REVIEW ON PNEUMATIC UPLIFTING MECHANISM OF BI-DIRECTIONAL MIXER

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Abstract -- 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 rules out the more costly initial investments, but differences in efficiencies must also be taken into account. Proper mixer selection is vital to process optimization.

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 with spiral blades applications 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 in additional pneumatic ram which dynamically move drive head of mixer in up & down direction.

Key Words: Viscosity, Density, USM (Unidirectional Stirring Machine)

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 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. 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 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).

II. Literature Review

Jagdish M. Chahandeet etl 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.

Charles Ross (2014) it represents an overview of mixing technologies implemented across many of today's highly competitive pharmaceutical and medical industries, as well as new equipment designs that are increasingly being recognized as potential solutions to prevailing mixing challenges.

J.M.Ottino & D.V.Khakar (2000) this paper solve the issue of transverse mixing in a rotating drum in the continuous-flow.

Osokam Shadrach Onyegu (2012) 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.

Amruta K. Wankhede and Dr. A.R. Sahu (2015) it is observed that there is a failure of shaft and blade in mixer thus, deign modification and analysis of mixer have been done and presented. A typical concrete mixer uses a revolving drum to mix the components. Mixing is a complicated process that is affected by the type of mixer, the mixing cycle as defined by the duration, the loading method, and the energy of mixing.

Sachin N. Waghmare (2016) To attain the uniform mixing of the solution with the desired quality and in order to remove the dull work of human folk this newly designed mixer is suggested.

Hans Lokke (2013) This paper shows the most important insights and focus on risk assessment of chemical mixtures combinations of chemical and natural stressors.

V.B. Bhandari & The data book of PSG Institute of technology (2013) has published his latest edition of book

— Design of Machine Elements, it consists of design parameters for design of various mechanical components. Tanguy et al. (1999) in this paper the mixing hydrodynamics in a double planetary mixer was investigated numerically and experimentally over the course of a cross-linking reaction. Use of various visualization techniques, it was shown that this mixer provided good radial dispersion capabilities but poor axial (top-to-bottom) pumping, irrespective of the viscosity level. Overall, the numerical predictions and the experimental results exhibited good agreement although at 85% conversion, the numerical model was not accurate enough to predict adequately the power consumption due to physical phenomena not considered in the computations.

III DESIGN CONSIDERATION

3.1 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 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**

3.2. Design of Belt Drive

Motor pulley diameter **d** = 20 mm

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

Coefficient of friction =0.23

Let,

d= diameter of belt = 5mm

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;

$$v = \frac{\pi(d+t)n}{60 * 1000}$$

$$v = \frac{\pi(20+5)60}{60 * 1000}$$

V= 0.078 m/s ……… Linear velocity

To find out tension in the belt is;

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

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

F1-F2 = 636.619 N ……………… (1)

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

3.3 Shaft design

To find diameter of shaft by ASME code

For commercial steel shaft, Actual shear stress

$T_{act} = 55\ N/mm^2$

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

$$\tau act = \frac{16 * T}{\pi * (d^3)}$$

$$7.76^3 = \frac{16 * 55}{\pi * (d^3)}$$

$d^3 = 737.089$

d = 9.033mm

d = 10mm

3.4 Bearing selection

As shaft dia.is 10 mm so we have selection a pedestal bearing having shaft outer dia. 20mm.

Selection of shaft ball bearing:

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 is = Weight of Blade + weight of shaft.

Assume = 30 N

Axial load on each bearings F_a = 30/2

= 15 N.

Equivalent dynamic load

Pe = $V.F_a.Ka$= 1 X 15 X 1.5

Pe = 22.5 N

bearing life is,

$$L^{10} = \frac{Lh^{10} \times 60}{106}$$

Lh10 from graph 4.6 PSG Design data book for 16000 rpm maximum speed of ball
bearing is 315000 Hours.

$$L^{10} = \frac{31500 \times 60 \times 4300}{106}$$

L^{10} = 8127 millions of revolutions.

L^{10} = $(c/pe)^{(10/3)}$

C = $(L10)^{(10/3)}$

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

C = 335.09 KN.

Bearing 3200 x (C=142.87 N) is suitable.

3.5 Design of Pneumatic Cylinder:

To determine the thickness of cylinder.

Let,

Material of the cylinder is Aluminum.

Sut =Ultimate tensile strength = 200N/mm^2

μ = Poisson's Ratio for the cylinder material =0.29 (std)

d_i = Inner diameter of cylinder =40mm

Consider,

Double acting cylinder Ø40 X 200 (Diameter X Stroke)

r_i =20mm

By assuming pressure in working cylinder is, P = 3 bar =0.3 N/mm^2

Assume,

p = 3 bar = 0.3 N/mm^2

μ = 0.29

r_i= 20 mm.

dia.- = 40mm

Stroke length= 200mm

Piston rod dia.- = 12mm.

For Calculating the thickness of the cylinder,

We consider factor of safety of pneumatic cylinder,

40% of bore cylinder diameter i.e., 16

$$\sigma_t = \frac{Sut}{FOS}$$

$$= \frac{310}{16}$$

= 19.375 N/mm^2

$$\sigma_t = \frac{P*D}{2*t}$$

$$19.375 = \frac{0.7*40}{2*t}$$

t = 0.9 mm

So that the thickness of cylinder by calculations is 0.9mm is safe for given diameter of cylinder So we will select the cylinder which has thickness above 0.9mm as per availability.

Available thickness, t = 0.5mm

Piston dia.- = 40mm

Stroke length= 200mm

Piston rod dia.- = 12mm.

Let,

A= Force area of cross-section of piston.

$A = \pi / 4 (D^2)\ mm^2$

$A = \pi / 4 (40^2)\ mm^2$

$A = \mathbf{1256}.63\ \mathbf{mm^2}$

A_{PR}= Force area of cross-section of piston on rod side.

$APR = \pi/\mathbf{4}(D^2 - d^2)\ mm^2$

$APR = \pi/\mathbf{4}(40^2 - 12^2)\ mm^2$

$APR = \mathbf{1143.54}\ mm^2$

Piston force acting during forward stroke.

$Fa = P \times \pi/\mathbf{4}(D^2)$

$= 0.3 \times 1256.63$

Fa = 376.989 N.

Piston force acting during return stroke.

$FR = \mathbf{P \times \pi/4(D^2 - d^2)}$

$= 0.3 \times 1143.539$

FR = 343.061 N.

Time required to complete stroke is 2 second.

Linear velocity of piston

V= L/t

V= 200 /2

= 100 mm/sec.

3.6 Material Requirement

SR. NO.	COMPONENTS	QUANTITY
1.	GEARED MOTOR 12VOLT SUPPLY,60RPM.	1
2.	PEDESTAL BEARING	2
3.	SHAFT	2
4.	WASHER	8
5.	NUT AND BOLT	16
6.	FRAME STRUCTURE	1
7.	SCREW ROTOR BLADE/STIRRER	2
8.	V-BELT	1
9.	PULLEY	2
10.	BEVEL GEAR	3
11.	DRUM	1
12.	SOLENOID VALVE	1
13.	TIMER	1
14.	PNEUMATIC FITTING	4
15.	PNEUMATIC HOSE PIPE	10 meter
16.	FLOW CONTROL VALVE	2

3.7 Components Used

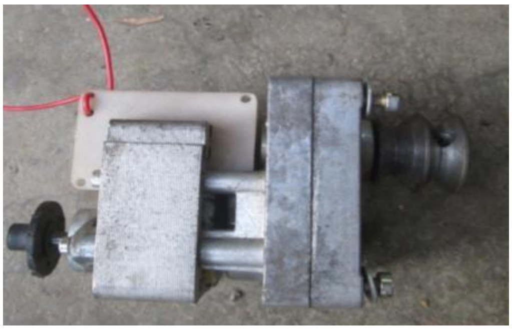

Fig.no. 1 Motor

Fig.no.2 Bevel Gear

Fig. no. 3 shaft

Fig no. 4 Bearing

IV WORKING

A chemical mixer is being designed which consist of a container, impeller spiral blades, electrical motor, pair of pulleys, pedestal bearings, pneumatic rams, timer, solenoid valve and drive shafts. We are using the container made up of stainless steel; 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 spiral impeller blades also rotate along the direction. Simultaneously the arrangements of pneumatic rams move up &
down the head of driver to maximize the agitating performance as per operation of timer.
Hence the mixing of chemical ingredients is obtained. The concept model of mixer is as fig 4.

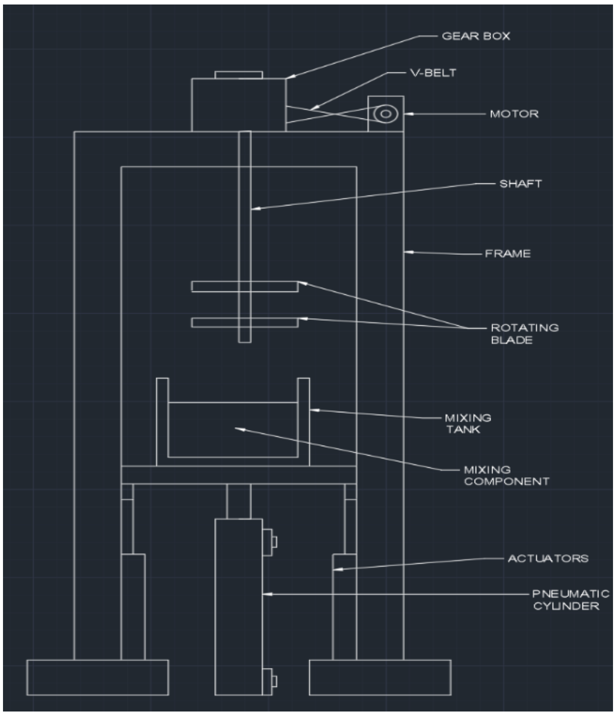

Fig.no. 4 Proposed model of mixer

V 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

VI. LIMITATIONS

1. Material should be stainless steel

2. Power of the motor is low

3. As the power is low the aped of motor is also low

4. It can be used for small capacity of mixing, for more capacity of mixing high power & high rpm motor should be selected

VII. CONCLUSION

This machine is developed by using electric motor. Thus, the worker needs to give some attention. This machine can be modified by using some sensor controls and programming. This machine can mix the substance liquid or liquid with liquid and. The model develop is for only 20-30 liters capacity It can be designed or more capacity of mixing. The high power and high rpm motor can also be used. The speed can also be increased by using different gear ratio.

The model will develop by us to 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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