not foreground. Edge-runners with rotating bowl and fixed grindstones are used to grind preliminary crushed material. Considering that a sufficiently large centrifugal force occurs during grindstones rotation around the axis, for its reduction you should decrease the number of bowl rotations or grindstones themselves. This consequently reduces edge-runners performance.

Kamath Archana, Gujarat Ayurvedic University, Jamnagar, Gujarat, India [6] has worked on different mills and within pharmaceutical manufacturing, size reduction is one of the most extensively used and vital unit operations. Size reduction is a process of reducing large solid unit masses into small unit masses, coarse particles or fine particles. Size reduction process is also termed as Commination or Diminution or Pulverizations. There are many types of size-reduction equipment, which are often developed empirically to handle specific materials and then are applied in other situations. Knowing the properties of the material to be processed is essential. Probably the most important characteristic governing size reduction is hardness because almost all size-reduction techniques involve somehow creating new surface area and this requires adding energy proportional to the bonds holding the feed particles together. Size Reduction is an important operation in many pharmaceutical applications. The important reasons for size reduction are easy handling, increase in surface area per unit volume and separation of entrapped components.

III. PRINCIPLE

'End-runner mill and Edge-runner mill (also known as Chilean mill or Roller stone mill) are the mechanized forms of mortar and pestle-type compression commination. This milling equipment consists of two heavy wheels made of either stone or metal, connected by a shaft. The wheels rotate at its axis in a shallow circular pan. The material to be milled is fed into the Centre of the pan and is worked outwards by the action of the wheels. Scrapers are employed in scraping the material constantly from the bottom of the wheel vessel after which it is feed to the wheel where it gets crushed to powders.

The principles of size reduction applied by these mills are crushing due to heavy weight of the stones or metal and shearing force which is as a result of movement of these stones or metal. In the End-runner mill, a weighted pestle is turned by the friction of material passing beneath it as the mortar rotates under powder.

IV. CALCULATION

LINE DIAGRAM OF POWER AND MOTION TRANSMISSION

Input = Motor (rotary motion)
Output = Granite (rotary motion)
Motion and power transmission line

Motor ⟶ **Belt and pulley Drive** (V Belt) ⟶ **Gearbox** (Worm and Worm wheel) ⟶ **Output load**

Required components are

Motor
Belt and Pulley Drive
Gear box
Structure
Shaft , bearing etc.

MOTOR

(Note- The output load is 700kg)
1 HP Takes 250 kg load
Therefore for 700 kg we require 3 HP motor Specification
Power = 3 HP (2.2 Kw) ……. (1HP = 746 Watt)
(N) Speed = 1440 rpm
Position = Foot mounted
Torque available at motor is

Power = $\frac{2 * \pi * N * T}{60}$

2.2 * 10^3 = $\frac{2* 3.14 * 1440*T}{60}$

T = 14.58*10^3 N.mm

SPEED CALCULATION

A) For Ayurveda [30-40 rpm]

Speed reduction ratio

1) Between motor and belt drive

G1 = n1/n2
= 1440 /720
= 2

2) Between Belt drive and gear box

G2 = n2 / n3
= 720 / 30
= 24

B) **For Pharma [100-110 rpm]**

Speed reduction ratio

1) Between motor and belt drive

G1 = n1/n2
= 1440 /720
= 2

2) Between Belt drive and gear box

G2 = n2 / n3
= 720 / 100
= 7.2

TORQUE CALCULATION

A) For Ayurveda

Torque at input of gearbox / bigger pulley

T = Torque at motor * reduction ratio betn. Motor and belt drive

= 14.58 *10^3 * 2

= 29.16*10^3 N.mm

Torque at output of gearbox

T = Torque at *reduction Ratio belt drive betn. Belt drive and gearbox

= 29.16*10^ 3* 24

= 699.84*10^3 N.mm

B) **For Pharma**

Torque at input of gearbox / bigger pulley

T = Torque at motor * reduction ratio betn. Motor and belt drive

= 14.58 *10^3 * 2

= 29.16*10^3 N.mm

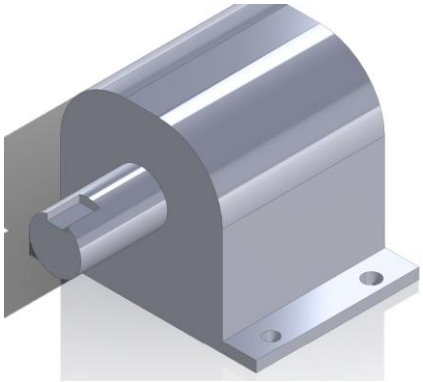
Torque at output of gearbox

T = Torque at *reduction Ratio belt drive betn. Belt drive and gearbox

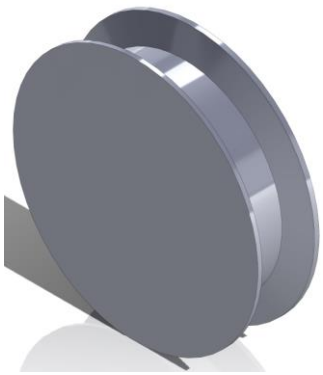
= 29.16*10^ 3* 7.2

= 209.9*10^3 N.mm

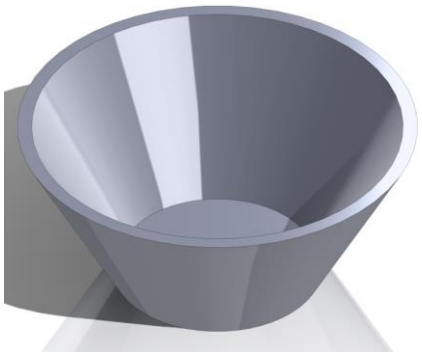
V. MODEL



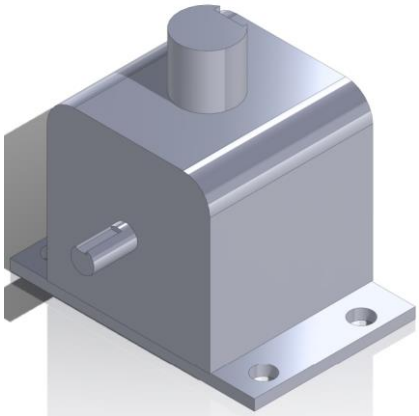
MOTOR



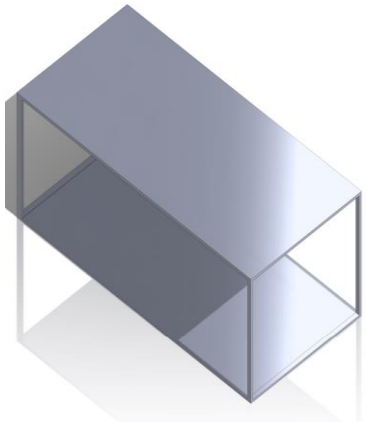
PULLEY



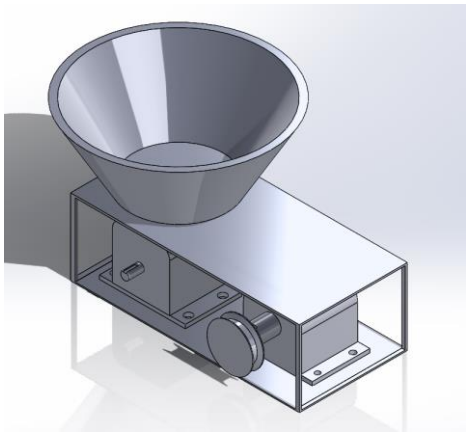
MORTOR



GEARBOX



STRUCTURE



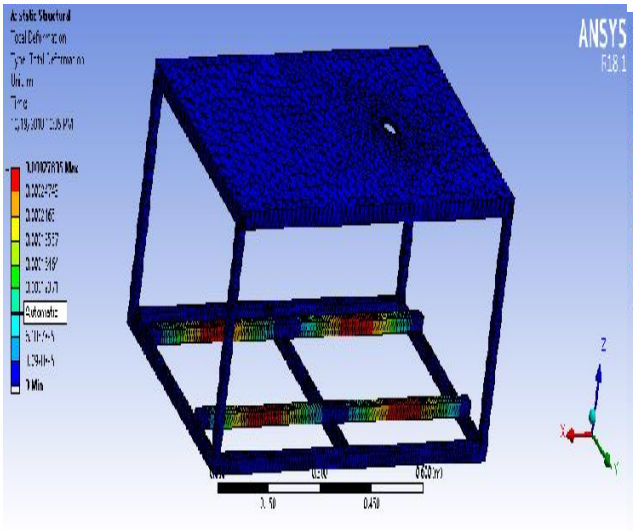
ASSEMBLY

VI. ANALYSIS

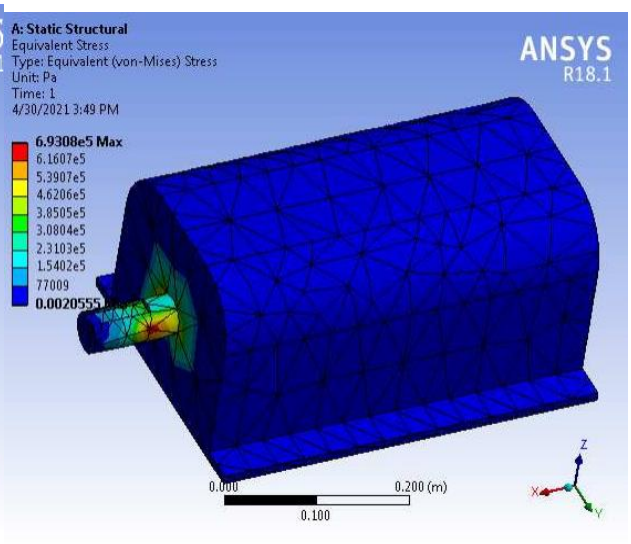
ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software Implements equations that govern the behaviour of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated, or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyse by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

Static Analysis

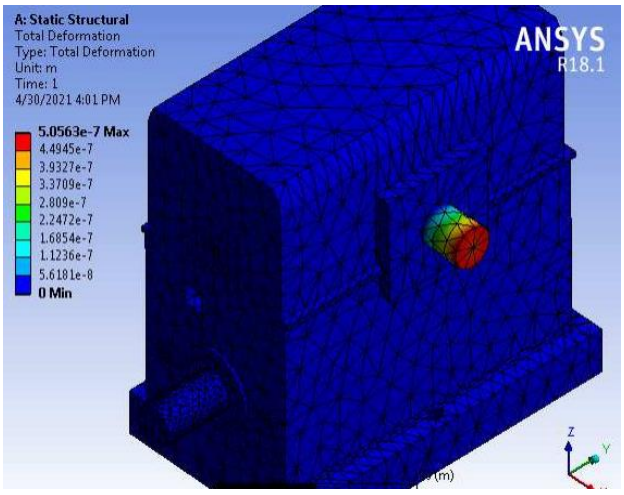
Used to determine displacements, stresses, etc. under static loading conditions. ANSYS can compute both linear and nonlinear static analyses. Nonlinearities can include plasticity, stress stiffening, large deflection, large strain, hyper elasticity, contact surfaces, and creep.



ANALYSIS OF STRUCTURE



ANALYSIS OF MOTOR



ANALYSIS OF GEARBOX

VII. OUTCOMES

- Reduce human effort.
- Take less time for preparation of medicine.
- Easy to operate and easy to maintain.
- No corrosion and no wear resistance.
- Increase the machine life.
- Less or negligible chemical affinity to mortar

VIII. CONCLUSION

It plays a vital role in processing of raw ingredients to get the homogeneous mixture of medicine as well as it can help to prepare the medicine very fast and in less time without aid of human being. The outcomes of the project are,

- Reduce the human effort.
- Take less time for preparation of medicine.
- Easy to operate.
- Easy maintenance.
- Increase the machine life
- No corrosion and wear resistance.

- Less or negligible chemical affinity to mortar

We compared the theoretical design data with the simulation software like ANSYS. After comparing the data, the actual and theoretical data was differed with 5% error. So, it is good for design perspective. The theoretical design was safe.
In theoretical calculation, we cannot take the environmental conditions and we consider some assumptions, but in actual simulation it takes some standards for validation of theoretical inputs. This will result in error between actual and theoretical calculations.

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