A Comparison of the Performance MR Fluid Damper Using Nano and Micro Ferrous Particles

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Abstract - **Magneto-Rheological (MR) dampers are semi- active control devices that use MR fluids to produce controllable dampers. They potentially offer highly reliable operation and can be viewed as fail-safe in that they become passive dampers if the control hardware malfunction. The advantage of MR dampers over conventional . The rheology of the MR fluid has to increase sufficiently and the agglomeration of the particles have to be minimal for an ideal MR Fluid Damper. The paper presented here discusses the performance of size based ferrous nano particles.**

Key Words: MR Fluid Damper; Rheology; nano ferrous

I. INTRODUCTION

Magnetorheological fluids (or simply “MR” fluids) belong to a class of controllable fluids that respond to an applied field with a dramatic change in their rheological behavior.[1-4] The essential characteristic of MR fluids is their ability to reversibly change from free flowing, linear viscous liquids to semi-solids having a controllable yield strength in milliseconds when exposed to a magnetic field. Normally, this change is manifested by a very large change in the resisting force of dampers in which MR fluid is used. These fluids are suspensions of micron-sized, magnetizable particles in an appropriate carried liquid.

MR fluids are free flowing liquids having a consistency similar to that of motor oil. However, in the presence of an applied magnetic field, the particles acquire a dipole moment aligned with the external field that causes particles forming linear chains parallel to the field. This phenomenon can solidify the suspension and restrict the fluid movement. Consequently, yield stress is developed. The primary advantage of MR fluids stems from their high dynamic yield stress due to the high magnetic energy density that can be established in the fluids.[5-6] A yield stress of nearly 100kPa can be obtained for MR fluids with magnetic suspensions containing carbonyl iron powder.

II. Preparation of Nano Ferrous

Fine particles of Fe_3o_4 are prepared by co-precipitating aqueous solution of di- ammonium ferrous sulphate and ferric chloride mixture respectively in alkaline medium. They are mixed in respective psychometry (1:2).The Mixture is heated to 80˚C and then it is added to boiling solution of sodium hydroxide under constant stirring. The solution is maintained at 150˚C for six hours. Ferrous particles is continuously washed with distilled water and dried at 100˚C for one hour. This results in nano ferrous roughly to the order of 100-200 nm as ascertained by SEM images.

III.Preparation of MR Fluid

In the preparation of MR fluid, 5gms (or 5.26ml) of white grease is added to 55 gm(60.7ml) of Silicon oil. The composition is stirred at a speed of 400rpm at room temperature, for approximately 4 hours. 150gms (or 49.6ml) of Iron powder of size 20 microns is added (39% Weight Composition) is added to the above mixture. This mixture is then manually stirred for 4 hours. After stirring, the mixture is kept aside for a few hours to settle down and sediment itself. The resulting mixture is MR fluid, having Non-Newtonian properties.

IV. WORKING OF MR FLUID

The magnetic particles, which are typically micrometer scale spheres or ellipsoids, are suspended within the carried oil are distributed randomly and in suspension under normal circumstances, as below.

When there is no magnetic field, the magnetic particles are suspended in the carried oil randomly. It continues to remain in this fluid state for as long as the magnetic field is not applied.

When a magnetic field is applied, however, the particles align themselves along the lines of magnetic flux. When the fluid is contained between two poles, the resulting chains of particles restrict the movement of the fluid, perpendicular to the direction of flux, effectively increasing its viscosity. It is crucial to ensure that the lines of flux are perpendicular to the direction of the motion to be restricted.

The term “magnetorheological” comes from this effect. Rheology is a branch of mechanics that focuses on the relationship between force and the way a material changes shape. The force of magnetism can change both the shape and the viscosity of MR fluids.[7-9]

V. Experimental Setup

Initially the readings are taken without electric current. The quarter car (Fig 1) setup along with the MR damper is mounted on the shaker machine.[10-12] The Shaker machine (Exciter) is turned on. The frequency is set using the Power Amplifier. The plates on the shaker machine starts to vibrate and the piston movement is brought about in the MR damper. The accelerometer that is placed on the top plate senses the vibrations and sends a signal to the computer, via the data acquisition card. Using the LabVIEW software, the vibrations are observed and recorded. (Fig 2)

Fig 1 Quarter Car Model

Now the coil windings coming out of the piston rod are connected to two terminals of the DC power supply. The DC power supply is turned on and the current is adjusted to 0.2amps. Again, the power amplifier that is connected to the shaker machine is adjusted for 2Hz. The plates on the shaker machine begin to vibrate and the piston movement is arrested better as the MR fluid inside the damper has changed its properties and attains a solid state. The accelerometer that is placed on the top plate senses the vibrations and sends a signal to the computer, via the data acquisition card. (Fig 2) Using the LabVIEW software, the vibrations are observed and recorded. (Fig 3 and Fig 4).

Fig 2 Experimental Set up

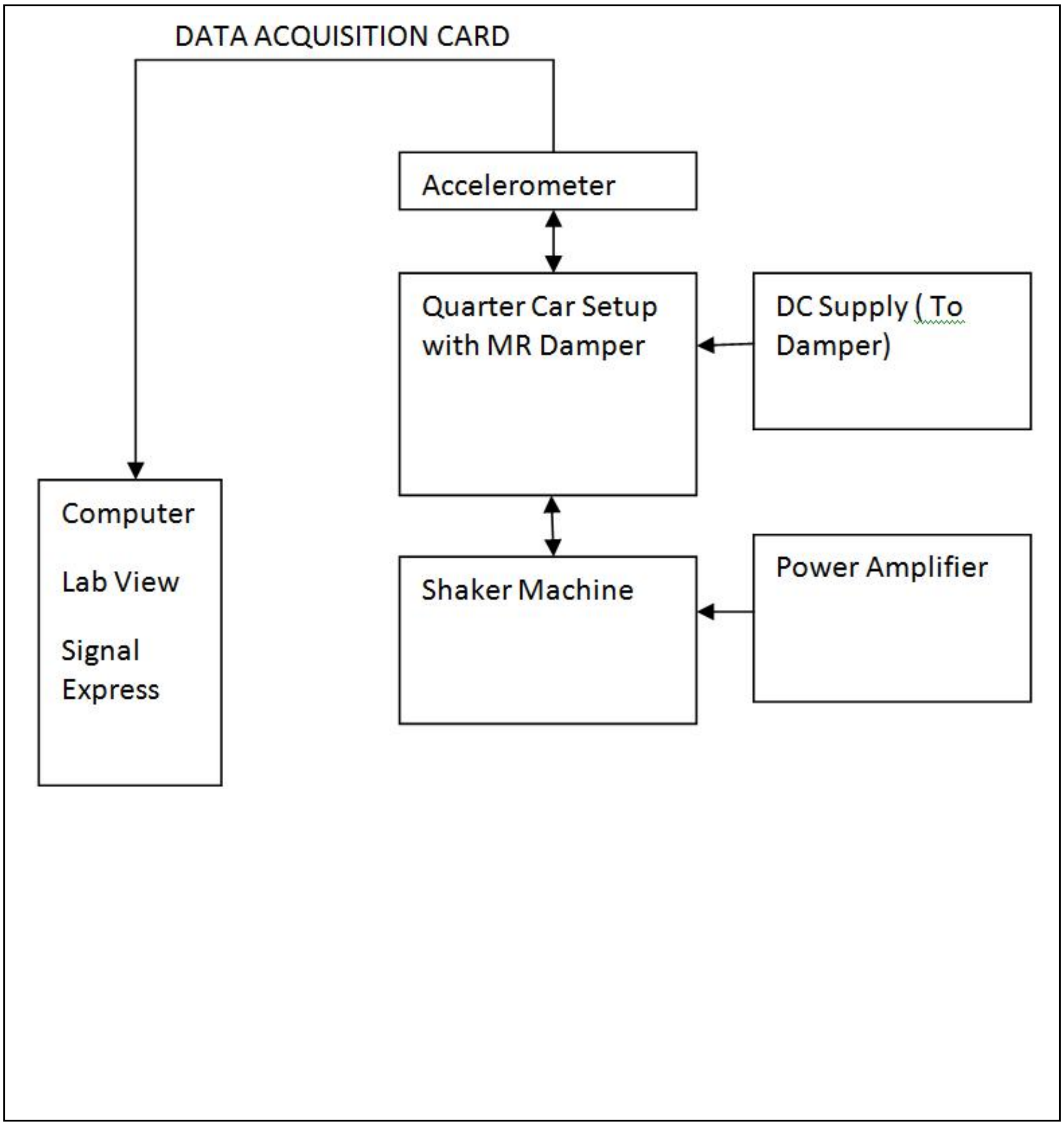


Fig 3 2 Hz without electric current

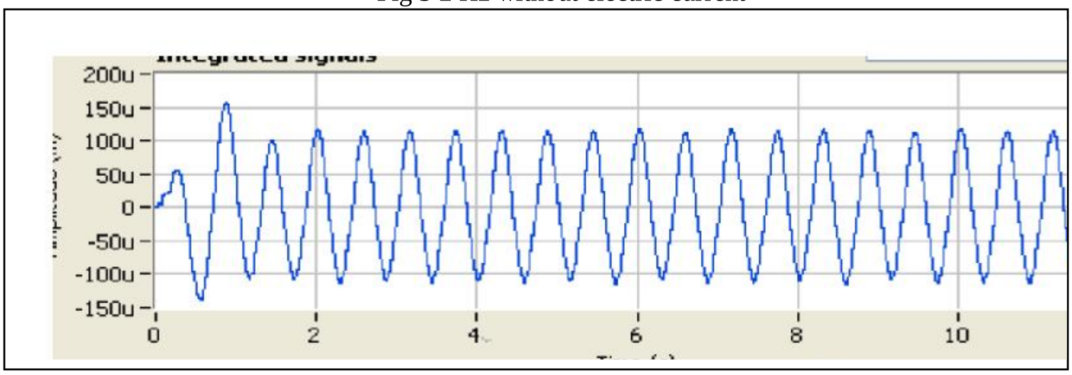
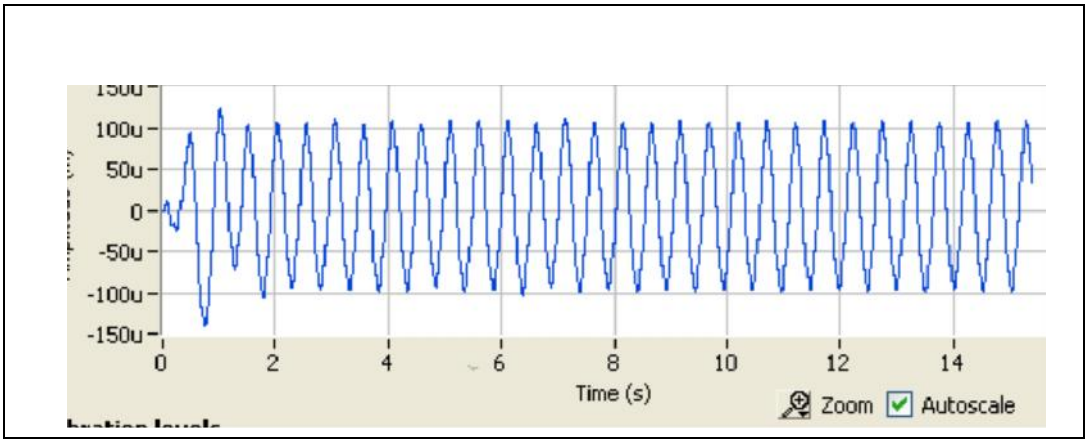


Fig. 4 2Hz, with 0.2A and 1.7V



VI. Conclusion

It has been observed that when the particle size was in the micron levels, the sedimentation rate was very high as a result of agglomeration. This agglomeration was considerably reduced when the particle size was in nano meters. This overall observation is expected to improve the performance of the MR Fluid. Further XRD studies are to be carried out. Studies based on the Hysteresis behaviour at various currents and particle sizes are to be carried out**.**

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