Review of Magneto Rheological fluid based braking system

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Abstract— Magneto rheological fluid (MRF) is a type of non newtotnion fluid whose properties can be controlled with the help of metal particles and magnetic field. These fluids have the ability to transmit force in a controlled manner with the help of magnetic field, thus improving their performance especially in areas where controlled fluid motion is required. In this research a Magneto rheological (MR) brake is fabricated and also MR fluid is prepared. The proposed brake consists of single rotating disk immersed in a MR fluid and enclosed electromagnet. When magnetic field is applied to the MR Brake, the MR fluid solidifies as its viscosity varies as a function of the magnetic field applied. This controllable viscosity produces shear friction on the rotating disk generating braking torque.

Key words: Magneto rheological fluid (MRF), Electromechanical brakes (EMB), Carbonic iron particles (CI Particle), Electromagnetic brake (EMB)

I. INTRODUCTION

Magneto-rheological fluids (MRF) are a heterogeneous mixture containing solid particles which can be magnetized, and exhibit fast, strong, and reversible changes in their rheological properties when a magnetic field is applied. Therefore, MR fluids hold great potential in many applications that require an electromechanical interface, such as clutches brakes, dampers and robotics.

Now a day various industries including the automobile industry are using MR FLUID for various applications.

In MR BRAKE, some of the pure mechanical components of the conventional brakes are replaced by electromechanical components. A simple example of such brake system is the drum brakes used in trailers where less braking torque is required. These brakes are actuated by an electromagnet installed in the drum brake instead of a hydraulic mechanism that attracts a magnetic rotating disk onto a stator. The friction generated between the stator and the rotor results in braking.

In this project an EMB based on magneto rheological fluids (MRF), i.e. a magneto rheological brake (MRB), is presented. MRB is a friction based brake like a CHB. However, the method of the friction generation in an MR is entirely different. In the CHB, when the braking pressure is applied, the stator and rotor surfaces come together and friction is generated between the two surfaces, resulting in the generation of the braking torque. But in the MRB, MRF is filled between the stator and the rotor, and due to controllable rheological characteristics of the MRF, shear friction is generated (thus the braking torque). MR fluids are created by adding micron-sized iron particles to an appropriate carrier fluid such as oil, water or silicon. Their rheological behaviour is almost the same as that of the carrier when no external magnetic field is present. However, when exposed to a magnetic field, the iron particles acquire a dipole moment aligned with the applied magnetic field to form linear chains parallel to the field. This reversibly changes the liquid to solid-like that has a controllable yield strength, which its magnitude depends directly on the magnitude of the applied magnetic field.

II. PREPARATION OF MR FLUID

1) CI particles (80% by wt) were mixed with oleic acid (0.25% by wt) for 30 minutes at 400 R.P.M in the stirrer.
2) After that white grease (0.25% by wt) was poured and mixed for 30 minutes at 400 R.P.M in the same stirrer.
3) Then servo medium e.g. paraffin oil(19.5% by wt) was poured in small amounts gradually (4% by wt) after every 30 minutes and mixed for 3 hrs at 450 R.P.M in the same stirrer.

III. DESIGN OF MR BRAKE

Detail of each component is as follows:

A. Frame:

A structure that gives shape or support

B. Pulley:

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a belt along its circumference. Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power.

C. Flywheel:

A flywheel is a rotating mechanical device that is used to store rotational energy. Flywheels have an inertia called the moment of inertia and thus resist changes in rotational speed.

Fig. 1:

D. Electromagnet:

A magnet consisting essentially of a coil of insulated wire wrapped around a steel or iron core that is magnetized only when current flows through the wire.

Fig. 2:

E. Bearing:

It is a support, guide or locating piece for a rotating or reciprocating mechanical part.

F. Freewheel:

A power transmission device that allows the drive shaft of a motor to continue turning when its speed is greater than that of the engine shaft.

G. Casing:

It is a shell which is used to enclosed and protect the inner components like core, disc etc. It protects parts of MR brake from dust and foreign particles.

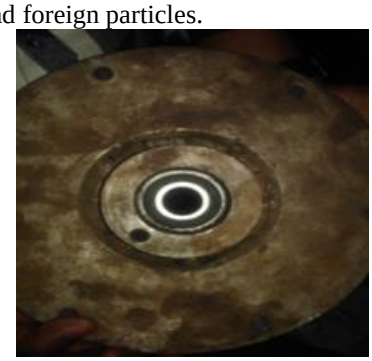

Fig. 3:

H. Shaft:

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The various members such as pulley sand gears are mounted on

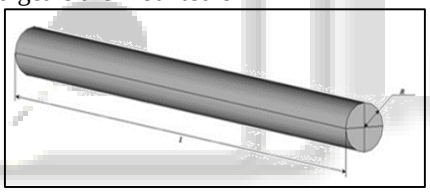

Fig. 4:

IV. SPECIFICATION

Sr No	Part Name	Mat	Qty
1	Frame	Ms	1nos
2	Ci Particle	Ci	2 Kg
3	Olec Acid	-	0.5 L
4	White Greese	-	0.5 Kg
5	Paraffin Oil	-	0.5 L
6	Mixing Container	Glass	1 Nos
7	Shaft Dia 20 Mm	Ms	5 Kg
8	3 Phase Ac Motor	Std	1 Nos
9	Pulley	Ms	2 Nos
10	Clip	Std	2 Nos
11	Electromagnet	Cu	1 Nos
12	Pedestal Bearing	Ci	2nos
13	Free Wheel	Ms	1 Nos
14	Nut Bolt Washer M 10	Ms	8 Nos
11	Battery 12 V	Std	1 No
12	Charger	Std	1 Nos
13	Sheet Metal	Ms	1 M^2
14	3 Core Wire	Cu	2 M
15	Casing Body	Ms	1 No

Table 1:

V. WORKING

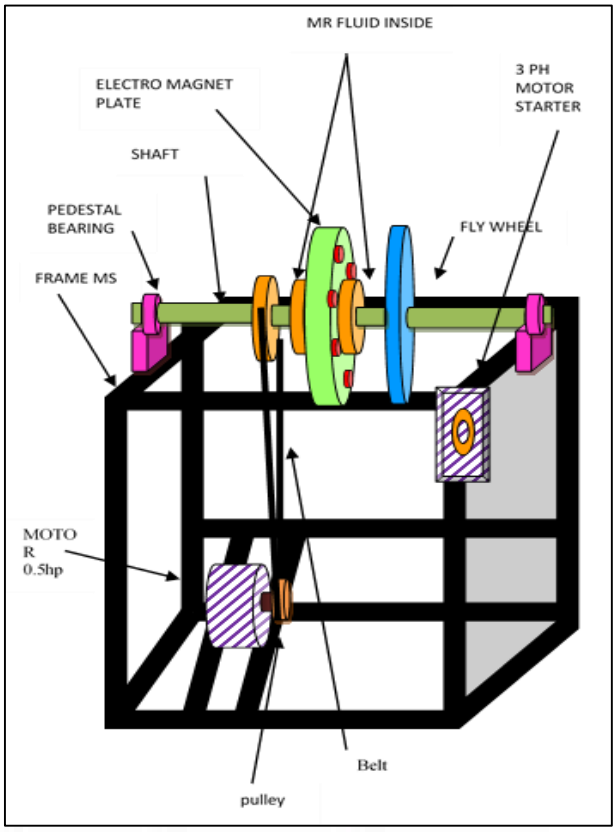

Fig. 5:

Operation of MR brake is based on the MR effect which changes the viscosity of working fluid and by creating magnetic field it tends to behave as a solid.

1) Coils are present in the gap which creates magnetic field in it. Coil is supplied with the 12V DC power supply; value of the current is set between 0-3A. Magnetic field strength and the viscosity are mainly depending on the current in the coil.
2) Viscosity of the fluid changes which makes it solid and influences torque and braking action takes place in rotor.
3) When the current in the coil is equal to zero there is no magnetic field and brake has torque equal to minimum Tmin. Tmin is equal to the torque caused by bearings, seal and viscosity of carrier liquid.
4) When current I= 3Amp the magnetic field in the coil is not equal to zero then the brake has highest possible value of torque Tmax, that is depend on the maximum current in the coil and construction of the brake.

VI. CONCLUSION

Magneto rheological fluid technology has a wide scope in the coming years. This technology is very useful in those places where controlled fluid with varying viscosity is required.

The main features of MRF technology are fast response, simple interface between electrical input and mechanical output. This technology is simple and involves less moving parts. Hence MRF based products require less maintenance and have comparatively longer life.

Some other fields rather than automobile field where this technology can be used are in aerospace and medical field.

In this work, a magneto rheological brake is introduced as possible substitute for the conventional hydraulic brake. Since Magneto rheological brake is an electromechanical device, it has several advantages over Conventional hydraulic brake, such as actuation delay, and lower system weight

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