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Design & Fabrication Of Bi-Directional Mixer

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Abstract

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 quiet 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.

Keyword- *mixer*

I.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 quiet 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.

II PROBLEM STATEMENT

The statement of project is "design & fabrication of bi- directional mixer" for used mixing powder, chemicals & semisolids work.

III LITERATURE SURVEY

[1] Jagdish M. Chahandeet, et.al. (2015) presented the methodology for design and fabrication of Planetary Mixer for Preparing Cake Cream with the related search. The study specifies factors influencing the cake cream making process and recommends a number of design options for planetary mixer. These are based on a systematic study of the cake cream making process and testing of a prototype model of planetary mixer.

[2] Rafiqueet, et.al. (2013) studied for contra–rotating mixing flow within a cylindrical container. The behavior compared against previously simulated numerical results and found with good agreement. Two-dimensional incompressible complex flow of Newtonian fluid is relevant to the food industry. The numerical method adopted is a finite element semi-implicit time-stepping Taylor-Gale kin /pressure-correction multi stepping scheme, posed in a cylindrical coordinate system. The flow replicates the behavior of actual industrial dough mixing.

[3] B. Kumar and E. Rajasekaran (2014) suggested a new design for the agitators. By careful study of three different models in all aspects one had been taken for the final fabrication. To finalize the best design, simulation which had used to conduct required experiment? Required inputs had been taken from different literature surveys and the discussion with the experts who were on the field and real time study had been conducted to get the exact requirement of the customer.

[4] H. S. Pordal and C. J. Matice (2015) studied inadequate understanding of mixing had resulted in unsatisfactory product quality, increase cost of production and loss of revenue. The use of analysis tool varying rigor to solve mixing problem was described. This solution strategy can be applied to solve mixing problems related to the design of process, Scale-up and scale-down of equipment.

[5] Ashish Panchgatte, et. al (2015) used planetary machine involved a rotating stirrer that revolves about the fixed container axis as well as incorporated an strainer that changes the flow pattern and also acted as a wiper. Machine has variable mixing speed feature at the same time delivers heavy torque to the stirrer for proper mixing.

[6] Tomas Jiroutand Frantisek Rieger (2011) studied effect of impeller type on off-bottom particle suspension. On the basis of numerous suspension measurements there were proposed correlations for calculation just-suspended impeller speed of eleven impeller types and geometries in the wide range of concentrations and particle diameters. The suspension efficiency of tested impellers was compared by means of the power consumption required for off-bottom suspension of solid particles.

[7] R. K. Thakur et al (2003) described the field of static mixers including recent improvements and applications to industrial processes. The most commonly used static mixers are described and compared .Their respective advantages and limitations are emphasized. Efficiencies of static mixers are compared based both n theory and experimental results from the literature

. **IV Planetary Mixer & Gear.**

Industrial Mixers 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 High 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.

Planetary Gear:

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. Let's say the sun gear must have 24 teeth. The other parameters can be found using the following equations:

- R: Gear ratio, 5: 1
- Nr: Number of teeth on the ring gear
- Ns: Number of teeth on the sun gear

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. The following table gives an example of the gears used in a particular planetary system, with all specifications included: Sun Gear Planet Gear Ring Gear

Quantity 1 3 1

- Module 1 1 1
- Number of Teeth 24 36 96
- Pressure Angle 20° 20° 20°

V CONSTRUCTION

SR. NO.	COMPONENTS	QUANTITY
1.	Geared motor 12 Volt supply, 60RPM.	1
2.	Pedestal bearing	2
3.	Shaft	2
4.	Washer	8
5.	Nut and Bolt	4
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

VI 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 1.1.

Fig. 1.1. Proposed Model of Mixer.

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VII .DESIGN

Motor selection:

Thus selecting a motor of the following specifications

- Single phase AC motor
- Power = 1/15hp=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 rope 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

Design of Rope Drive:

Motor pulley diameter **d** = 20 mm

IP _ shaft pulley diameter **D** = 60 mm

Coefficient of friction = 0.23

Let,

d= diameter of rope = 5 mm

Mass of rope per unit length is given by;

ρ= density of belt material = 950 kg/m^3

m= 0.0285 kg/m

Velocity of rope is given by;

$$V = \frac{\Pi dn}{60 X 1000}$$

$V = \frac{\Pi x \, 5 \, x \, 60}{60 \, X \, 1000}$

V=0.078 m/s **Linear velocity**

To find out tension in the rope is;

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

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

F1 − F2 = 636.619 N **------------- (1)**

Center distance between two pullies of motor & pullies output **C**=**200mm.**

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

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

$\alpha = 5.739^0$ (In Degrees)

$\alpha = 5.739 \, X \, (\Pi / 180)$

$\alpha = 0.10^c$ (In Radians)

θ = Angle of lap of belt.

$\theta = \Pi - 2\,\alpha$

$= \Pi - [2 \, X \, 0.10]$

$\theta = 2.94^c$ (In Radians)

$\theta = 168.54^O$ (In Degrees)

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

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

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

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 = 91.3 N

Put in Eq. (3)

F1 = 727.69 N

Centrifugal force in belt is given by,

$Fc = mV^2$

$=0.0285 X (0.078)^2$

Fc = 1.73 N

Shaft design:

To find diameter of shaft by ASME code

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

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

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

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

$d^3=737.089$

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

Bearing selection:

As shaft dia. – is 20 mm so we have selection a pedestal bearing having shaft outer dia. – 20mm.

Motor power P=$\frac{1}{15}$ HP=50watt

N=60rpm.

Small pulley dia. d=20mm.

Big pulley dia. D=60mm.

Center dist-between two bullies C=200mm.

Shaft dia. d=20mm.

Modification of differential gearbox system:

No teeth on gear Zg = 18

No teeth on pinion Zp=18

Material of gear & pinion both are C40.

Sup =580 N/ mm^2

Sug =580 N/ mm^2

Given Data:

Power P = 1/15 watt

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)

tanδp = $\frac{Zp}{Zg}=\frac{18}{18}$ = 1

δp= tan^{-1} (1)

δp= 45^0

tan δg = $\frac{zg}{zp}=\frac{18}{18}$ = 1

δg =tan^{-1} (1)

δp =45^0

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

Z'p=$\frac{zp}{cos\gamma\ p}=\frac{18}{cos45^0}$=25.45

Z'g=$\frac{zg}{cos\gamma\ g}=\frac{18}{cos45^0}$=25.45

Assuming 20^0 full depth involution system,

Y’p=0.484 - $\frac{2.87}{Z'p}$=0.484 - $\frac{2.87}{25.45}$ = 0.3712

Y’g=0.484 - $\frac{2.87}{Z'g}$=0.484 - $\frac{2.87}{25.45}$ = 0.3712

Now, δ_{bp} . Y’p = 193.33×0.3712 = 71.75 N/mm^2

δ_{bg} . Y’g = 193.33× 0.3712 = 71.75 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 = 18 m dia. Of pinion.

dg = m.zg = 18 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× $6.36m \times m \times 0.3712 \times [1 - \frac{6.36m}{12.727m}]$

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

Fb =228.335m^2 N

Wear strength (Q’)

Q' = $\frac{2Zg'}{Zg'+Zp'} = \frac{2X25.45}{25.45+25.45}$ =1

Tooth from factor (K)

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

Buckingham's eq^n for the wear strength (Fw)

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

Fw =$\frac{0.75\times 18m\times 6.36m\times 1\times 1.96}{COS\ 45^o}$

Fw=237.99 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

237.99m^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

ZP = 18

Zg =18

B = 6.36 = 38.16 m

Dp = m×zp = 6×18 =108 mm

Dg = m×zg = 6×18 =108 mm

A_0 =12.272 m =76.36mm

ha = 1m = 6 mm

hf = 1.2m = 1.2×6 = 7.2 mm

δp =45^0

δg =45^0

VIII 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

CONCLUSION

Hence we designed and fabricated Bi- Directional Mixer successfully.

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