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# A SURVEY ON MAGNETO RHEOLOGICAL DAMPER (MR FLUID): A SMART FLUID TECHNOLOGY

**Mr. Divyarajsinh Rathod***

**Abstract**

Magneto Rheological Fluids are classified as a smart fluid depending on their smart magnetic property. The properties of the smart fluids are rapidly varying by applying the magnetic field. The properties are changing from solid state to semi solid state within the few seconds due to changing their viscosities by applying the current. This paper represents the basic property of Magneto Rheological Fluids and their construction and Developments in our day to day life. In now days Magneto Rheological Fluid technologies are found very wide Applications in many fields. The basic Application imparts in the Vibration Isolation systems. In now days we are dealing with Magneto Rheological Damper (MR Damper) which is used MR Fluid as a working substance and isolate the vibration by changing the property of Magneto Rheological Fluid within few seconds. To improve the ride comfort, effective vibration control of suspension systems our modern vehicles are implement with MR Fluid Damper suspension systems.

**Keywords:Magneto Rheological Fluid;Smart Fluid;Magnetic Property;MR Damper;Vibration Isolation.**

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## 1. Introduction

Magnetic fluids, discovered by J. Rabinow in the 1940's, are used in many fields of engineering. Since the 1990's, when the manufacture of magnetic fluids was mastered, many devices using these fluids have been developed. New devices and new suggestions of their structural design keep on emerging. The features of magnetic fluids enable these devices to change properties of mechanical systems (stiffness, damping force) by controlling electrical quantities (supply voltage, current intensity).

Due to their unique properties, these fluids are classified among non-Newtonian fluids. Many mechanical systems should separate from sources of vibrations. In parallel to commonly used systems with passive damping appliances more advanced solutions that contain active or semi-active components present increasing popularity [1].

Nowadays, handling stability and ride comfort are considered very important features of an automotive driving. Semiactive vibration control systems in automobile suspension had received a great attention among the researchers community as the smart materials are being used in these devices. Further, these smart materials have the characteristics of rapid reversible response phenomenon at low power consumption. The smart materials have multiple properties (electrical, magnetic, mechanical, and thermal) and can also transform energy. These properties can be altered very easily using some external fields, for example, magnetic or electric, and so forth. Magneto rheological (MR) fluids are one of such smart material that exhibits drastic and reversible change in its rheological properties, for example, elasticity, plasticity, viscosity, and so forth, which mainly depend upon the intensity of the magnetic field [2] being applied on it.

The MR fluids are the most commonly used fluids in the dampers to achieve variable damping coefficient of it. It, thus, makes the vibration control more effective in wide spectrum of frequencies which is more suitable for the automotive applications. A typical magneto rheological damper consists of cylinder, piston, electromagnetic coil, and the MR fluid which is enveloped in a cylinder [3].

## 2. Litrature review

In recent years, a flurry of interest has been shown for a relatively old technology called magneto-rheological fluids, or MR fluids. Multiple types of devices have been designed to implement this versatile fluid, including linear dampers, clutches, work-piece fixtures, and polishing machines. The devices have been used in automobiles, washing machines, bicycles, prosthetic limbs, and even smart structures.

*M. Awais a, T. Hayat b, Aamir Ali, S. Irum* [4]:- This article examines the magneto-hydrodynamic (MHD) flow of nanofluid bounded by a stretching surface. The involved differential systems are solved for the velocity, temperature and mass fraction. Graphical and numerical results are reported for the analysis of various parameters of interest entering into the modeled problems. Streamlines are plotted showing the rheology for the slip and no slip flow regime. Plots of skin friction are also prepared for the slip and magnetic field effects. Figs. 1 and 2 present the streamline analysis for no-slip and slippage characteristics. It is noted that the rheology is quite different in both cases. Moreover the magnitude of velocity of an boundary layer is also quite different in both cases.

*X.C. Guana, P.F. Guoa, J.P. Oub* [5]:-This paper imparts the Modeling and Analysis of Hysteresis Behavior of MR Dampers. Damping force-velocity hysteresis of a magneto rheological (MR) damper under sinusoidal displacement excitation is not only a typical indication of its dynamic performance, but also the foundation upon which a practical control strategy is established. In this paper the corresponding lumped parameter model is developed, that is, a quasi-static MR model connected in series with a spring expressing compression of MR fluid. To predict damping force-velocity hysteresis of MR dampers under sinusoidal displacement excitation, a physical model is developed by considering compressibility of MR fluid. Straightforward mechanical analogy is presented and a further simplified analogy model in which viscous element is neglected permits derivation of a formula for estimating the hysteresis width. With the help of this formula, dynamic design method of MR dampers is proposed at then end of this paper. It is found that the hysteresis width of a MR damper is independent of piston area and only a function of spring stiff for given sinusoidal displacement.

*Sadak Ali Khan, A.Suresh N. Seetha Ramaiah* [6]:- In this paper, the various modes of usage and characteristics are discussed. Mathematical modelling of the MR fluid dampers based on Bingham plastic model and Herschel Buckley model are presented. Commonly, the MR damper piston does not remain centered during operation.

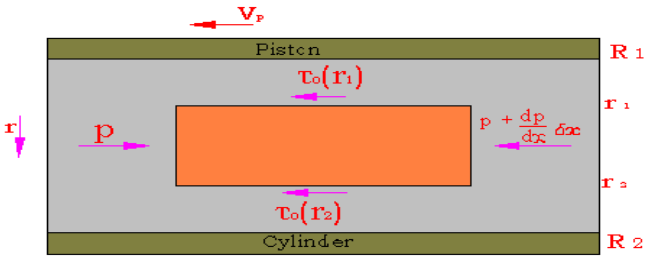


*Figure 1 Free body diagrams of MR fluids through an annular gap*

Figure 1 indicates the Free body diagrams of MR Fluids of an angular gap. Figure describe the various types of forces which are applied on it. Figure indicates the equation of motion of fluid material enclosed by the boundaries r = $r_1$ and r = $r_2$.This may due to either manufacturer error or side loads due to inappropriate installation (which may result in non uniform temperature increases and local overheating, bearing malfunction and leakage or scratching of the insulation and causing a short in the magnetic coil. To overcome this problem, two end collars made up of bronze are installed on either side of prototype MR damper.

*Fengchen Tu, Quan Yang, Caichun He, Lida Wang* [7]:- This paper contains A single piston rod MR damper with an accumulator was designed in order to satisfy with the demand of a certain automobile front suspension. The damper structural parameters were obtained by integrated optimal design combining magnetic circuit and structure. Magnetic circuit was analyzed by means of finite element method. The calculating formula derivation of damping force of MR damper with an accumulator was also achieved. Then the properties of designed damper were investigated by experiments, and the relationship between damping force, circuit and speed was fitted by the experimental results. This work provided promising method for the experimental study and design on automobile suspension made of MR damper. Applying the least square method to fit the relationship between damping force and current and speed was a better way to describe the damper performance and with little error.

*Martin Orecny, stefan Segla, Robert Hunadya, Zelmíra Ferkova* [8]:- This article deals with the Application of MR Damper for a suspension of a working machine seats. It contains Two alternatives of semi active suspensions of a seat of working machine. A magneto-rheological damper is used in the first case and in the second case the suspension of the seat is a combination of magneto-rheological damper and dynamic absorber. The dynamic absorber is composed from passive elements. In both cases, the dampers are controlled by the well known Sky hook algorithm. The dynamic analysis is focused on the influence of the applied passive dynamic absorber on the reduction of the seat displacements. The passive parameters of the seat suspension and the dynamic absorber were evaluated based on the optimization process using genetic algorithms according the defined minimization function. In this paper the affectivity of a DA on seat suspended by a MR damper was studied. From the results of the optimization it is clear that the application of the DA can vastly changes the values of the identified parameters.

*T. Imthiyaz Ahameda, R. Sundarrajana, G.T. Prasaatha, V. Raviraj* [9]:- This paper deals with the idea of implementing the magneto Rheological bumper in the front overhang of the four wheeler, which reduces the loss and deformation of vehicle during accident. It includes the basic characters and properties of the magneto rheological fluids (MR) and implementation of MR damper in bumpers of four wheelers. Vibration produced during impact is partially absorbed by the magnetic field and remaining by spring action. This paper discusses about the conventional bumpers and replacing it with magneto rheological bumpers which we called as Impact Reducing System. It also deals with fabrication and assembly of Magneto Rheological Dampers in bumpers. Instead of preventing these accidents which is not possible, collision effects can be reduced by providing Bumpers in the front side of vehicles.

*Bhau K. Kumbhar, Satyajit R. Patil, Suresh M. Sawant* [10]:- In this research, an effort has been made to synthesize MR fluid sample/s which will typically meet the requirements of MR brake applications. In this study, various electrolytic and carbonyl iron powder based MR fluids have been synthesized by mixing grease as a stabilizer, oleic acid as an antifriction additive and gaur gum powder as a surface coating to reduce agglomeration of the MR fluid. MR fluid samples with different compositions preferably to suit braking application have been synthesized. MRF

samples Csu 60% and Esu 60% cannot meet the requirements of braking application; however, they may be used for low yield stress applications.

*H. Shokrollahi* [11]:- The purpose of this work is to investigate the effects of the volume fraction and bimodal distribution of solid particles on the compression and tension behavior of the Co-ferrite-based magneto-rheological fluids (MRFs) containing silicon oil as a carrier. The results indicated that the increase of the volume fraction has a direct increasing influence on the values of the compression and tension strengths of fluids. The results show that the greater the volume fraction is, the greater the off-state and on-state viscosity of the MRF will be, thereby contributing to a significant rise in mechanical properties. Moreover, should a mixed MRF with bimodal particles be utilized, the resulting compression and tension strengths will be higher than an MRF with the uniform particles and the same volume fraction.

*Mr. Vinayak D. Dabade, Prof. Y. R. Patil, Prof. M.V. Kharade, Prof. P.R. Patil* [12]:- This paper presents basic properties of the magneto rheological fluids (MR) and their development in recent years. A very useful material for the engineers engaged in the design of brakes, dampers, clutches and shock absorbers systems. A magneto-Rheological (MR) fluid brake is a device to transmit torque by the shear force of an MR Fluid. In this paper, the design method of the cylindrical MR fluid brake is presented theoretically. Based on a commercially available magneto rheological fluid, a new automotive brake system was proposed.

*S. Kciuk , R. Turczyn , M. Kciuk* [13]:- They describe the Results of experimental studies of a prototype magneto rheological damper at various magnitudes of control current as well as the manner of modeling electromagnetic phenomena occurring in the damper. In this paper the Model of MR fluid was prepared using silicone oil OKS 1050 mixed with carbonyl iron powder CI. Furthermore, to reduce sedimentation, as stabilizers was added Aerosol 200. The observations of the surface morphology of carbonyl iron and fumed silica were carried out using Digital Scanning Electron Microscope SUPRATM25 ZEISS. The effect of magnetic field on magneto rheological fluid is modeled by the finite element method.

*Ashwani Kumar and S. K. Mangal* [14]:- In this paper, a finite element analysis of magneto rheological fluid damper is presented. An axi-symmetric fem model is thus built on ANSYS platform to analyze and examine a prototype of the MR Damper. In this paper, geometrical parameters and magnetic flux density at the clearance space of the damper are studied. It indicated that the fem modeling is effectively portraying the behavior of a MR damper and is adequate enough for estimation of the damping force, its control and design.

## 3. Conclusion

Magneto-Rheological (MR) dampers are semi- active control devices that use MR fluids to produce controllable dampers. The advantage of MR dampers over conventional dampers are that they are simple in construction, compromise between high frequency isolation and natural frequency isolation, they offer semi-active control, use very little power, have very quick response, has few moving parts, have a relax tolerances and direct interfacing with electronics.

Magneto- Rheological (MR) fluids are Controllable fluids belonging to the class of active materials that have the unique ability to change dynamic yield stress when acted upon by an magnetic field. This property can be utilized in MR damper where the damping force is changed by changing the rheological properties of the fluid magnetically. Semi-active control devices have received significant attention in recent years because they offer the adaptability of active control devices without requiring the associated large power sources.

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