Design & Fabrication of Bevel Multi-Mill to Improve Liquid Mixing Performance.

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ABSTRACT

Blending is vital activity in any interaction industry. All activities including fluid stage responses, mixing homogenization, emulsion arrangement, disintegration, extraction, and so forth, need blending in one structure or then again, the other. Blending of powders, glues, paints jams and numerous different items is required to have been done in quite a large number businesses for some applications; it very well may be finished by the thorough shaking and making choppiness in the items. The interaction is called as tumult for which directionally reversible combinations are used. These reversible blenders Can give fractional homogenization for more powerful homogenization it is expected to plan of an extraordinary reason machine which gives cyclic inversion of the rotor and make more compelling unsettling disturbance. This project is about a particularly specific reason dynamic blender planned and produced for a paint fabricating industry. In this paper, the plan and advancement of this machine is examined in subtleties, the aftereffects of this work is empowering and giving better disturbing execution over ordinary technique

Paint creation is a significant interaction which has wide applications in a few fields. The report involves the improvement of a paint creation machine. The machine basically involves a 3 kW variable speed electric engine, a ball valve, a pad bearing, 3 mm thick hardened steel tube shaped tank and a stirrer gathering that pivots in the tank with four perplexes to control the sprinkling. Execution assessment of the created paint creation machine was done with the development of emulsion paint at various mix speed going from 100-500 rpm. From the outcome acquired, speed up past 300 rpm prompts decline in paint consistency as well as creation time. All in all the machine has a quick creation time than regular machine while likewise being harmless to the ecosystem and savvy.

Keyword: - *Agitator, Mixers, Emulsion, paint, stir speed viscosity, special purpose machines, Bidirectionalmixer*

1.INTRODUCTION

Process industries like chemical plants, food processing plants, paint industry etc. Largely employ mechanical mixers to carry out mixing of powders, semisolid jelly fluids etc. Mixing is a process where powder or jellies are mixed together through in the form of uniform mixture where stirring is the process to mix the fluid and powder to dissolve the powder thoroughly in given mixture and form a uniform product or output. In either of above cases thorough mixing of material is desirable to give and good and uniform quality output. Mixing of powders of different material in order to form a uniform product or a powder mix is quite easy but when it is desirable to mix powder in a fluid matter specially when the density of powder is high the problem occurs due to heavy weight of particles of powder has a tendency to settle down, so we make bidirectional mixer which move opposite direction in one cycle. For that motion we using the crank and fork mechanism. Which form the turbulence in mixer and make homogeneous mixture Mixing is one of the qualities of the product.

At the heart of transforming raw ingredients into food for human consumption is the mixing operation. One of its main tasks, which other food processing steps also share, is to establish consistency. Whether a food product requires small-scale mixing by hand or high volume blending of multiple ingredients, at-home cooks and process engineers alike know the importance of proper mixing. Even with the right amount of ingredients and flavors, a great recipe will not transform into good food unless the components are well-mixed. Taste, texture, color, appearance – these are all crucial parameters intimately influenced by the mixing process. Consumers expect that the food products they patronize will be exactly the same as the one they had last. It is easy to understand that within the food industry a high level of consistency is required not just batch-to-batch but facility-to-facility. In this market, consistency is the backbone of consumer loyalty. Various types and styles of mixing equipment are utilized within the food industry. Their use and application are determined by the phases being mixed (liquid-liquid, solid-liquid, or solid-solid) as well as physical characteristics of the end product (like viscosity and density).

In reality, many mixing technologies overlap in use and function such that certain applications can actually be successfully produced by two or more types of mixing systems. In these situations, economics rule out the more costly initial investments, but differences in efficiencies must also be taken into account. Proper mixer selection is vital to process optimization.

1.1. Statement of project:

The stirrer of conventional mixer rotates in one direction only which creates a particular single flow pattern in the fluids hence the particles tend to stick to the walls of container owing to the centrifugal force rather than mixing thoroughly in mixture, ultimately results into poor quality mixture of liquid there by poor quality output of final mixed liquid. In order to have a homogeneous mixing would be appropriate to have a bi-directions of rotation of stirrer shaft which will rotate two concentric stirrer's blades in opposite directions in one cycle this will form turbulent flow pattern there by leading to creation of irregular flow pattern and resulting into thoroughly mixed liquid mixture preparation which will create the good quality liquid mixture.

1.2. Objective:

1) To reduce the power consumption during liquid mixing.

2) To maintain the accuracy in pharmaceutical production.

3) To develop automation unit, so that machine can easily be adopted in today's automated pharmaceutical plants.

4) This type of machine provides work practically at low cost, low maintenance, low capital investment in less space.

5) To perform the most rigid operation with high-speed liquid material mixing.

1.3. Scope of the Project:

To achieve homogeneous mixing of liquid, we have to make a multi-mill. This multi-mill having bi-directions of rotation of stirrer shaft which will rotate two concentric stirrer's blades in opposite directions. This multi-mill will form turbulent flow which will create the good quality liquid mixture.

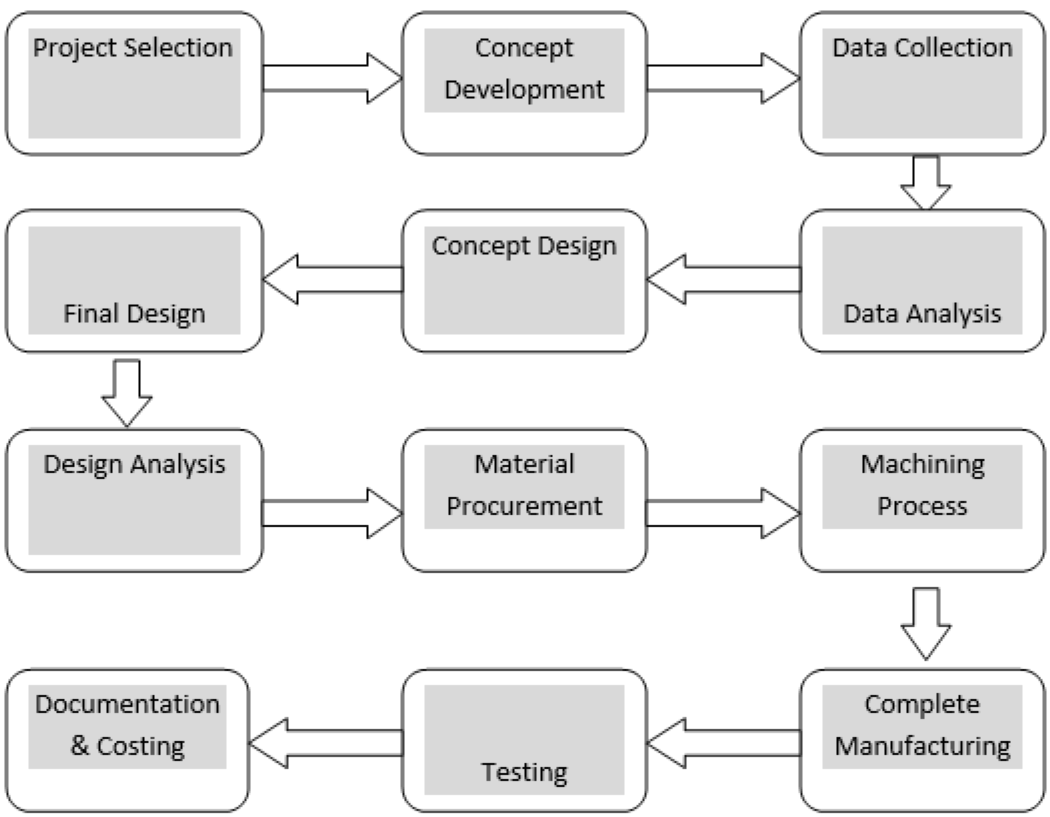
1.4. Methodology & Process Flow Chart:

The below flow chart shows the sequential operation/steps that will be performed during the project process. We have proposed a methodology to solve the problems. Our methodology is divided in different parts, under different titles.

The below flow chart shows the sequential operation/steps that will be performed during the project process.

Sequence of proposed methodology is as follows –

- Proposed Methodology 1 – Problem Definitions
- Proposed Methodology 2 – Basic Information & literature survey
- Proposed Methodology 3 – Design of Components
- Proposed Methodology 4 –Selection of material & standard parts.
- Proposed Methodology 5 – Manufacturing process & testing.
- Proposed Methodology 6 –Cost Estimation & Report writing.



<u>1.</u> <u>Proposed Methodology 1</u>: Basic Information & Literature survey.

This project report discusses about how to use literature data & identify the problems from field. By studying the literature of previously available system that help in maximizing the output by minimizing the effort, cost, time & money in future develop new machine.

2. Proposed Methodology 2: Identify & Design of Machine Components Available in Market.

This project work will first introduce the background of the study. Presents the design constraints that influence on the use, efficiency & benefits their impacts on machine. After that machine parts design all different existing machine assembly units will done to make a probable machine model.

3. Proposed Methodology 3: Selection of Components for Machine as per design specifications.

We will discuss the construction & working of system components. Various resources and factors were considered for getting the information on the project: First, the requirement of the field is to identify. The specification of the material is thought according to the need. Then, the allocation of budget is taken into consideration. Different research papers were read, we visited many markets & fields. Guidance was taken from college staff regarding the initial research of project. The Resources/Consumable required are: The main components of machine are to be purchase.

4. Proposed Methodology 4: CAD modeling & Fabrication of Machine parts.

This project work will start to manufacture after purchasing of required specification material & making sample simulations which will be easy for visualization. After that manufacturing procedure of machine will be done, after this cost estimation of machine will calculate.

5. Proposed Methodology 5: Assembly & Testing of Machine.

Finally, after complete manufacturing procedure, will test the working model which will satisfy probable objectives or not. After that complete working & satisfied testing will discuss advantages & applications of the machine while performing satisfied operation with complete report writing.

2. LITRATURE REVIEW

Dattatraya P. Patil, Amod P. Shrotri, Vishal P. Patil & Nikhil S. Mane, done work on, Design and Development of a Special Purpose Bidirectional Mixer to Maximize Agitating Performance, according to his work, Mixing is very important operation in any process industry. All operations involving liquid phase reactions, blending homogenization, emulsion preparation, dissolution, extraction, etc., need mixing in one form or the other. Mixing of powders, pastes, paints jellies and many other products is needed to be done in many industries for many applications; it can be done by the rigorous shaking and creating turbulence in the contents. The process is called as agitation for which directionally reversible mixtures are utilized. These reversible mixers Can give partial homogenization for more effective homogenization it is needed to design of a special purpose machine which gives cyclic reversal of the rotor and create more effective agitating turbulence. This project is about such a special purpose dynamic mixer designed and developed for a paint manufacturing industry. In this paper, the design and development of this machine is discussed in details, the results of this work are encouraging and giving better agitating performance over conventional method. [1]

Ikponmwosa Iyobosa Omorusi, done work on, Design and Construction of an Electrically Operated Paint Mixing Machine, according to his work, An electrically operated paint-mixing machine was developed. The machine consisted of a mixing drum with a capacity of 30.6 L. The test was carried out by mixing 25%, 50%, and 75% of the total mixing capacity of the machine, and the time taken for the constituents to be thoroughly mixed were recorded. The mixer member (agitator) was used to mix the paint components by the use of an electric motor. For easy mixing of denser paint components i.e. paints with high viscosity, particularly oil-based (or enamel) paint, a hydraulic lift, with a travel height (distance) of about 40 cm, was introduced to move the mixing disc vertically in the upward (up to a height of 19 cm above the drum) and downward direction (up to a height of 15 cm above the bottom of the drum) to prevent clogging of the paint components while mixing. The hydraulic mechanism also allows the operator to remove the drum after mixing as well as to install the drum in place before starting the mixing operation. The machine was powered with a 0.74 hp (550 W) electric motor, which transmitted the rotary motion of the driving component through a V-belt to the driven component which was supported with two bearings. The test results obtained from the running of the machine showed that the time taken to mix thoroughly 30.6 L of paint constituents was 102 minutes. This was done to study the reliability and the time taken to accomplish the thorough mixing of the paint components. To achieve this, the volume of paint constituents (L) ranged from 10.2 L at 35 minutes to 30.6 L at 102 minutes. This finding elucidates the ability to tackle the problems of mixing paint locally by hand and by manually operated machines, which are not only primitive but both time and energy consuming, and as well serves as an innovation in the paint industry. [2]

Mohtasim. A. Mapkar, Prasad. A. More, Shreyans. D. Mehta, done work on, Design and Fabrication of Portable Industrial Mixer, according to his work, In mixing industry, different mixers are required for mixing at various stations, for applications having minimum process time and involves use of big tanks for mixing, it is economical to equip a mixer that facilitates transfer from one station to another than the tank. This work is aimed at achieving the required portability without compromising the process requirement and achieving economical mixing in the industry. In this work, an industrial mixer is designed to ensure hassle free mixing at various stations and portability in operation. To facilitate portability, the industrial mixer is designed with certain degrees of freedom like longitudinal/axial motion of mixer for loading and unloading, traversing ability to operate between different mixing stations, facility to adjust the impeller location from the bottom, etc. In this dissertation, different components required for the industrial mixer such as shaft, impeller, motor mount and frame were modelled using CAD software (Solid works). Stress analysis of the components was carried out using FEA software package (Solid works Simulation). [3]

Ajibola O.O, Alamuoye O.F, Omoyeni D.O., Adebayo A.O., Borisade S.G., Olotu V., Adetoye O., Adebanji S., done work on, Design and Fabrication of a Multi-Purpose Homogenizer, according to his work, The homogenizer is vital equipment in numerous production sectors such as in food processing, animal feed processing, chemical and pharmaceutical industries, waste recycling and mineral and allied industries. In this work, a multi-purpose homogenizer suitable for the mixing of different materials (animal and fish feeds, coal fuel, foundry sand etc) was designed; fabricated and the performance of the machine evaluated. The relevant basic engineering principles were used in the design and construction of the homogenizer. The machine was test run and found to be suitable for solid-solid particle mixing especially for light mineral and agricultural products, and it could be used for small-scale experimentation. The results of fabrication, test run and assessment of mixing efficiency are under consideration for publication in other report elsewhere. Further research could improve and reduce the common errors to the minimum allowable limit.[4]

Daniyan Ilesanmi Afolabi and Cookey-Gam Richard Senibo, done work on, Development of a Paint Mixing Machine, according to his work, Paint production is an important process which has wide applications in several fields. The report entails the development of a paint production machine. The machine essentially comprises of a 3-kW variable speed electric motor, a ball valve, a pillow bearing, 3 mm thick stainless steel cylindrical tank and a stirrer assembly that rotates in the tank with four baffles to control the splashing. Performance evaluation of the developed paint production machine was carried out with the production of emulsion paint at different stir speed ranging from 100-500 rpm. From the result obtained, increase in stir speed beyond 300 rpm leads to decrease in paint viscosity as well as production time. In conclusion the machine has a fast production time than conventional machine while also being environmentally friendly and cost effective. In conclusion, design and fabrication of a paint mixing machine with a capacity of 100 litres was achieved, performance evaluation was carried out on the machine by the production of emulsion paint and it was observed that the machine had a faster production time than conventional machine while also being environmentally friendly and cost effective. [5]

A. S. Adekunle, P. O. Omoniyi, S. E. Ibitoye, E. C. Ogbonna, G. A. Akoh, done work on, Development and Performance Evaluation of Portable Liquid Soap Making Machine for Small and Medium Scale Industry, according to his work, The project work entails design, fabrication and testing of a 15 litres semi-automatic liquid soap making machine for small and medium scale industry using cold process method. A survey carried out on conventional method (the local method) showed that the conventional method consumes time, energy, has low output and efficiency and is hazardous to health. The fabricated machine consists of four major components which are gear mechanism, four cylindrical chambers, agitators (impellers) and an electric motor. After evaluating its performance, the machine produced had a mixing and time efficiency of 93% and 92.2% respectively as compared to the conventional method which had a mixing and time efficiency of 81.7% and 36.7% respectively. Results obtained from the performance evaluation indicated that the machine saves time and energy, reduces material wastage, reduces hazards and hence; is far more efficient than the conventional method.[6]

Ogedengbe, done work on, Development and Performance Evaluation of a Liquid Soap Production Machine for Local Soap Industry in Nigeria, according to his work, A liquid Soap production Machine was developed and evaluated to facilitate local production of liquid soap in Nigeria. A Preliminary study of the liquid soap production process was carried out within the local soap industry to collect necessary information and establish the appropriate production procedure. This was translated into the design concept of the machine. Detailed design of the components of the machine was done followed by its fabrication. The developed machine which was powered by a 1 Hp (0.746 kW) variable speed electric motor comprises a main mixer, two pre mixers, machine frame, V-belt drive and geared drive systems. All materials used in the fabrication of the machine were sourced locally. Result of machine evaluation revealed that the machine run smoothly in operation. Also, it was established that drudgery and fatigue associated with local production of liquid soap had been substantially reduced according to the responses from the users of the developed machine. The viscosity and turbidity of the liquid soap produced using the developed machine was found to be higher than that of the manually produced one while its viscosity was found satisfactorily at par with that of the liquid soap produced using one of the commercially available mixing machines (MMs). However, the cost of production of the machine developed herein and its subsequent maintenance cost is cheaper than that of the MMs.[7]

2.1. Planetary Mixer & Multimill:

Industrial Mixers, Multimill and Blenders are used to mix or blend a wide range of materials used in different industries including the food, chemical, pharmaceutical, plastic and mineral industries. They are mainly used to mix different materials using different types of blades to make a good quality homogeneous mixture. Included are dry blending devices, paste mixing designs for high viscosity products and high shear models for emulsification, particle size reduction and homogenization. Industrial mixers range from laboratory to production line scale, including Ribbon Blender, V Blender, Cone Screw Blender, Screw blender, Double Cone Blender, Double Planetary Viscosity Mixer, Counter-rotating, Double & Triple Shaft, Vacuum Mixer, Planetary Disperser, High Shear Rotor Stator and Dispersion Mixers, Paddle, Jet Mixer, Mobile Mixers and Drum Blenders. Mixing fulfils many objectives beyond simple combination of raw ingredients. These include preparing fine emulsions, reducing particle size, carrying out chemical reactions, manipulating theology, dissolving components, facilitating heat transfer, etc. So even within a single pharmaceutical product line, it is not common to employ a number of different style mixers to process raw ingredients, handle intermediates and prepare the finished product.

A planetary gear system will not assemble unless the number of teeth for each gear is selected properly. Once the design requirements are specified, the remaining parameters must be calculated to create a working configuration. Let's say the desired gear ratio is 5:1. This means the sun gear must make 5 revolutions for each revolution of the output carrier (Note: this assumes that the sun gear is the input, the planet gears drive the output carrier, and the ring gear is stationary. Other configurations are possible depending on the application). One more design requirement must be specified to do the remaining calculations. Plugging in the known values, we get solving for Nr, we find that the required number of teeth on the ring gear is 96. We can now begin to solve for the number of teeth on the planet gear: Np: Number of teeth on the planet gear(s) Plugging in the known values, we get Solving for Np, we find that the required number of teeth on the planet gear is 36. This is independent of how many planet gears are used. Note that the pitch of the gears is not specified. These equations hold true regardless of the pitch, but a pitch will ultimately need to be selected when designing a planetary gear system. Either the pitch itself will be a design requirement, or size limitations will be a factor, and the pitch can be selected accordingly.

A planetary gear system, also referred to as Epicyclic gearing, consists of three elements – a sun gear, one or more planet gears, and a ring gear. The sun gear is located at the center, and transmits torque to the planet gears that orbit around it. Both are located inside the ring gear. The tooth formation of the sun and planet gears is external, while the ring gear is internal. Planetary gear systems can vary greatly in size and configuration to produce a broad range of speed ratios and meet various design requirements. They are used in many different applications such as clocks, lunar calendars, car mirrors, toys, gear head motors and turbine engines.

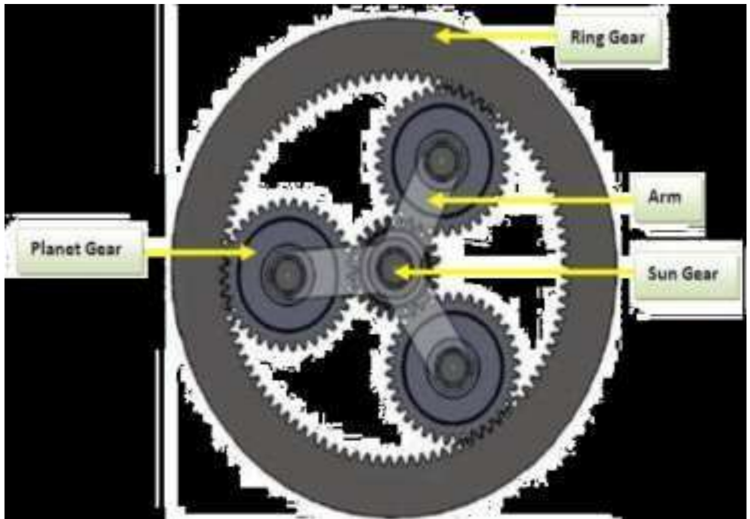


Fig.2.1. 2D view of Planetary Gear.

Multi Mill is used for high-speed Granulating, Pulverizing, Mixing, Shredding and Chopping etc. of a wide range of wet and dry materials without special attachments. As compared to the four-common principal of reduction, i.e. grinding, compression, impact and shearing, which do not produce controlled size machine utilizes the principle of variable force swing hammer blades having both knife and impact edges rotating reduction, this with a carefully selected screen to control size reduction. The Lab Multi Mill is used in laboratories for research and development due to which it is also known as R&D Multi Mill. It is also known by the names Mini Multi Mill, Small Multi Mill and Compact Multi Mill due to its small and compact size.

Flow path of material in vertical rotor machine is streamlined. During Comminuting, material entering the chamber travels to the periphery and passes through the screen tangentially and radially avoiding chocking and temperature rise. The multi mill is most suitable for dry pulverization of lumps to small particles to small particles of the desired size by high shear action. The compact multi mill offers a high degree of automation, safety, and stable performance. The unbeatable range of R&D multi mill is a very affordable and mobile tool for dry and wet granulation as well as pulverizing, mixing shredding, and chopping. A unique feature of this machine is that a wide range of wet and dry drug materials can be added to this industrial machine without the need for special attachments. It is a very elegant, compact, and proven design model and can be used with less electric power.

Special features:

- Machine portable on castor wheels
- High output with process uniformity
- Direction of the blade rotation can be change using a reversing switch for hammer or knife operation
- Multiple combinations of Screens/ Speeds/ Number of Blades
- Direction of blade rotation for every product type
- High Screen opening area for Higher Throughput
- Easy dismantling and cleaning of all components reducing

3. CONSTRUCTION

Components are used for manufacturing the mixer are:

-

SR. NO.	COMPONENTS	QUANTITY
1.	Geared motor 12 Volt supply, 60RPM.	1
2.	Pedestal bearing	3
3.	Shaft	2
4.	Washer	6
5.	Nut and Bolt	6
6.	Transformer 12 Volt	1
7.	Frame Structure	1
8.	Rotor Blade/stirrer	2
9.	V-Belt	1
10.	Pulley	2
11.	Bevel gear	3
12.	Drum	1

Table.3.1. Material Requirement.

4. WORKING

A chemical mixer is being designed which consist of a container impeller blades, electrical motor, pair of pulleys, pedestal bearings and drive shafts. We are using the container made up of PVC; it is placed at about 6inches from ground, so that it is easy to pour the material for the workers preparing the chemical solution. The motor is placed vertically in order to mount the pulley and belt assembly on the motor shaft. This machine is designed to mix the cleaning solution used for cleaning the floors. In electrically powered system an electrical motor is used to run the motor shaft. As the motor shaft rotates, the pulley mounted on motor shaft also rotates. The power transmission will be takes place from motor to impeller shaft. As the impeller shaft rotates the impeller blades also rotate along the direction. And hence the mixing of chemical ingredients is obtained. The speed of the electrical motor is controlled using speed regulator. The 3d model of chemical mixer is as shown in fig 4.1.

Fig.4.1. Proposed Model of Bevel Multi mill.

5.DESIGN

DESIGN CALCULATION

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy and efficiency. Hence a careful design approach has to be adopted. The total design work has been split up into two parts;

SYSTEM DESIGN

System design mainly concerns with various physical constrains, deciding basic working principle, space requirements, arrangements of various components etc. Following parameters are looked upon in system design. Selection of system based on physical constraints. The mechanical design has direct norms with the system design hence system is designed such that distinctions and dimensions thus obtained in mechanical design can be well fitted in to it. Arrangement of various components made simple to utilize every possible space. Ease of maintenance and servicing achieved by means of simplified layout that enables quick decision assembly of components Scope of future improvement.

MECHANICAL DESIGN

In mechanical design the components are listed down and stored on the basis of their procurement in two categories,

Design parts & Parts to be purchased.

For designed parts detailed design is done and dimensions there obtained are compared to next dimensions which are already available in market. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified. The process charts are prepared and passed to manufacturing stage. The parts to be purchased directly are selected from various catalogues and are specified so as to have case of procurement In mechanical designed at the first stage selection of appropriate material for the part to be designed for specific application is done. This selection is based on standard catalogues or data books;

E.g.:- (PSG DESIGN DATA BOOKS) (SKF BEARING CATALOGUE) etc.

5.1. Motor selection:
Thus, selecting a motor of the following specifications

- **DC motor**
- **Power = 50 watt**
- **Speed= 60 rpm**

Motor Torque

$$P = \frac{2 \Pi N T}{60}$$

$$T = \frac{60 \times 50}{2 \Pi \times 60}$$

T = 7.96N-m

Power is transmitted from the motor shaft to the input shaft by means of an open belt drive,
Motor pulley diameter = 20 mm
IP _ shaft pulley diameter = 60 mm
Reduction ratio = 3
IP shaft speed = 60/3 = 20 rpm
Torque at IP rear shaft = 3 x 7.96= **23.88 Nm**

5.2. Design of belt Drive:
Motor pulley diameter **d** = 20 mm
IP _ shaft pulley diameter **D** = 60 mm
Coefficient of friction = 0.23
Let,
Thickness of belt = 5 mm
Width of belt = 6 mm
Mass of belt per unit length is given by;
ρ= density of belt material = 950 kg/m^3
m= 0.0285 kg/m
Velocity of belt is given by;

$$V=\frac{\Pi(d+t)n}{60 \times 1000}$$

$$V=\frac{\Pi x(20+5) \times 60}{60 \times 1000}$$

V= 0.078 m/s **Linear velocity**
To find out tension in the belt is;

$$P=\frac{(F1-F2)V}{1000}$$

$$50 \times 10^{-3} = \frac{(F1-F2) \times 0.078}{1000}$$

F1 – F2 = 636.619 N---(1)
Center distance between two pullies of motor &pullies output **C**=**200mm.**

$$\alpha = \sin^{-1}\frac{D-d}{2C}$$

$$\alpha = \sin^{-1}\frac{(60-20)}{2 \times 200}$$

α = 5.739^0 **(In Degrees)**

α =5.739 X (∏/180)

α =0.10^c^ **(In Radians)**

θ = Angle of lap of belt.

θ = **∏ – 2 α**

= ∏ – [2 X 0.10]

θ = 2.94^c^ **(In Radians)**

θ = 168.54^O^ **(In Degrees)**

Now $\frac{F1}{F2} = e^{\frac{\mu\theta}{\sin\beta}}$

$\frac{F1}{F2} = e^{\frac{(0.23x2.94)}{\sin 19^\circ}}$

$\frac{F1}{F2} = 7.97$

F1= 7.97 F2 --(2)

Put Eq. (2) in Eq. (1)

F1- F2 = 636.619

7.97 F2 - F2 = **636.619**

6.972 F2 = **636.619**

F2 = 91.3N

Put in Eq. (3)

F1 = 727.69N

Centrifugal force in belt is given by,

Fc = mV²

=0.0285 X $(0.078)^2$

Fc = 1.73 N

5.3. Shaft design:

To find diameter of shaft by ASME code

For commercial steel shaft, Actual shear stress $\tau_{act} = 55N/mm^2$

$T = \Pi/16 \times \tau_{act} \times d^3$

$\Rightarrow \tau_{act} = \frac{16xT}{\Pi x d^3}$

$7.76^3 = \frac{16 \times 55}{\Pi \times d^3}$

d^3=737.089

d=9.033mm **select d=20mm**

5.4. Bearing selection:

As shaft dia. – is 20mm so we have selection a pedestal bearing having shaft outer dia. – 20mm.In selection of ball bearing the main governing factor is the system design of the drive i.e.; the size of the ball bearing is of major importance; hence we shall first select an appropriate ball bearing. Taking into consideration convenience of mounting of ball bearing. As shaft diameter is 20mm to it &selected a pedestal ball bearing having shaft outer dia-20mm ball bearing to support the shaft of 20mm.

Total Axial load on bearings are = Weight of Blade + weight of shaft.

Assume = 30 N

Axial load on each bearings **Fa** = 30/3

= 10 N.

Equivalent dynamic load

Pe = V.Fa.Ka

= 1 X 10 X 1.5

Pe = 15 N

bearing life is,

$\mathbf{L^{10}} = \frac{Lh10 \text{ X } 60 \text{ X } n}{10^6}$

L_{h10} from graph 4.6 PSG Design data book for 16000 rpm maximum speed of ball bearing is 315000 Hours.

$\mathbf{L^{10}} = \frac{31500 \text{ X } 60 \text{ X } 4300}{10^6}$

L^{10} = 8127 millions of revolutions.

$L^{10} = (\frac{C}{Pe})^{(\frac{10}{3})}$

$C = (L10)^{(\frac{10}{3})}$ X Pe

$C = (8127)^{(0.3)}$ X 15

C = 148.92 kN.

PSG Design data book P.No. 4.13.

5.5. Modification of differential gearbox system:

No teeth on gear Zg = 20

No teeth on pinion Zp=12

Material of gear & pinion both are C40.

Sup =580 N/ mm^2

Sug =580 N/ mm^2

Given Data:

Power P = 50Watt.

Np= 60 rpm

BHM=350

Factor of safety =1.5

Beam strength (δb)

$6bp = \frac{Sup}{3} = \frac{580}{3}$ = 193.33 N/ mm^2

$6bg = \frac{Sug}{3} = \frac{580}{3}$ = 193.33 N/mm^2

Pitch cone angle (δ)

$\tan\delta p = \frac{Zp}{Zg} = \frac{12}{20} = 0.6$

$\delta p = tan^{-1}$ (0.6)

$\delta p = 30.96^0$

tan δg = $\frac{zg}{zp}$ =$\frac{20}{12}$ = 1.66

δg =tan^{-1} (1.66)

δg =59.03^0

Virtual/fermentative /equivalent no. of teeth on gears,

Z'p=$\frac{zp}{cos\gamma\ p}$=$\frac{12}{cos30.96^0}$=13.99

Z'g=$\frac{zg}{cos\gamma\ g}$=$\frac{20}{cos59.03^0}$=38.86

Assuming 20^0 full depth involution system,

Y'p=0.484 - $\frac{2.87}{z'p}$=0.484 - $\frac{2.87}{13.99}$ = 0.278

Y'g=0.484 - $\frac{2.87}{z'g}$=0.484 - $\frac{2.87}{38.86}$ = 0.410

Now, δ_{bp} . Y'p = 30.96×0.278 = 8.6068 N/$_{mm^2}$

δ_{bg} . Y'g = $59.03 \times 0.410 =$ 24.210 N/mm^2

As δ_{bp} . Y'p = δ_{bg} . Y'g

Same behavior of both gear & pinion Is in bending. Hence, it is necessary to design the pinion for bending.

dp = m.zp = 12 m dia. Of pinion.

dg = m.zg = 20 m dia. Of gear.

∴ **Pitch cone distance (A_o)**

Ao = $\sqrt{(\frac{dp}{2})^2+(\frac{dg}{2})^2}$ = $\sqrt{(\frac{18m}{2})^2+(\frac{18m}{2})^2}$
Ao= 12.727m

Face width of bevel gear (B) in mm

B =$\frac{Ao}{3}$ or 10m } whichever is smaller.
$= \frac{12.77m}{2}$ or 10m

=6.36m or 10m whichever is smaller.

B=6.36m

Bending force (Fb)

Fb=bp .b .m.Yp [1$-\frac{b}{A0}$]

=193.33× $6.36m \times m \times 0.278 \times [1 - \frac{6.36m}{12.727m}]$

$=456.419\, m^2 [1 - \frac{6.36m}{12.727m}]$

Fb $=228.335m^2$ N

Wear strength (Q')

$Q' = \frac{2Zg'}{Zg'+Zp'} = \frac{2X38.86}{38.86+13.99} = 1.47$

Tooth from factor (K)

$K=0.16\, [\frac{BHN}{100}]^2 = 0.16[\frac{350}{100}]^2 = 1.96N/mm^2$

Bucking eq^n for the weer strength (Fw)

$Fw = \frac{0.75\times dp\times b\times Q'\times K}{COS\ \gamma p}$

$Fw = \frac{0.75\times 18m\times 6.36m\times 1.47\times 1.96}{COS\ 0.278^0}$

$Fw=247.38\ m^2$

Effective load

$V=\frac{\pi\times dp\times np}{60\times 1000} = \frac{\pi\times 18m\times 60}{60\times 1000} = 0.3596m$ m/s

Tangential force (f_t)

$F_t = \frac{P}{V} = \frac{0.066}{0.3596m} = \frac{0.1853}{m}$ N

As per the gear pair is manufactured by generation, the velocity factor is given by,

$Kv = \frac{5.6}{5.6+\sqrt{v}} = \frac{5.6}{5.6+\sqrt{0.3596m}}$

$Feff = \frac{Ka.Km.Ft}{Kv}$

Feff=effective load

Ka=application factor

Km=distribution factor

Kv=velocity factor

$Feff = \frac{2\times 1}{\frac{5.6}{5.6+\sqrt{0.3596m}}} \times \frac{0.1853}{m}$

Estimate the module- In order to avoid the pitting failure,

Fw=Nf .Feff

$247.38m^2 = 1.5\times \frac{2\times 1}{\frac{5.6}{5.6+\sqrt{0.3596m}}} \times \frac{0.1853}{m}$

Solving by above equation by trial & error, we get,

Dimensions of gear pair -

m = 6 mm

Z_P = 12

Zg =20

B = 6.36 m = 38.16mm

Dp = m×zp = 6×12 =72mm

Dg = m×zg = 6×20 =120 mm

A_0 =12.272 m =76.36mm

ha = 1m = 6 mm

hf = 1.2m = 1.2×6 = 7.2 mm

6. PROCESS SHEETS.

6.1.Part Name:- OUTER PIPE
Part size :- Ø20mm x 350 mm
Part WT :- 1 kg
Part Qty:- 1
Part Material: - M.S.

Sr. No	Operation	Machine	Tool	Time
1	Cutting the material as required size.	Cutting machine	Cutting machine	20 min
2	Turning shaft to make Ø20mm.	Lathe machine	Turning Tool	20 min
3	Facing side ends.	Lathe machine	Facing Tool	15 min

6.2.Part Name:- INNER PIPE
Part size :- Ø14mm x 400 mm
Part WT :- 1 kg
Part Qty:- 1
Part Material: - M.S.

Sr. No	Operation	Machine	Tool	Time
1	Cutting the material as required size.	Cutting machine	Cutting machine	20 min
2	Turning shaft to make Ø14mm.	Lathe machine	Turning Tool	20 min
3	Facing side ends.	Lathe machine	Facing Tool	15 min

6.3.Part Name: - UPPER BEARING PLATE
Part size : -125 mm X 75mm X 3 mm.
Part Qty : - 1
Part Wt : -1 kg
Part Material: - M.S.

Sr .No	Operation	Machine	Tool	Time
1	Cutting the material as our required size	Cutting machine	Cutter wheel	25 min
2	As in center M20 drill	Drilling machine	Drilling Bit 20mm	15min
3	Drilling two hole	Drilling machine	Drilling bit 10mm	15 min

6.4.Part Name: - MIDDLE BEARING PLATE
Part size : -150 mm X 75mm X 3 mm.
Part Qty : - 1
Part Wt : -1 kg
Part Material: - M.S.

Sr .No	Operation	Machine	Tool	Time
1	Cutting the material as our required size	Cutting machine	Cutter wheel	25 min
2	As in center M20 drill	Drilling machine	Drilling Bit 20mm	15min
3	Drilling two hole	Drilling machine	Drilling bit 10mm	15 min

6.5.Part Name: - BASE BEARING PLATE
Part size : -125 mm X 75mm X 3 mm.
Part Qty : - 1
Part Wt : -1 kg
Part Material: - M.S.

Sr .No	Operation	Machine	Tool	Time
1	Cutting the material as our required size	Cutting machine	Cutter wheel	25 min
2	As in center M20 drill	Drilling machine	Drilling Bit 20mm	15min
3	Drilling two hole	Drilling machine	Drilling bit 10mm	15 min

6.6.Part Name: - SUPPORTING FRAME
Part size : -300mm X 300mm X 500mm.
Part Qty : - 1
Part Wt : - 8 kg
Part Material: - M.S.

Sr .No	Operation	Machine	Tool	Time
1	Cutting the material as per our required size 300 X300X500mm	Saw machine	Saw machine blade	65 min
2	Welding the Frame	Welding machine	Arc Welding torch	75 min

7. COST OF MATERIAL

7.1. TOTAL COST OF MATERIAL

Part Name	Material	Wt in kg	Rate / kg	Total Rate
plate	M.S	60	5	300
Pipe	M.S	70	3	210

Supporting frame	M.S	50	8	400

TOTAL COST OF MATERIAL: 910/- RS.

7.2. COST OF MACHINENING

Machine Name	Using Time (min)	Rate /hr	Total Rate Rs/-
cutting	180	400	1200
Lathe m/c	70	500	600
Welding	75	500	600
Grinding	30	300	150
Drilling	90	300	450

TOTAL COST OF MACHINENING: 3000/- RS.

7.3. COST OF STD PART

Sr.No.	Name	Qty.	rate	Total rate
1	Gear Motor	1	500	500
2	Pulley(small)	1	30	30
3	Pulley(Big)	1	65	65
4	Belt	1	40	40
5	Bevel gear(small)	2	800	1600
6	Bevel gear(Big)	1	1200	1200
7	Padestal bearing	3	150	450
8	Nut & bolt	8	10	80
9	Foundation gripper	4	30	120
10	Tank	1	450	450

TOTAL COST OF STD PART: 4535/- Rs.

7.4. COST OF TRANSPORTATION & OVERHEAD = 1000 / - Rs.

COST OF PROJECT =

Cost of material + Cost of machinating + Cast of STD part + Cost of transportation & overhead

=910+3000+4535+1000

=9,145/-

8. ADVANTAGES, LIMITATIONS & APPLICATIONS.

8.1. Advantages:

1. Stirrer has bi-directional i.e. it rotates in both directions; this gives uniform mixing.
2. Quality of mixing is very high.
3. Low cost of mixing.
4. Fast production rate.
5. Compact size so minimal space requirements.

8.2. Limitations:

1) The machine develop by us is having capacity only 20 liters, which can be made only to prove models reliability or change in functionality for model synthesis. It is not an actual production model, but fulfills all basic requirements given by the company.

2) The machine develop by us is having small capacity of motor, so that it cannot be use large quantity of chemicals or liquid.

3) The machine develop by us is having low speed of motor which give less speed of chemical or liquid mixing.

4) The machine gearbox made by us may have misalignment while working.

8.2. Applications:

1. Mixing of multiple color paint in paint industry.

2. Dairy applications with suitable change in stirrer material.

9. CONCLUSIONS

While concluding this report, we feel quite fulfill in having completed the project assignment well on time, we had enormous practical experience on fulfillment of the manufacturing schedules of the working project model. We are therefore, happy to state that the in calculation of mechanical aptitude proved to be a very useful purpose. Although the design criterions imposed challenging problems which, however were overcome by us due to availability of good reference books. The selection of choice raw materials helped us in machining of the various components to very close tolerance and thereby minimizing the level of balancing problem. Needless to emphasis here that we had lift no stone unturned in our potential efforts during machining, fabrication and assembly work of the project model to our entire satisfaction.

Energy consumption comparison:

Electrical power consumption comparison of mixer is given below,

1) Existing old mixer systems (General): 1 Hp motor.

$$= \frac{[\text{watt X no.working days in year X working hrs in days X unit Rs/–}]}{1000}$$

$$= \frac{[746 \text{ X } 300 \text{ X } 12 \text{ X } 10]}{1000}$$

= **26,856 Rs / year.**

2) Replacement / Investment:

Replace old mixer systems with new mixer (General):

a) Energy used per year for 50 watt motor

$$= \frac{[\text{watt X no.working days in year X working hrs in days X unit Rs/–}]}{1000}$$

$$= \frac{[50 \text{ X } 300 \text{ X } 12 \text{ X } 10]}{1000}$$

= 1800 Rs / year.

Annual saving by / year

= 26,856 - 1800

= 25,056 Rs / year.

As we conclude from results that the system of mixer develop by us is save time as well as power consumption. The model develops by us fulfill the required objectives that it reduces human efforts & time in mixing operations. Similarly, it maintains the accuracy in chemical mixing process. It performed the most rigid operation with high-speed chemical mixing in any types of liquids. After some modifications in this machine develop automation unit for the mixer so that machine can easily be adopted in today's automated plants. Hence, we are satisfied with our project work.

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