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Design and fabrication of braking system using Magneto-Rheological fluid

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Abstract- The aim of this project work is to develop a braking system using the magneto-rheological fluid that has performance advantages over the conventional hydraulic brake system. The proposed brake system consists of rotating disks immersed in a MR fluid and enclosed in an electromagnet, which the yield stress of the fluid varies as a function of the magnetic field applied by the electromagnet. The controllable yield stress causes friction on the rotating disk surfaces, thus generating a retarding brake torque. The braking torque can be precisely controlled by changing the current applied to the electromagnet. The performance of the MRB in a vehicle was studied using a quarter vehicle model. A sliding mode controller was designed for an optimal wheel slip control, and the control simulation results show fast anti-lock braking.

I.INTRODUCTION

A brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction. The convectional friction brake (FB) is the most commonly used brake type. It has drawbacks such as wear, large mechanical time-delay, bulky size etc. Magnetorheological (MR) fluid is a type of intelligent materials that respond to applied magnetic field with fast, continuous, and reversible change in its rheological behavior .MR fluids are a type of suspensions, with carrier fluid usually mineral or synthetic oil, water, kerosene and micro size magnetic able particles dispersed in it. When external magnetic field is applied particles form a Chain like structures thus changing the viscosity of the fluid. A lot of work was done on MR fluid brakes modelling. We have planned to develop a braking system by using magneto rheological fluid. By applying a proper control effort, viscosity with large varying range is achievable with MR fluid brake. Some MR fluid brakes with attractive properties, such as high yield stress and stable behavior, have been developed and commercialized.

II. LITERATURE SURVEY

[1] KeremKarakoc(2008), Showed that, an electromechanical brake (EMB) prototype suitablefor ‘‘brake-by-wire” applications is presented. The magnetorheological brake (MRB) that potentially has some performance advantages over conventional hydraulic brake (CHB) systems. A CHB system involves the brake pedal, hydraulicfluid, transfer lines and brake actuators (e.g. disk or drum brakes).When the driver presses on the brake pedal, the master cylinder provides the pressure in the brake actuators that squeeze the brake pads onto the rotors, generating the useful friction forces (thus the braking torque) to stop a vehicle.

[2] Marannano G. V (2011),Analysedand Magneto-Rheological Brake (MRB) is one of the possibilities to replace a friction brake in an EBS with abrake in which Magneto-Rheological Fluid (MRF) is interposed between a rotor and a stator. These fluidsare known in the literature as-Controllable Fluids (CF) to emphasize the characteristic of being governed intheir rheology, if crossed by a magnetic field. The main advantage

that characterizes them is the ability torespond in a simple, quiet and quick way to external controls. They also have the ability to provide a quickand simple interface between the electronic control and mechanical system.

[3]PozinciA. (2012) Studied objective of this work was to compare overall braking torque analytical expressions and design complexity for all MR fluid brake types. Based on results obtained from these comparisons, MR fluidbrake type with the most promising properties was manufactured and tested on a specially designed test rig.

[4] LuoYiping, (2014) studied the characteristics of MRF rheological properties in the magnetic field, MRF dampers can adjust itself damping in real time according to external vibration to achieve the purpose of damping. So the MRF damper is an important field of MRF application.

[5]KshirsagarPrashant R (2016)have discussed the concept of modelling and analysis of magneto rheological brake. Magneto rheological fluid (MRF) fluid has the smart property that its viscosity changes with respect to magnetic field applied. As magnetic field applied, the particles get chain aligned in the direction of field. Which results in increase in fluid viscosity. This phenomenon takes only milliseconds to occur. The yield strength of MRF varies from 50 kPa to 100 kPa at magnetic field of 150 to 280 kA/m. So, it can be consider for its application in brakes.

III.MAGNEO RHEOLOGICAL FLUID

A magnetorheological fluid (MR fluid, or MRF) is a type of smart fluid in a carrier fluid, usually a type of oil. When subjected to amagnetic field, the fluid greatly increases its apparent viscosity, to the point of becoming a viscoelastic solid. Importantly, the yield stress of the fluid when in its active ("on") state can be controlled very accurately by varying the magnetic field intensity. The upshot is that the fluid's ability to transmit force can be controlled with an electromagnet, which gives rise to its many possible control-based applications. The magnetic particles, present in the MR fluid in which they are typically micrometer or nanometer scale spheres or ellipsoids, are suspended within the carrier oil and distributed randomly in suspension under normal circumstances, as below.

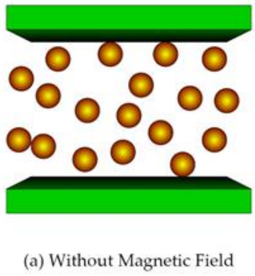

Fig.1 Without magnetic field

When a magnetic field is applied, however, the microscopic particles (usually in the 0.1–10 µm range) align themselves along the lines of magnetic flux, see below.

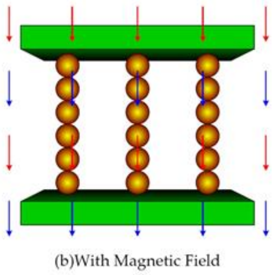

Fig.2 With magnetic field

Table.1 Properties of MR fluid

PROPERTY	MR FLUIDS
Max. yield stress τ0	50-100 kpa
Apparent plastic viscosity	0.1-10 pa-s
Operable temp. range	-40 to 150^0C
Stability	Unaffected by most impurities
Density	3-4 g/cm^3
Size	1 to 10 µm

IV. EXPERIMENTAL SETUP

By using the above components that is MR fluid and battery the braking system is developed. The main components are MR fluid and battery.

V. WORKING PRINCIPLE

Here we are using the MR fluid as a main source in this braking system. In this MR fluid isplaced in a drum where coil is wound around it. The rotating shaft is connected to the drum. When electrical energy is applied magnetic particles are magnetized, they gather in chains and make liquid flow through them to be difficult Thus causes the magnetized iron particles in the fluid to become a solid state. By this the brake is applied.

VI. RESULTS AND DISCUSSIONS

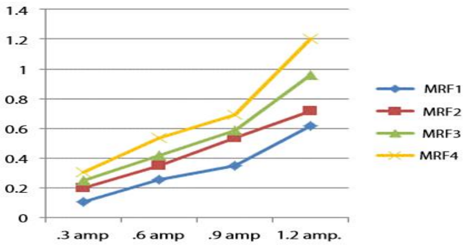

Figure 5. Brake torque "x" vs. Current (at 1000 rpm).

Fig.3 Brake torque vs current

The maximum torque obtained is 1.2 newton-meters from MRF4 sample at 1.2 amperes current and 450 gauss of magnetic field at 1000 rpm. The brake torque shows slightly linear trends for MRF 1 and MRF 2 sample that has been attributed to the fact that since the fraction of iron particle is low and hence chain formation is not adequate due to vibrations and other dynamic factors.

VII. CONCLUSION

In order to increase torque, better utilization of the existing magnetic field is needed. We suggested different approach in comparison to the conventional MR brake design that would increase the overall braking torque by increasing the magnetic field efficiency and the contact area of the MR brake fluid.

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