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Analysis and Performance Evaluation Wobble Mixer Machine

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ABSTRACT

The use of conventional mixers like the stirrers, cone mixer, paddle mixers, agitator mixers etc. in mixing of semi-solid or suspended solids in liquid vehicles is shown to be prone to problems of quality related to mixture viscosity and spread ability of mixture.

The paper discusses the development of kinematic linkage based mixture in form of wobble mixer. The testing was carried out to evaluated the performance of the developed unit. The viscosity (centi-stokes), Cycle time and spread ability are parameters considered for evaluation of performance of the developed unit. The developed mixer is also compared with the conventional mixer to prove the efficiency of the developed unit.

Keywords:— *Wobble mixer, Viscosity, Cycle time, Spread ability, Efficiency.*

I. INTRODUCTION

In case of process industries, process of mixing and stirring forms and integral and the important part of the total manufacturing process. Mixing is the process which determines uniformity and overall quality of product. The viscosity of the paint, spreadability of paint and cycle time were found to be significant parameters of study. Variety of devices were found to be used in testing of the viscosity of the fluid or produce ranging for viscometers such as Ford cup viscometer, Saybolt viscosity tester etc. Some of the researchers studied the viscosity through the flow pattern observation through optical spectrometry.

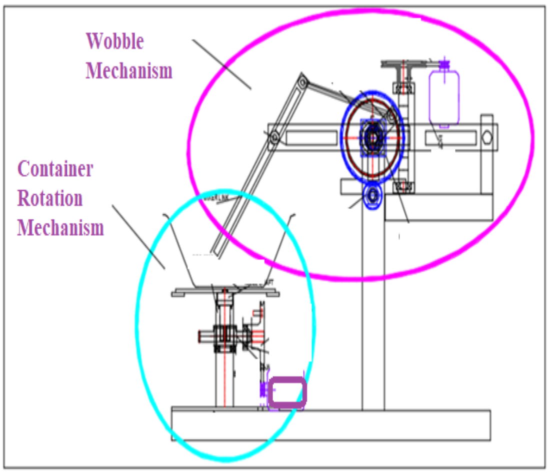

Figure 1: Design of Worm Shaft for wobble Mechanism

The components of the wobble mechanism namely the connecting rod and stirrer link are designed and analysis of these components is discussed below.

Analysis of connecting rod-1

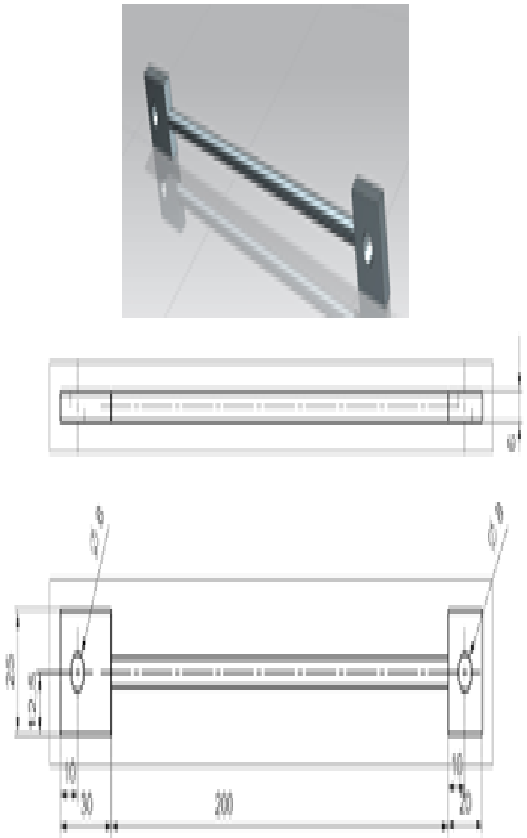

Figure 2: Connecting rod

Check for direct tensile failure of connecting rod

Tensile stress = Tensile Force/ Area

Shear force = 230 N

Area = π x 8^2 /4 = 50.2 mm^2

Shear Stress = 230/50.2 = 4.58 MPa

As the maximum stress 4.58 Mpa< Allowable stress …hence the connecting rod is safe.

Maximum Stress induced in connecting rod:

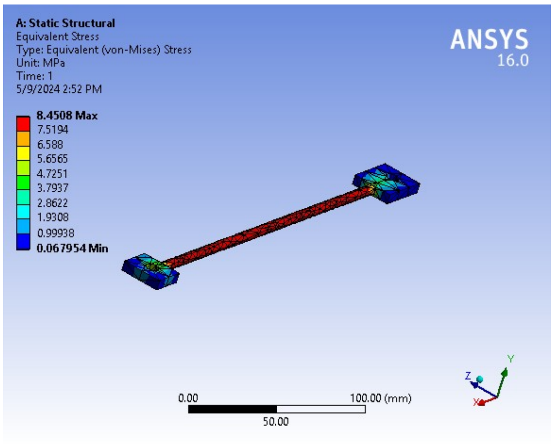

Figure 3: Analysis of connecting rod-1

The maximum Von-misses stresses in the part are 3.3163 MPa which is far below the allowable value 104 MPa hence the part is safe under given loading conditions.

Design and Analysis of Worm :

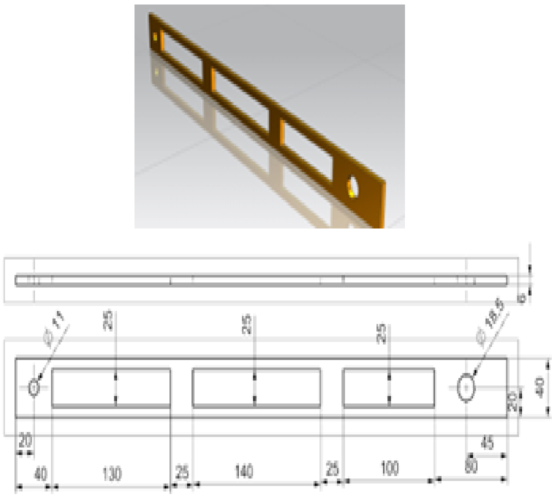

Figure 4: Analysis of Worm

Check for direct shear failure of slider link

Tensile stress = Tensile Force/ Area

Shear force = 230 N

Area = (40x6)- (25x6) = 90 mm^2

Shear Stress = 230/90 = 2.55 MPa

As the maximum stress 2.55 Mpa< Allowable stress …hence the slider link is safe

Maximum Stress induced in stirrer link :

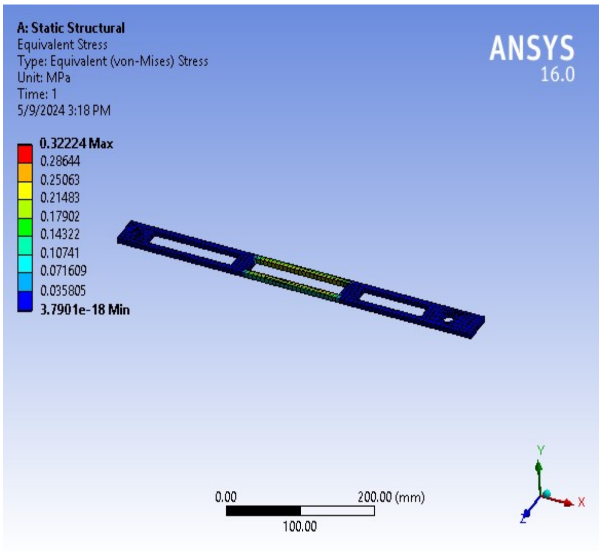

Figure 5: Maximum Stress induced in stirrer link

As the maximum stress induced in the stirrer link is 0.32 N/mm2 < allowable stress shows that the crank-1 is safe under given system of forces.

II. Testing and Comparison of Wobble Mixer

Equipment used for test and trial

Measurement of viscosity :

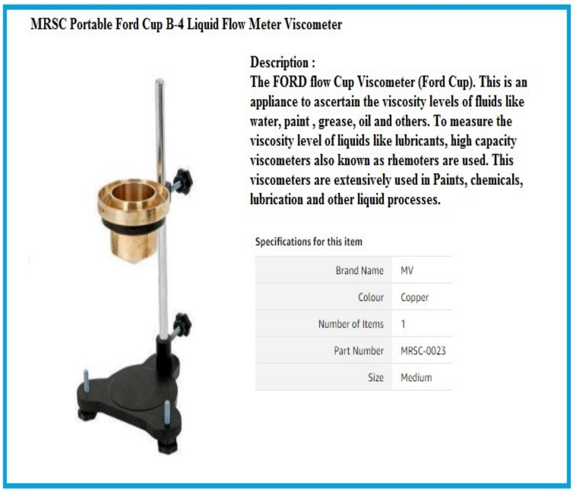

Figure 6: MSCRC Portable Ford cup B-4 Viscometer

The measurement of viscosity is done using Ford cup B-4, and time required to pass the content of the cup entirely is measured and noted as observation and this value of time is converted to viscosity in centistokes.

Measurement in stirrer shaft speed :

Figure 7: Depicting the digital tachometer for turbine speed measurement

Testing of Wobble mixer for viscosity

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 volume is tested after cycle time of 28 minutes
4. The Ford cup viscometer is used to derive the viscosity of specimen paint
5. The viscosity of paint in centistokes is determined using Ford cup viscosity conversion table.

Table 1: Observation table for Viscosity : Conventional mixer

Sr.No	Stirrer linkage speed (rpm)	Ford cup time(sec)	Viscosity (centistokes)
01	10	30	108.8
02	15	31	110.3
03	20	33	118.4
04	25	35	124.6
05	30	37	133.4
06	35	39	140.6

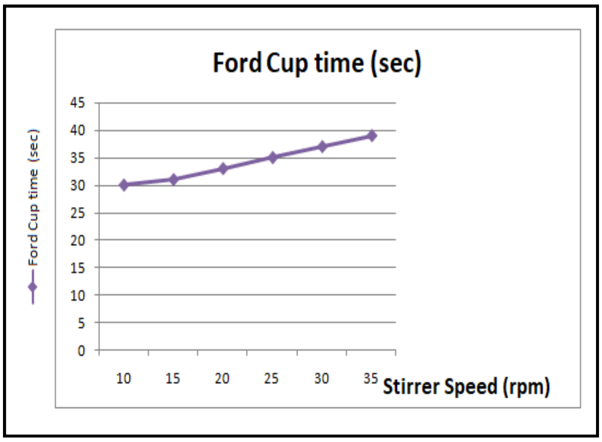

Figure 8: Ford cup time (sec) Vs Stirrer speed (rpm)

The Ford cup time (sec) is seen to increase with the increase in the stirrer speed and the maximum viscosity time of 39 seconds is observed at maximum stirrer speed of 35 rpm for wobble mixer.

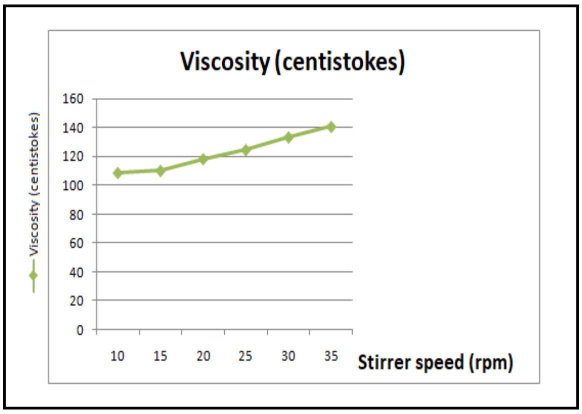

Figure 9: Paint Viscosity (centistokes) Vs Stirrer speed (rpm)

The Viscosity of paint is seen to increase with the increase in the stirrer speed and the maximum viscosity of 140.6 centistokes is observed at maximum stirrer speed of 30 rpm for conventional stirrer.

Testing with Wobble 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 140 centistokes
4. The Ford cup viscometer is used to derive the viscosity of specimen paint
5. The cycle time to get 140 centistokes is noted.

Observation table for Cycle time : Wobble mixer

Table 2: Observation table for Cycle time : Conventional mixer

Sr.No	Stirrer Speed (rpm)	Cycle time (min)
01	10	46
02	15	41
03	20	38
04	25	34
05	30	31
06	35	27

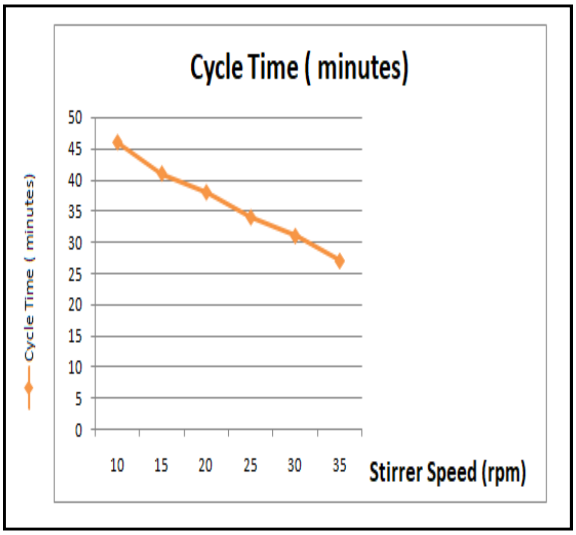

Figure 10: Cycle time (min) Vs Stirrer speed (rpm)

The cycle time to produce paint of viscosity of 140 centipoise is seen to decrease with the increase in the stirrer speed and the minimum cycle time of 27 min is observed at maximum stirrer speed of 35 rpm for wobble mixer and maximum cycle time of 46 min is observed at minimum stirrer speed of 10 rpm.

Testing with conventional mixer for spreadability Test standards :IS 101-4-1 (1988)

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 volume is tested after cycle time of 28 minutes
4. The spreadability set up as perIS 101-4-1 (1988): Methods of Sampling and Test for Paints,

Varnishes and Related Products of specimen paint is determined observation table for spreadability : Conventional mixer

Table 3: Observation table for spreadability :Wobble mixer

Sr.No	Stirrer speed (rpm)	Spreadability m2/L
01	10	9.1
02	15	9.3
03	20	9.6
04	25	9.8
05	30	10.1
06	35	10.35

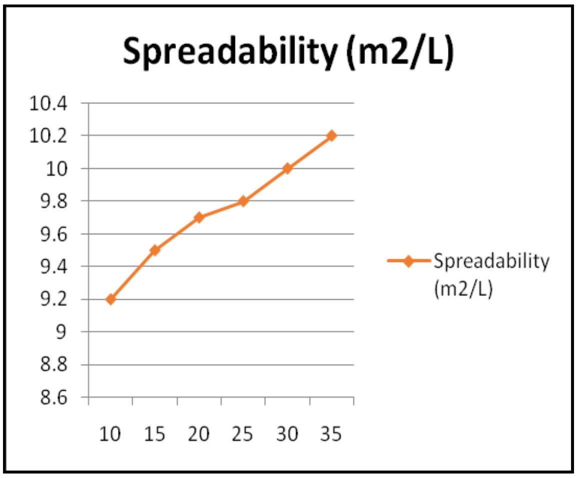

Figure 11: Spreadability (m2/L) Vs Stirrer speed (rpm)

The spread ability of paint is seen to increase with the increase in the stirrer speed and the maximum spread ability of 10.35 (m^2/L) is observed at maximum stirrer speed of 35rpm for conventional stirrer.

III. Result and Discussion

The components of the Wobble mixer have been designed theoretically and analysis was carried out using Ansys Workbench 16.0 and all parts were found to be safe.

The Ford cup time (sec) is seen to increase with the increase in the stirrer speed and the maximum viscosity time of 39 seconds is observed at maximum stirrer speed of 35 rpm for wobble mixer.

The Viscosity of paint is seen to increase with the increase in the stirrer speed and the maximum viscosity of 140.6 centistokes is observed at maximum stirrer speed of 30 rpm for conventional stirrer.

The cycle time to produce paint of viscosity of 140 centipoises is seen to -decrease with the increase in the stirrer speed and the minimum cycle time of 27 min is observed at maximum stirrer speed of 35 rpm for wobble mixer and maximum cycle time of 46 min is observed at minimum stirrer speed of 10 rpm

The spreadability of paint is seen to increase with the increase in the stirrer speed and the maximum spreadability of 10.35(m^2/L) is observed at maximum stirrer speed of 35rpm for conventional stirrer.

IV. Conclusion

In conclusion, the Wobble Mixer Machine presents a highly efficient, versatile, and cost-effective solution for industries that require high-quality, homogeneous mixtures. With its advanced mixing technology, it offers notable advantages over traditional mixing methods, contributing to greater operational efficiency and product quality.

The wobble mixer linkage component design and analysis was done and the components were found to be safe. After the development and fabrication of the unit, the unit was tested tested for performance evaluation of the same.

The unit showed improvement in the performance parameters of viscosity, cycle time and spread ability. The comparison of the wobble mixer with the conventional mixer also revealed its superior performance.

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