Review on Electromagnetic Shock Absorber using Magnetorheological Fluid

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Abstract—One of the main criteria of any vehicle suspension is the shock absorber which is used to absorb vibration. Description of a vehicle such as driving comfort and control over a vehicle are mainly decided by the suspension system which transmits forces between vehicle and road. In this case for controlled suspension Magnetorheological fluid is employed. Magnetorheological fluid consists of magnetic particles of micron size which are suspended in a carrier fluid like oil. Magnetorheological fluid has the capability to change its viscosity as the surrounding magnetic field changes. Like the conventional suspension systems, electromagnetic shock absorber also has no mechanical valves or small moving element that can wear out.

Key words: Magnetorheological Fluid, Electromagnetic Shock Absorber

I. INTRODUCTION

For any suspension system its main function is to reduce impacts. Over a period of time the routine suspension systems has transformed a lot [6]. In most dashpots, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid will heat up, while in air cylinders, the hot air is usually exhausted to the atmosphere[1]. In addition to carrying the load of the vehicle it also tries to decrease or remove vibrations arising from the road surface irregularities and aerodynamic forces. And it also reduces vibration due to steering, braking and non-uniformity of tyre/wheel assembly. The conventional shock absorber cannot meet these requirements appropriately. This has increased the use of Active/semi active suspension system. And this increase in the use of active/semi active suspension has led to growth of magnetorheological fluid.

II. BASICS OF MR FLUID

Magneto rheological fluid was first discovered by jacob rabinow in 1940's. Magneto rheological is a class of smart materials which contains low viscosity oil. As magnetorheological fluid is having low viscosity and high yield stress it is being used in automobiles as shock absorber fluid[4].

III. PREPARATION OF MR FLUID

MR fluid is a fluid which is having a low viscosity property, which is being converted into high viscosity by passing current through it. In order to make MR fluid we require two components that is mechanical stirrer and beaker. MR fluid consist of paraffin oil / silicon oil as a carrier fluid , grease as an additive, iron particles of micron size as magnetic particles and citric acid as a surfactants which helps to slow down settling of iron particles[7].

First of all low viscosity silicon oil / paraffin oil is mixed with all-purpose grease in very small concentration using a mechanical stirrer. This stirring is done for about one hour continuously till it is seen that the grease is totally dissolved in the oil.

After, that adds iron particles of micron size in the above mixture with the help of mechanical stirrer for some time. The percentage of iron particles added to the mixture is 20-30% of the total MR fluid prepared.

Also in these , MR fluid preparation we can add citric acid in order to slow down the settling period of iron particles

In this way we can prepare MR fluid whose property is 92-95% equivalent to commercially available MR fluid.

IV. DAMPER

The main function of damper is to control the transient behaviour of sprung and unsprung masses of the vehicle. It is also known as shock absorber. A damper has a piston which moves inside a sealed oil filled cylinder with up and down movement of the wheel. The sprung mass is the mass supported by suspension i.e. half the mass of suspension members. The unsprung mass includes wheels, brakes, splindles and other half of the mass of suspension member.[4]

V. ELECTROMAGNETIC PISTON

As the viscosity of magneto rheological fluid increases in presence of magnetic field. There are possibly two ways to create magnetic field i.e. through permanent magnet or by using electromagnet. An electromagnet is preferable because of its variable magnetic field which can be produced by varying the current. The main component of shock absorber is spring, cylinder and piston. The component in MR shock absorber is spring, cylinder and piston with electromagnet assembly. The position of electromagnet can be vary according to cylinder design ,it can be installed on top and bottom of the cylinder rather than on piston. To make electromagnet on piston, copper wire winding is to be done.
on piston and wire should be connected to battery to produce magnetic field. The magnetic field created will depend on the number turns of copper winding and ampere of current flowing through it. Moreover piston should have orifices for the passage of fluid through it.

![Electromagnetic Piston](image)

**VI. WORKING OF FLUID**

Magnetorheological (MR) fluids are suspensions of micron-sized magnetisable particle disperse in a nonmagnetic carrier fluid. The essential characteristic of these materials is that they can be rapidly and reversibly varied from the state of a Newtonian-like fluid to that of a stiff semisolid with the application of a moderate magnetic field [7]. The dampers are filled with magnetorheological fluid, which is a mixture of iron particles in hydrocarbon oil. The damper consists of a piston, which has electromagnetic coil windings and small fluid passages through it. Across the fluid passages, the electromagnets can create a variable magnetic field. The fluid travels freely through the passage when the electromagnets are turned off. However, when the electromagnets are turned on, the iron particles present in the oil start attracting each other and create a fibrous structure. This fibrous structure of iron particles results in increase in viscosity of the fluid resulting in stiffer suspension. By varying the current strength, the fluid viscosity varies accordingly and so does the shock absorption capacity.

![Magnetorheological fluid behaviour](image)

**VII. CONCLUSION**

After studying many research papers, gathering information through internet and discussing on various shock absorbers. We concluded that a smart fluid known as magnetorheological fluid whose viscosity can be change by varying magnetic field can be employed in place of hydraulic oil in hydraulic shock absorber with some changes in design to increase riding comfort and to have better control.

**REFERENCES**