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Concept of Electromagnetic Shock Absorber using Magnetorheological Fluid

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Abstract: One of the important part of vehicle suspension is the shock absorber which is used to reduce shock impulse. Characteristics such as ride comfort and handling of a vehicle are mainly determined by the suspension system which transmits forces between vehicle and road. This paper deals with electromagnetic shock absorbers which is the future of suspension system. An electromagnetic shock absorber uses magnetic energy which can be actively controlled according to our requirement. In this case Magnetorheological fluid is used for controlled damping. Magnetorheological fluid is composed of nano magnetic particles which are suspended in a carrier fluid like oil. Magnetorheological fluid has the ability to change its viscosity according to the surrounding magnetic field. Like the traditional suspension systems, electromagnetic shock absorber also has no mechanical valves or small moving parts that can wear out.

Keywords: Electromagnetic shock absorber, suspension system, active control, Magnetorheological fluid.

I. INTRODUCTION

The main function of the suspension system is to reduce impacts. Over a period of time the methods on damping suspension systems have changed a lot. Magnetorheological shock absorbers have a very simple structure. They are no different in structure to the previous hydraulic shock absorber models, except that the fluid used in the oil reservoir which is a special fluid whose viscosity can be controlled by a magnetic field. The function of suspension system is to provide shock absorption in automobiles. Besides carrying the weight of the vehicle it attempts to minimize or eliminate vibrations that may be induced by variety of sources including road surface irregularities, aerodynamic forces, forces induced due to steering and braking and non uniformity of tyre/wheel assembly. Ordinary passive shock absorber cannot meet these requirements properly. Thus the use of active/semi active suspension has increased. Hence the increase in the use of active/semi active suspension has led to development of magnetorheological fluid.

The paper describes the modeling of electromagnetic shock absorbers using magnetorheological Fluid. Instantaneous variation of damping force is possible with introduction of magnetorheological damper. Magnetorheological fluid is composed of nano magnetic particles which are suspended in a carrier fluid like hydrocarbon oil. Magnetorheological fluid has the ability to change its viscosity according to the surrounding magnetic field. By this property of magnetorheological fluid the yield stress of the fluid can be controlled by varying magnetic field intensity. Hence we obtain controlled damping. It is obvious that the shock absorption would be better using controlled damping rather than fixed damping obtained from ordinary hydraulic shock absorbers.

II. MODEL SUMMARY

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.

III. CONSTRUCTION AND WORKING

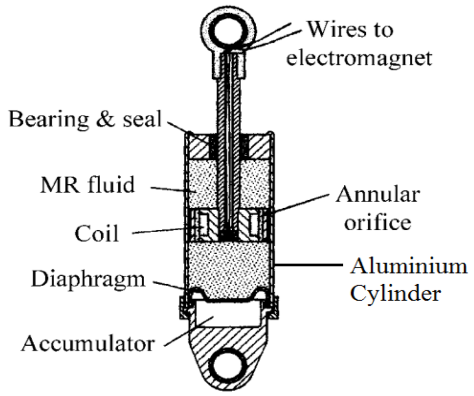

Fig. 1: Model cut-section.

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Shock absorbers are attached at the end of the piston rod. The oscillating movements of suspension force the magnetorheological fluid through the minute holes inside the piston.

However, only small amount of fluid is forced inside the piston. The insertion of fluid reduces the speed of the piston which in turn slows down the piston, resulting in slowing down of spring and suspension movement. The following figure gives the enlarged view of the electromagnetic piston. The standard dimensions are also provided accordingly.

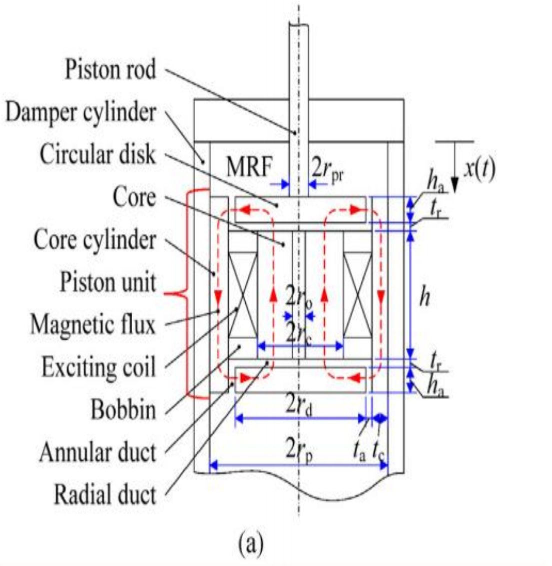

Fig. 2:Electromagnetic piston.

Rheology is a science that studies the deformation and flow of materials. Rheological fluids have flow characteristics that can be changed in a controllable way using electrical current or a magnetic field. In this model of Electromagnetic suspension the magnetorheological fluid plays a very vital role. As stated earlier, magnetorheological fluids are generally oils with suspended iron particles. These iron particles comprises of 20 to 40 percent of fluids volume.

Iron particles are tiny measuring between 3 and 10 microns. However, they have a powerful effect on fluid consistency. When exposed to magnetic field the particles line up, thickening the fluid dramatically.

The term "MAGNETORHEOLOGICAL" comes from this effect. The force of magnetism can change both the yield stress and the viscosity of magnetorheological fluids. This property of magnetorheological fluids is utilized for controlled damping.

The figure below depicts how the iron particles in the fluid interact with the magnetic field.

Such an alignment of iron particles inside the holes of the electromagnetic piston creates restriction to the flow of the fluid. The change in yield stress and viscosity of the fluid results in damping. Here electromagnetic coil is incorporated into the piston and the reservoir is filled with magnetorheological fluid. With the application of current through the wire leads, a magnetic field is developed in the piston orifice. It is in this form that they have served as solutions to many engineering challenges.

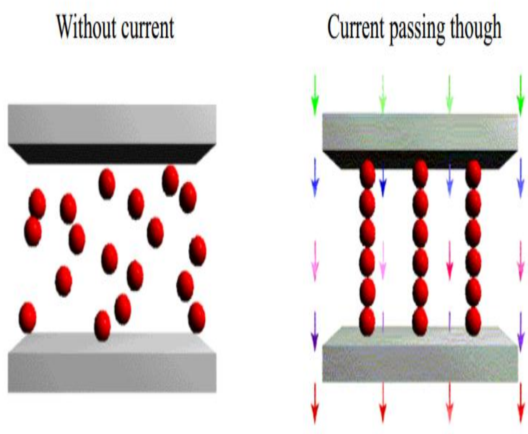

Fig. 3:Magnetorheological fluid behaviour.

Advantages:

1. System is independent of weather conditions
2. No mechanical contact
3. No lubrication required
4. Least maintenance
5. Low losses

IV. APPLICATION

Generally these shock absorbers are applied on four wheeler automobiles, thus we came with an idea to implement this on a two wheeler automobile. This can be used as MONO SUSPENSION for rear wheel in two wheeler motorcycle. By positioning the suspension close to the centre of gravity of the automobile, turning characteristics, stability during braking and the overall riding performance is substantially enhanced. Originally the mono suspension technology comes from the racing bikes. More advanced version of this technology is employed in these bikes. The international production models also incorporate mono suspension in order to provide style and comfort. The performance of mono suspension motorcycles is vastly superior to twin suspension motorcycles.

V. CONCLUSION

The primary objective of this research was to determine the feasibility of magnetorheological dampers for motorcycle rear suspension systems. Providing a background of magnetorheological technologies and motorcycle suspension history, it is concluded that magnetorheological dampers for motorcycles would be a perfect application of the technology. We also conclude that magnetorheological dampers have better shock absorbing property than passive hydraulic dampers. Hence, electromagnetic shock absorbers can be used as

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mono suspension in motorcycles to improve handling and stability of the vehicle.

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