Study and Design Of Damper for Reducing Vibrations Using Mr Fluid

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Abstract- *In recent decades researchers are attracted towards magneto-rheological damper, eddy current damper etc. because of their quick response. Conventional damper has limitations like comparatively slow response than Electro-rheological fluid and Magneto-rheological fluid. MR fluids are materials which give response to magnetic field by changing its rheological behaviour, because of quick response MR fluid has wide applications in industries[1]. Once magnetic field applied it induces dipole in each of magnetic particle and solidifies. The change in viscosity completely reversible when magnetic field removed. There are many applications of MR fluid such as mechanical damper, brakes and clutches, seismic protection of buildings, household applications etc.[6] MR fluid is prepared by using magnetisable particle carrier fluid and additives in proper proportion. selection of coil by trial & error method and experimentation. Vibration analysis graphs are plotted with the help of NI instrument.*

Keywords- MR Fluid, Magneto-rheological damper, comparison of MR and Viscous fluid, Solenoid.

I. INTRODUCTION

Modern damping techniques focus on safety, comfort and environmental protection. Role of suspension or isolation system is very crucial in industries and automobile sector. The mechanical suspension system includes mainly spring, mass, damper. Damper is one of the important parts in suspension system, it required for vibration reduction. Magneto-rheological damper is semi-active type control system. Semi-active consists of spring, dampers and value of damper coefficient can be controlled. According to a customer requirement semi-active damper change their damping force in real time. [7].

In latest category, rheological effect of controllable fluids such as magneto-rheological or electro-rheological fluid is used to provide adjustable damping forces. In past few years theologically controllable damper have received more attention because great advances in magneto-rheological fluid

Therefore, it is found that performance of electromagnetic damper depend on electrical parameters like flux density, axial distance between solenoid coil, current etc. This electromagnetic damping technique eliminates limitations of viscous damper which exist in conventional suspension system.

II. LITERATURE REVIEW

Magneto- rheological (MR) fluid is one of the smart materials available. Literature review gives idea about MR fluid and its properties. Given reports gives brief information about limitations of existing dampers and innovative applications of MR fluid explained in brief.

ZAMM .Z .angew et al. [1] had given that MR fluid gives sufficient strong electric or magnetic field within millisecond from liquid semi solid state.

Mr. B. K. Kumbhar et al. [3] had given properties and selection criteria for MR fluid.

Mark R. Jolly et al. [4] had presented and discussed rheological and magnetic properties of various commercial MR fluids. In the paper composition of different MR fluid were studied. Fluid viscosity is significant function of the composition and chemistry of the carrier oils.

N.M. Wereley et al. [5] had analyzed Bidisperse MR fluid which is the combination of micron size particles and nano particles. Increase in the weight percentage of nano particles in the MR fluid increases the time to mud line formation, showing that the bidisperse fluids are capable of maintaining the suspension for longer periods of time.

Pranav Gadekar et al. [6] had investigated various applications of Magneto-Rheological fluid like MR dampers in automotive industries, damper for seismic protection of buildings, in household application such as washing machine.

M.M.Rashid et al. [7] had investigated the effect of damper for suspension control. The damping coefficient of the MR damper in terms of input current, displacement amplitude and frequency are examined

III. METHODOLOGY

Magneto-rheological fluid has property of solidification of fluid in vicinity of magnetic field when current and voltage passes through coil. Preparation of MR fluid is done by mixture of iron particle (35%), carrier fluid (64.5%) and additive (0.5%) by continuous stirring for 8hrs. [3][5][8] Initially designing of setup is done with help of solid works. Then calculations regarding various components involved in it like main coil, piston, cylinder etc are done. By trial and error method solenoid coil is selected from calculations and testing the effect of magnetic field.

Design of solenoid coil:-

Following figure shows schematic construction of solenoid. It includes coated copper wire, core material and source of electric current. Current passes through the winded copper wire that produces magnetic field. Direction and alignment of magnetic flux lines are as shown in figure 2.1

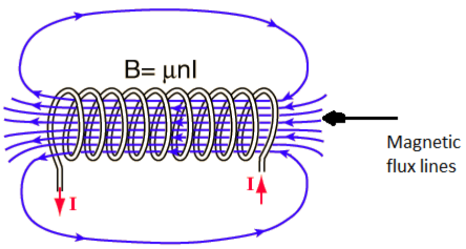


Fig.2.1: Representation of magnetic flux lines.

Magnetic flux density given by following formula [2]

$$B = \frac{\mu_r * \mu_o * N * I}{L} * 10000$$

- Where, B=magnetic field

μr=Relative permeability=100
$(\mu)_0$= 1.256*10ˆ(-6)
N= No. of turns =170
L=core length =0.02m
I=current = 1 A

B=1062.5 gauges

Table 2.1: Calculations for Selection of no.of turns

No. of turns	Current	Length	Permeability	gauss power
110	2	0.02	0.0000125	1375
120	2	0.02	0.0000125	1500
130	2	0.02	0.0000125	1625
140	2	0.02	0.0000125	1750
150	2	0.02	0.0000125	1875
160	2	0.02	0.0000125	2000
170	2	0.02	0.0000125	2125
180	2	0.02	0.0000125	2250
190	2	0.02	0.0000125	2375
200	2	0.02	0.0000125	2500

From the all above theoretical calculations, designed solenoid coil has following configurations.

Inner radius of coil -: 10 mm
Length of solenoid coil -: 30 mm
Copper wire -: 24 Gauge, insulated
Wire diameter 0.511 mm
No of turns -: 170turns

Insulated copper wire was wound on metal core (MS round pipe 75mm ID, 7cm long). Wornish solvent was added while wounding to fill up the air gaps between wires which serves as coolant also

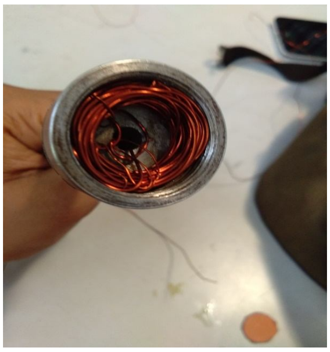


Fig 2.2: Designed solenoid coil

Design and development of damper assembly

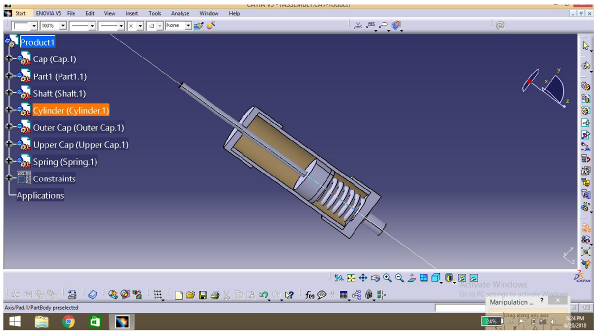


Fig 2.3 Cross section of piston cylinder assembly

Dimensions of piston cylinder are derived from main spring which is standard suspension spring of two wheeler vehicle BAJAJ PLATINA

Dimensions of Piston:

Inner diameter (Di) =22mm
Outer diameter (Do) =28mm
width of piston =13mm
Length of piston rod=120mm

Dimensions of Cylinder:

Diameter=30mm
Length =160mm

Assembly of components

Following assembly shows all parts of like piston, cylinder, core etc.

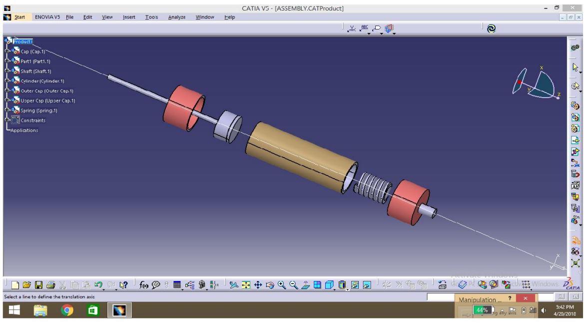


Fig. 2.4 Inline assembly of component

Actual test setup

Experiments are performed on above setup which comprises D.C. motor (0.5KW) to which eccentric mass is connected. To supply controlled voltage dimmer stat is connected to dc motor. Accelerometer is connected to set up for recording vibrations produced. With the help of NI instrument graphs are recorded. Experiments are performed on setup within the range of 100 to 400 RPM with interval of 50 RPM. Voltage is supplied up to 12V with step of 4V.

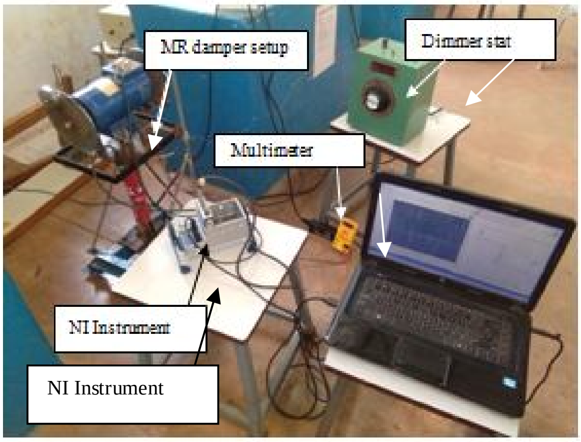


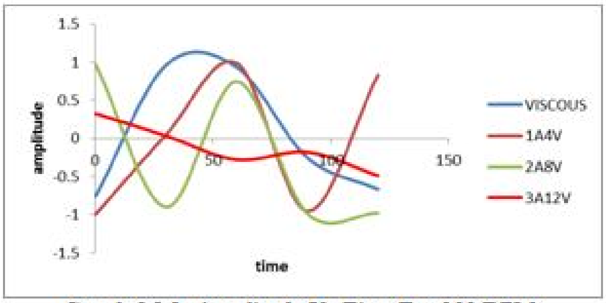
Fig 2.5 Experimental setup

IV. PRACTICAL OBSERVATIONS

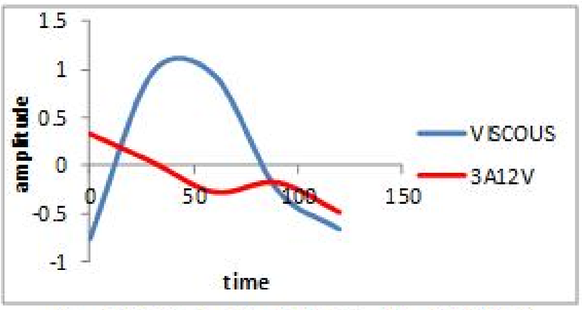
Amplitude Vs Time graphs were plotted with data acquired from NI instrument.

Table3.1: Readings of 100 RPM

	Amplitude			
TIME	viscous	1A4V	2A8V	3A12V
0	-0.76362	-0.99638	0.979112	0.32843
30	0.962928	0.05054	-0.89783	0.035994
60	0.935344	0.989811	0.747269	-0.27803
90	-0.251	-0.94961	-0.98503	-0.177
120	-0.6648	0.832513	-0.97629	-0.48804



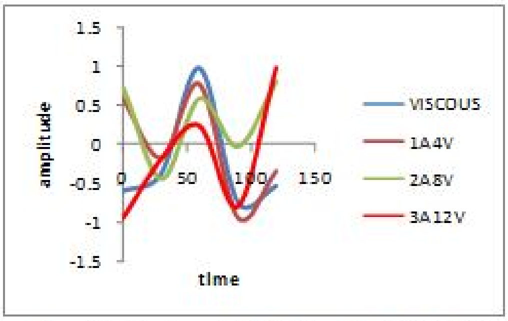
Graph 3.1.1: Amplitude Vs Time For 100 RPM



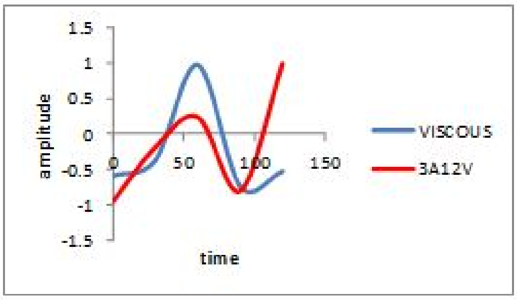
Graph 3.1.2: Amplitude Vs Time For 100 RPM

Table3.2: Readings of 200 RPM

	Amplitude			
TIME	viscous	1A4V	2A8V	3A12V
0	-0.5957	0.585198	0.747122	-0.95619
30	-0.37279	-0.1773	-0.43964	-0.18789
60	0.979671	0.774887	0.599925	0.241756
90	-0.74007	-0.94811	-0.02171	-0.80718
120	-0.5308	-0.34645	0.812742	0.99319



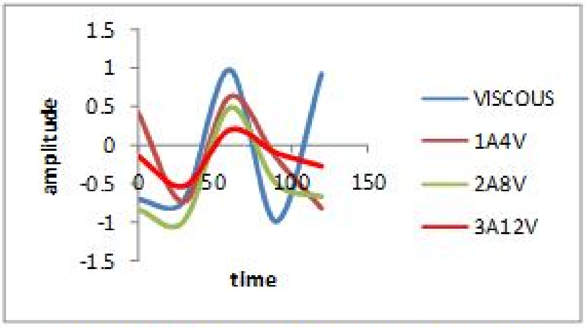
Graph 3.2.1: Amplitude Vs Time For 200 RPM



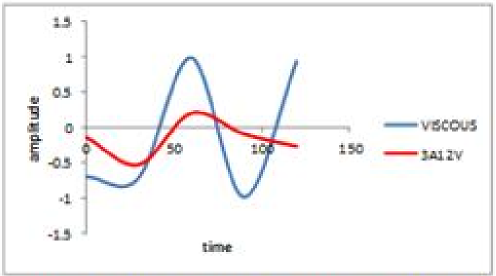
Graph 3.2.2: Amplitude Vs Time For 200 RPM

Table 3.3: Readings of 300 RPM

	Amplitude			
TIME	viscous	1A4V	2A8V	3A12V
0	-0.70273	0.425615	-0.83584	-0.14298
30	-0.7194	-0.7379	-0.9826	-0.52996
60	0.986671	0.63942	0.481544	0.199595
90	-0.99288	-0.15589	-0.49647	-0.09686
120	0.934083	-0.81955	-0.67021	-0.26936



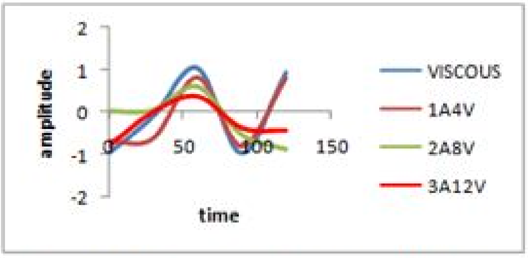
Graph 3.3.1: Amplitude Vs Time For 300 RPM



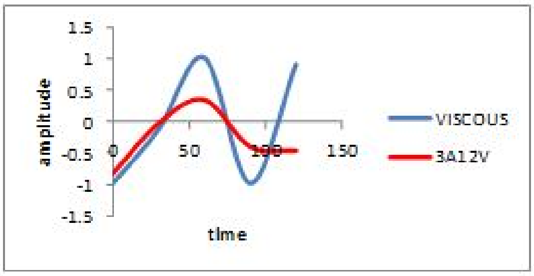
Graph 3.3.2: Amplitude Vs Time For 300 RPM

Table3.4: Readings of 400 RPM

	Amplitude			
TIME	Viscous	1A4V	2A8V	3A12V
0	-0.98537	-0.69651	0.024115	-0.82895
30	-0.11808	-0.63347	0.040594	-0.02036
60	1.02555	0.821717	0.599882	0.353348
90	-0.9846	-0.81359	-0.53935	-0.39835
120	0.920796	0.812172	-0.8816	-0.45932



Graph 3.4.1: Amplitude Vs Time For 400 RPM



Graph 3.4.2: Amplitude Vs Time For 400 RPM

From all above graph we can conclude that as current and voltage increases magnetic flux also increases and aligning strength of MR fluid increases. So MR fluid solidifies in milliseconds and damp vibration quickly. Effective result can be observed in graph of amplitude Vs Time for viscous and MR fluid when current is 3A and voltage is 12 V.

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V. CONCLUSION

The purpose of study was to compare both viscous and MR damper. From the experimentation it can be concluded that As current and voltage increases viscosity of MR Fluid also increases with increasing alignment strength of MR fluid. When current and voltage passes through fluid, iron particles gradually align and strength of MR fluid increases. Because of this property of particle alignment in magnetic field, MR fluid gives better damping effect in vibrating surrounding and damped the vibrations in milliseconds. By using MR fluid comfort conditions can be achieved smartly and efficiently. It can be give better damping effect if voltage will increase above 12V.

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