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BI-DIRECTIONAL MIXER

Mr. Raghunath Rajaput

Mr. Tamboli Najirkhan

Prof. S.T Waghmode

Department of Mechanical Engineering,
Shivaji University / A.I.T.R.C. Vita, India

ABSTRACT

In conventional method of mixing the metal oxide powder and vehicle mixing is carried out on 'Unidirectional Stirring Machine' The stirrer of conventional machine rotates in one direction only which creates a particular 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 of paint, ultimately results into poor quality mixture of paints there by poor quality output of paint .In order to have a homogeneous mixing would be appropriate to have a directions of rotation of stirrer shaft which will rotate stirrer 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 paint mixture preparation which will create the good quality paint.

KEY WORDS: Unidirectional, Homogeneous mixture, Uniform, Periphery of blades Shape, oscillating motion

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,

EXPERIMENTAL SRT-UP

The mechanism as shown in the figure is developed to produce an oscillating motion in the vertically suspended output shaft trough the continuously rotating horizontal input shaft'. The input shaft carries an input crank that engages with inputshaft at one end and the fork at other. The fork is coupled to output shaft by means of fork pin. During 0 to 180 degree rotation of the input shaft the crank and the fork together make output shaft to rotate in clockwise direction by 60 degrees, whereas during 180 to 360 degrees of input the output changes direction and returns to mean position

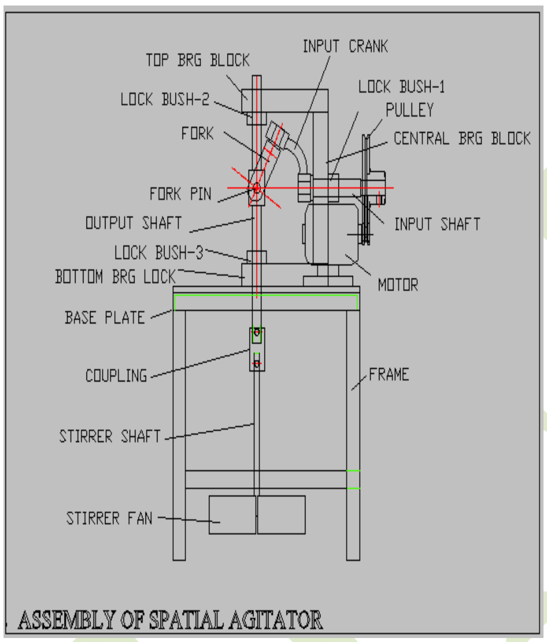

Fig 1.Auto CAD of Assembly Set-up

Fig 2.Actual set-up

DESIGN PROCEDURE OF BI-DIRECTIONAL MIXER

Careful design approach has to be adopted. The total design work has been split up into two parts;

- System design
- Mechanical Design.

SYSTEM DESIGN:

System design mainly concerns the various physical constraints and ergonomics, space requirements, arrangement of various components on main frame at system, man and machine interactions.

ISSN: 2394-3696
VOLUME 2, ISSUE 4APR.-2015

MECHANICAL DESIGN:

For design parts a detailed design is done & designation thus obtain are compared to the next highest dimension which is ready available in market. The processes charts are prepared & passed on to the work are specified. The parts to be purchased directly are selected from various catalogues & specification so that anybody can purchase the same from the retail shop with the given specifications

SELECTION OF MOTOR

Input data (Ref. www.engineering toolbox.com)

1. Kinematic viscosity of Paint = 2.4 poise

=2.4/0.01 centipoise

= 240 centipoise

2. Specific gravity of paint = 1.59 kg/lit

In design of spatial agitator the approach to design would be to calculate the torque required at the output shaft for stirring, and based on this torque selecting an appropriate motor after incorporating a suitable factor of safety. The torque calculation will be based on two analogies namely; torque required to overcome the viscous force by virtue of the fluid viscosity and secondly the torque required to overcome the static total pressure on each blade owing to the stationary fluid i.e., paint.

Total torque on Output shaft = Torque owing to viscous force + Torque owing Static pressure

Calculation of Torque Owing To Viscous Force At Periphery Of Blades

The blade tip traces a loci of points which is a circle; hence the motion of the bracket due to oscillation of the output shaft can be considered to be a cylinder (assuming blade angle $=0^0$), which is moving against another cylinder i.e., the container both separated by a fluid film of thickness of 30 mm.

We can put up the above problem as follows;

Problem: Find the force and power required to move a shaft of diameter 10 cm against a journal of internal diameter 14 cm, separated by a fluid of kinematic viscosity 2.4 poise. Shaft rotates at 80 rpm.

Solution: Given: μ = 2.4 poise = 1/10*2.4 = 0.24 Ns/m^2

Speed of shaft = 80 rpm

Tangential speed of shaft = u = πDN/80

= π x 0.10 x 80/60

=.0418 m/sec

Now,

$\tau = \mu$ du/dy

Where;

τ = Shear stress (N/m^2)

du = Change in speed = u-0 = 0.418 m/sec

dy = Distance between shaft and journal = 0.01m

τ = 0.24 x 0.418/0.01 = 10.032 N/m^2

Area of the cylinder that is exposed to this shear intensity will be the circumferential area ;(assuming width of blade = 40 mm)

A= c x D x w

= π x 0.1 x 0.04

=0.012 m^2

Shear force (F) = Shear stress x Shear area
= 10.032 x 0.012

= 0.126 N

Power = F x u

=0.126 x 0.418

=0.0526 Watt

Calculation of Torque owing to viscous force at top and bottom ends of blades

The blades along the length when rotated along with bracket will trace an annular ring at the either ends of the blade.

We can put up the above problem as follows;

Problem: Find the force and power required to move a plate of width 5 cm and length 100 cm against a stationary plate extending infinitely, separated by a fluid of kinematic viscosity 2.4

Poise at a distance of 1 cm. Plate moves at 0.418 m/sec.

ISSN: 2394-3696
VOLUME 2, ISSUE 4APR.-2015

Solution : Given : $\mu = 2.4$ poise

$= 1/10*2.4$

$= 0.24\ Ns/m^2$

Speed of plate = 0.418 m/sec

Now,

$\boldsymbol{\tau} = \mu\ du/dy$

Where;

$\boldsymbol{\tau}$ = Shear stress (N/m^2)

du = Change in speed = u-0 = 0.418 m/sec

dy = Distance between shaft and journal = 0.01m

$\boldsymbol{\tau} = 0.24 \times 0.418/0.01$

$= 10.032\ N/m^2$

Area of the cylinder that is exposed to this shear intensity will be

A = L x B

= 1 x 0.05

$= 0.05\ m^2$

Shear force (F) = Shear stress x Shear area

= 10.032 x 0.05

= 0.528 N

Total shear force = 3 x F

= 1.584 N

Power = F x u

=1.584 x 0.418 = 0.662 Watt

Calculation of Torque owing to Static total pressure acting on the blades by virtue of the stationary fluid:
In calculation of torque due to static force exerted by the fluid we use the following analogy;

Problem*:*Determine the total pressure on a flat plate of length 50and width 40mm which is placed vertically in such a way that the centroid of plate is at a distance of 100mm below the free surface of fluid of specific gravity 1.59kg/lit

Solution : Given : sp gr. =1.59 kg / lit=1.59*1000kg/m^3

Total pressure is given by;

$$F = \rho g\ A\ h$$

$$=1590 \times 9.81 \times 0.05 \times 0.04 \times 0.1$$

$$=3.115N$$

There are three such blades,

Thus the total force = 3 x 3.115

= 9.35 N

The torque that each pinion has to overcome to rotate about its own axis is given by;

$$T = 9.35 \times 0.04$$

$$=0.374\ N\text{-}m$$

Power required at the output shaft to overcome the static resistance of fluid is ,

$$Ps = 2\pi NTs/60$$

$$=2 \times 3.142 \times 80 \times 0.374/60$$

$$=3.13\ Watt$$

Thus the net power required at the output shaft is the summation of the above three powers;

$$P_{net}= 0.0526+0.662 +3.13$$

=3.8446 Watt approximately 4 watt

The mechanism used for converting rotary power into oscillatory energy is tested for its efficiency so assuming only 50% efficiency and assuming that further power is lost in friction at the bush bearings we shall assume overall efficiency to be 30 % only thus power required by machine will be 28 watt approximately. As we intend to run machine at various speeds hence we shall employ a commentator motor speed of which can be varied by placing an rheostat in series.

DESIGN OF OPEN BELT DRIVE

Motor pulley diameter (D2) = 10 mm

IP _ shaft pulley diameter (D1) = 36 mm

Reduction ratio = 5

Coefficient of friction = 0.23

Maximum allowable tension in belt = 200 N

Center distance (X) = 182

$$V = \Pi DN/(60 \times 1000)$$

$$= 4.188 m/sec$$

$$\sin\alpha = \frac{R1 - R2}{X}$$

$$\sin\alpha = (18 - 5) / 182$$

So,

$$\alpha = 9.8069$$

$$\theta = (180 - 2\alpha)\,\pi/180$$

$$= (180 - 2\times 9.8069)\,\pi/180$$

$$\theta = 2.7964 rad$$

Now,

$$2.3\log[T1/T2] = \mu\theta$$

$$= 0.23\times 2.7964$$

$$= 0.64319$$

$$\log[T1/T2] = 0.6431\times 2.3$$

$$= 0.2796$$

$$T1/T2 = 1.9039$$

$$= 200/1.9039$$

$$T2 = 136N$$

Result Table

Tension in tight side of belt (T_1) = 200 N

Tension in slack side of belt (T_2) = 136 N

DESIGN OF INPUT SHAFT.

MATERIAL SELECTION:-

Ref: - PSG (1.10 & 1.12) + (1.17)

DESIGNATION	ULTIMATE TENSILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
EN 24	900	700

Table1: Material Selection

ASME CODE FOR DESIGN OF SHAFT.

According to ASME code permissible values of shear stress may be calculated form various relations.

$$Fs_{max} = 0.18 \text{ fult}$$

$$= 0.18 \times 900$$

$$= 162 \text{ N/mm}^2$$

OR

$$Fs_{max} = 0.3 \text{ fyt}$$

$$=0.3 \times 700$$

$$=210 \text{ N/mm}^2$$

Considering minimum of the above values;

$$\Rightarrow Fs_{max} = 162 \text{ N/mm}^2$$

Shaft is provided with key way; this will reduce its strength. Hence reducing above value of allowable stress by 25%

$$\Rightarrow Fs_{max} = 121.5 \text{ N/mm}^2$$

This is the allowable valve of shear stress that can be induced in the shaft material for safe operation.

CHECK FOR TORSIONAL SHEAR FAILURE OF SHAFT.

Assuming minimum section diameter on input shaft = 16 mm

$$\Rightarrow d = 16 \text{ mm}$$

$$Td = \Pi/16 \times Fs_{act} \times d^3$$

$$\Rightarrow Fs_{act} = (16 \times Td) / \Pi \times d^{3}$$

$$= (16 \times 1.19 \times 10^{3}) / \Pi \times (16)^{3}$$

$$\Rightarrow Fs_{act} = 1.47 \text{ N/mm}^2$$

$$\text{As} \quad Fs_{act} < FSs_{all}$$

$\Rightarrow$ I/P shaft is safe under torsional load.

SELECTION OF BEARING

Shaft bearing will be subjected to purely medium radial hence we shall use ball bearings for our application.

Selecting; Single Row deep groove ball bearing as follows Series 62

No	**Bearing of basic design no (SKF)**	**D**	**D1**	**D**	**D_2**	**B**	**Basic capacity**	
17BC02	6203	17	21	40	36	12	4440	7500

Table2: Selection of Bearing

$$P = X F_r + Y F_a$$

For our application F_R Belt Tension =196+49 = 245 N

$$\Rightarrow P = X F_r + Y F_a$$

$$\text{As; } F_a / F_r < e \Rightarrow X = 1, Y = 1$$

$$\Rightarrow P = F_r$$

Max radial load = F_r =245 N.

$$\Rightarrow \quad P = 245 N$$

Calculation dynamic load capacity of brg

$$L = \left(\frac{C}{P}\right)^{p}, \text{ where } p = 3 \text{ for ball bearings}$$

When P for ball brg

For m/c used for eight hr of service per day;

L_H = 12000- 20000hr

But;

$L10 = (60\ n\ L10_{H}) / 10^6$

$L10 = (60 \times 800 \times 12000) / 10^6$

L10=576 mrev

Now;

L10=(C/P) ^1/p

576=(c/245) ^1/3

C = 2038.48 N

Here,

C = 2038.48 N < 4440 N

⇒As the required dynamic capacity of brg is less than the rated dynamic capacity of brg;

DESIGN OF OUTPUT SHAFT.

MATERIAL SELECTION: -

Ref:- PSG (1.10 & 1.12) + (1.17)

DESIGNATION	ULTIMATE TENSILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
EN 24	900	700

Table3: Material Selection

ISSN: 2394-3696
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$$= (16 \times 1.19 \times 10^3)/\Pi \times (16)^3$$

$$\Rightarrow Fs_{act} = 1.47\ N/mm^2$$

As

$$Fs_{act} < Fs_{all}$$

$\Rightarrow$ I/P shaft is safe under tensional load

ADVANTAGES

1. Stirrer has bi-directional ie,it rotates in both directions; this gives uniform mixing.
2. Quality of mixing is very high
3. Low cost of production because it does not require an gear box.
4. Fast production rate
5. Compact size so minimal space requirements

APPLICATIONS

1. Mixing of multiple colour paint in paint industry.
2. Mixing of metallic powders in pigment in preparation of ionic paints.
3. Can be used as skimming machine.
4. Dairy applications with suitable change in stirrer material.
5. Mixing applications in pharmaceutical industry.

FUTURE SCOPE

1) In this project if you connect the two mutually perpendicular stirrer which moving in perpendicular direction then it increase the efficiency of Bi-directional mixer.

2) Increasing the angle of opposite side rotation increasing the efficiency

MIXING SYATEM

The mixing system consists of the container and impeller spun by a motor drive .The dc motor is mounted on the base plate. With help of the pulley and belt transfer the it motion to the stirrer. Container is glass beaker. When undergoes mixing the upper side of the tank closed with plate the mixing is undergoes for paint and lassi as fallow.

1. First tank filled with 500grm oil bond then in it added the seven drop of the sterner to identify proper mixing with help of the colour. Then output shaft take place inside the tank centrally. Then start the switch varies speed of the motor.

2. For another mixing system we take curd, water, sugar. Firstly we take 350ml water in container then add the 500grm crud and add 100grm sugar. Then outer shaft place in the container centrally and on the switch, and varies speed of the motor.

MIXING RESULT

The mixing result for paint and lassi as fallow.

1. By mixing observation we get that oil bound properly mix with colour and we get the homogeneous mixture of the oil bound and sterner.

2. The curd, sugar water properly mix and form the homogeneous mixture. Sugar will not seetal down at the bottom due to turbulence created in the container.

CONCLUSION

Mixing process has been performed which conform that the proposed mixing prevent the formation of segregated region hence shorten the mixing time than other mixing method (constant speed, manual mixing, sinusoidal bidirectional). Also by using the bi-directional mixer in container create turbulent flow of mixture and we get the homogeneous mixture.

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