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Design Analysis & Performance Evaluation of Wobble Mixer

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ABSTRACT - Mixing or Stirring process constitutes an important part in process engineering especially in paint manufacture industry. After the sizing, design development of wobble mixer, the critical components of the wobble mixer have been designed and analysis of the components is done. The paper deals with design development of the critical components of the system and performance evaluation of the mixer. The theoretical design of the components has been done after appropriate selection of materials, followed by solid modelling of the components using Unigraphics Nx. The static structural analysis of the components has been done using Ansys work bench 16.0. The test and trial on the conical mixer was done for 4 liter capacity and results were compared to the conventional planetary stirrer machine. The results are tabulated and comparative study of the results is presented in the paper and productivity of the sinusoidal mixer is presented in the paper

I. INTRODUCTION

In case of process industries, process of mixing and stirring forms an integral and the important part of the total manufacturing process. Mixing is the process which determines uniformity and overall quality of product. 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 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

II. PROBLEM STATEMENT

In conventional method of mixing the metal oxide powder and vehicle mixing is carried out on a vertical shaft mixer with a static mixer blade at the bottom, this machine the motor is driven on reduction gear box through coupling the output shaft of gear box is coupled to stirrer shaft to which the blades are connected, when the motor rotates output shaft of gear box rotates at slow speed. Thereby driving the stirrer. The stirrer rotates in one direction to agitate the mixture to prepare paint.

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.

III. OBJECTIVES

1. Design and analysis of components of wobble mixer components
2. Test and trial on the mixer for production of 4.0 litres of ferrous oxide paint, derivation of result as to viscosity (centistokes), spread-ability (mm), and quality of paint produced by mixer and its comparison to productivity over the conventional mixer of same capacity. Parameters of study
 - a) Reduction in cycle time of mixing
 - b) Improvement of viscosity and spread-ability
 - c) Productivity improvement owing to use of developed system



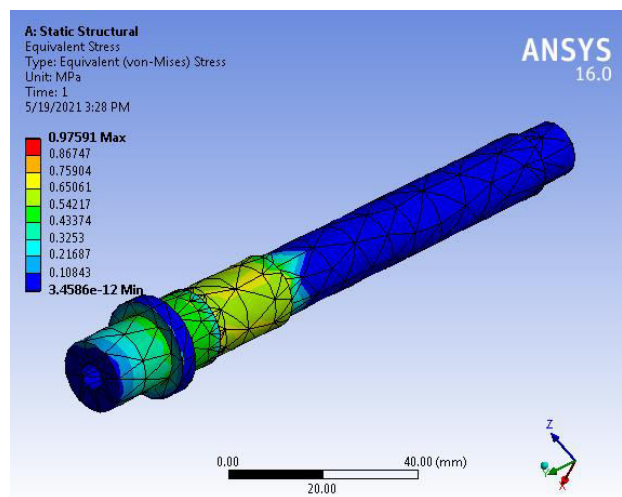
IV. METHODOLOGY

- a. **Market survey:** During this period detail market survey has been done to learn available mixing systems and their utility also their literatures of different types of mixing systems and its difference between have been observed.
- b. **Problems in existing systems:** The problems regarding the existing mixing system have been found such and thorough mixing is not attained by the conventional mixing.
- c. **Conceptual Design:** Taking problem statement from above and studying the fundamental engineering concepts various concepts regarding modified mixing system are prepared and amongst those best mixer design has been selected for further phases. Testing phase includes testing of the Prototype model under real environment.
- d. **Modeling in software:** Putting the ideas on the modeling Modeling of the components has been done using the Unigraphix software and the analysis of the components has being done using Ansys work bench 16.0.
- e. **Fabrication:** This phase includes fabrication of prototype in the workshop from the procured material and preparing the Prototype model from the software model.
- f. **Assembly & Testing:** This include Assembly of all the sub parts, also the arrangement of the motor and its wiring is done, all finishing operations like grinding, trimming, painting is done here. Testing phase includes testing of the Prototype model under real environment.

V. MODEL AND ANALYSIS

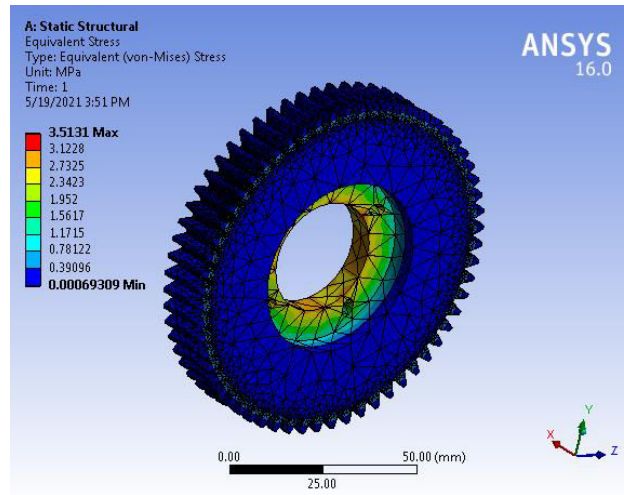
The components of the system were designed using theoretical method and the solid modeling was done using Unigraphix Nx and the Analysis of components is done using Ansys workbench 16.0 . The safety of the components has being attained through the combined theoretical and analytical design.

Design-Analysis- Worm-shaft



The maximum Von-misses stresses in the part are 0.975MPa which is far below the allowable value 104 MPa hence the part is safe

Design-Analysis- Worm-Wheel.



The maximum Von-misses stresses in the part are 0.975MPa which is far below the allowable value 104 MPa hence the part is safe

VI. EXPERIMENTAL WORK



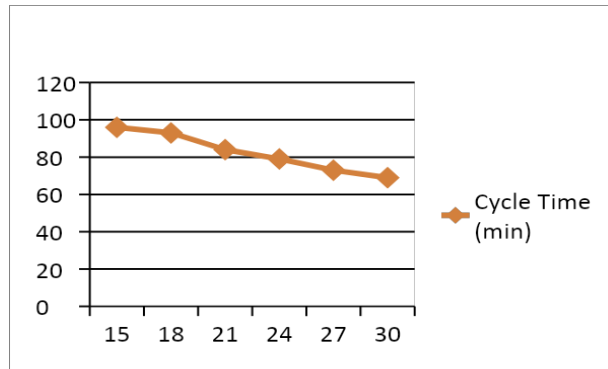
Testing with conventional mixer for cycle time

Procedure :

1. Container volume of vehicle and pigment is 4 litres filled
2. Stirrer motor is started and speed is set to desired rpm
3. Specimen viscosity target of 180 centistokes
4. The Ford cup viscometer is used to derive the viscosity of specimen paint
5. The cycle time to get 180 centistokes is noted.

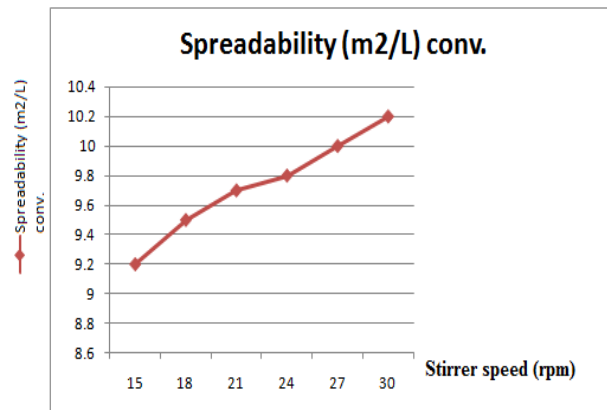


Graph of Cycle time (min) Vs Stirrer speed (rpm)



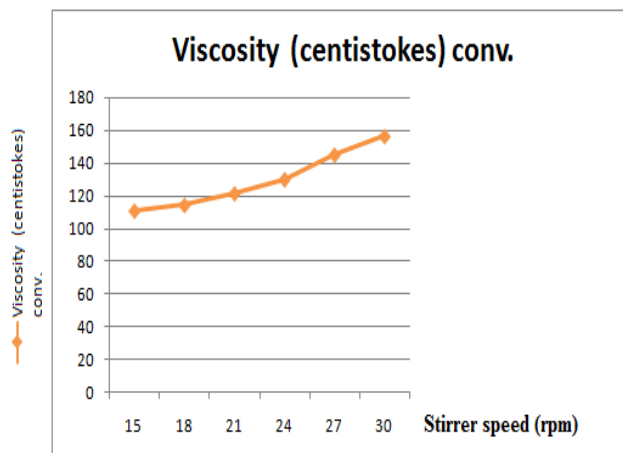
The cycle time to produce paint of viscosity of 180 centipoise is seen to decrease with the increase in the stirrer speed and the minimum cycle time of 69 min is observed at maximum stirrer speed of 30 rpm for conventional stirrer and maximum cycle time of 96 min is observed at minimum stirrer speed of 15 rpm

Graph of Spreadability (m²/L) Vs Stirrer speed (rpm)



The spreadability of paint is seen to increase with the increase in the stirrer speed and the maximum spreadability of 10.2 (m²/L) is observed at maximum stirrer speed of 30 rpm for conventional stirrer.

Graph of Paint Viscosity (centistokes) Vs Stirrer speed (rpm)





VII. RESULT AND DISCUSSION

1. Worm shaft is safe under torsional load as maximum theoretical stress is 0.88 MPa where as the analytical stress is 0.975 Mpa
2. Worm gear is safe under torsional load as maximum theoretical stress is 0.05 MPa where as the analytical stress is 3.51 Mpa.
3. The Viscosity of paint is seen to increase with the increase in the stirrer speed and the maximum viscosity of 156.3 centistokes is observed at maximum stirrer speed of 30 rpm for conventional stirrer.
4. The cycle time to produce paint of viscosity of 180 centipoise is seen to decrease with the increase in the stirrer speed and the minimum cycle time of 69 min is observed at maximum stirrer speed of 30 rpm for conventional stirrer and maximum cycle time of 96 min is observed at minimum stirrer speed of 15 rpm
5. . The spreadability of paint is seen to increase with the increase in the stirrer speed and the maximum spreadability of 10.2 (m²/L) is observed at maximum stirrer speed of 30 rpm for conventional stirrer

VIII. CONCLUSION

Worm gear is safe under torsional load as maximum theoretical stress is 0.05 MPa where as the analytical stress is 3.51 Mpa. The wobble mixer has been manufactured as per specification and testing will be done on the same to plot graphs as mentioned above. The Viscosity of paint is seen to increase with the increase in the stirrer speed and the maximum viscosity of 156.3 centistokes is observed at maximum stirrer speed of 30 rpm for conventional stirrer. The cycle time to produce paint of viscosity of 180 centipoise is seen to decrease with the increase in the stirrer speed and the minimum cycle time of 69 min is observed at maximum stirrer speed of 30 rpm for conventional stirrer and maximum cycle time of 96 min is observed at minimum stirrer speed of 15 rpm. The spreadability of paint is seen to increase with the increase in the stirrer speed and the maximum spreadability of 10.2 (m²/L) is observed at maximum stirrer speed of 30 rpm for conventional stirrer.

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