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Development and Testing of MR fluid using Soybean oil as a carrier oil

Shashikant K Nimbalkar[1], Mahammadrafeeq Manvi[2], Basavaroodh Badiger[3], Shashir Kenganal[4], Sarfarazali Khazi[5], Sachin Pandey[6]

[123456]*Assistant Professor, Dept. of Mechanical Engineering, SECAB.I.E.T. Vijaypur, Karnataka, India.*

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Abstract - *Magneto Rheological is a branch of rheology that deals with the flow and deformation of the materials under an applied magnetic field. These types of materials change their rheological properties under the application of magnetic field applied and turn from liquid to solid in just few seconds. The main aim of this project was to prepare a low cost (economical) MR fluid by using soybean oil. According to experimental result, the prepared MR fluid shows good efficiency in presence of external magnetic field. The MR fluid is tested in parallel plate rheometer, which shows that the shear stress and shear rate property of the prepared fluid varies between 0-2A. After this range, fluid shows the properties same as the 2A. Hence, the soybean oil can be used as carrier oil for the preparation of the MR fluid.*

Key Words: Magneto Rheological, low cost MR fluid, rheometer, soybean oil, shear stress and shear rate.

1.INTRODUCTION

Rheology is branch of science that deals with the study of deformation and flow of matter such as magneto rheological fluids, blood, paint etc. under the impact of a stress. Magneto Rheological is a branch of rheology that deals with the flow and deformation of the materials under an applied magnetic field. These types of materials change their rheological properties under the application of magnetic field applied and turn from liquid to solid in just few seconds.

1.1 WHAT IS MR FLUID?

The discovery of Magneto Rheological (MR) fluid is attributed to Jacob Rabinow in 1940's. Magneto rheological fluids are a class of smart material which can be simply referred as a controllable fluid. Nowadays they are stable and have many influencing property such as high yield stress and low viscosity. Because of this magneto rheological fluids are recently used in vehicle suspension system. Magneto rheological fluids are mixture of micron sized iron particles (ferromagnetic particle) and grease in appropriate carrier oil. MR fluids respond to a change in rheological properties on the application of external magnetic field.

1.2 PROPERTIES OF MR FLUID

The typical properties of magneto rheological fluids are as shown in Table -1.

Table -1: Properties of magneto rheological fluids

Property	Range
Density	3 - 4.5gm/cm3
Initial viscosity	0.2 – 1.0 (Pa.s) at 240C
Magnetic field strength	160 – 240 (KA/m)
Maximum yield stress	50 – 100 (KPa)
Reaction Time	10 – 20 millisecond (ms)
Stability	Good
Working temperature	-50oC – 1500C
Supply voltage and current	12V and 0.1 – 2A

2. LITERATURE SURVEY

Vaibhav R. et.al., observed the experimental results of "*PREPARATION AND TESTING OF MAGNETO RHEOLOGICAL FLUID"* that shows the good efficiency of prepared MR fluid in presence of external magnetic field. The MR fluid is tested on guassmeter which shows the result as magnetic field is applied to MR fluid; it changes the physical state that is liquid state to semi-solid state. Guassmeter shows reading of magnetic field intensity by varying the current. Graph1 shows that as current increases then magnetic field intensity of MR fluid also increases. For our application we have used MR fluid in magneto rheological damper which shows better damping performance under the influence of external magnetic field. Graph 2 shows that as the current increases gradually to electrical winding of MR damper then displacement goes on decreasing so that we get sufficient damping.

Zhou Feng, et,al., analyzes the "*STUDY OF SEDIMENTATION STABILITY OF MAGNETORHEOLOGICAL FLUID"* where the main force of the magnetic particles under zero-field intensity, studies main factors of settlement of MRF, such as the size of magnetic particles, the difference of density between magnetic particles and carrier fluid, the viscosity of the carrier fluid, etc. Currently, there are some measures to improve the sedimentation stability of MRF at home and abroad. Here are several measures: adding appropriate additives and surfactant, adding magnetic particles coated withorganic polymer, improving the preparation process and parameters, adding composite magnetic particles, pulling in some nanomaterials, adding some oxidant etc.

Bhau K. Kumbhar, et.al., studied the "*SYNTHESIS AND CHARACTERIZATION OF MAGNETO-RHEOLOGICAL (MR) FLUIDS".* Here, MR fluid samples with different compositions preferably to suit application have been synthesized. Based on this synthesis and characterization results, qualitative analysis (worse, better &best) for various MR fluid samples from braking context have been presented in Table .6MRF samples Csu 60% and Esu 60% cannot meet the requirements of braking application; however, they may be used for low yield stress applications. The difference between the OFF state viscosities of examined samples is very small, however the ON state shear strengths produced by them are significant. MR fluid sample Esu 60% with OFF state viscosity 0.32 Pa s could produce shear strength of only 40.64 kPa whereas, with 0.7 Pa s OFF state viscosity MR fluid sample Csi 45% has developed highest shear strength of 92.34 kPa. CI powder is better for MR fluid samples used for braking application as compared to the EI powder as it produces considerably higher saturation magnetization. Thus based on the overall study CSi 45% is recommended for the brake application as the most suitable MR fluid.

Vikram G. Kamble, et.al., studied the "*PREPARATION OF MAGNETORHEOLOGICAL FLUIDS USING DIFFERENT AND DETAILED STUDY ON THEIR PROPERTIES".* In this study, the experimental investigation of MR fluids in terms of dynamic viscosity, frequency, storage modulus (G´), loss modulus (G´´) and loss factor (G´´/G´) are presented. Results are summarized as follows:

• Storage modulus as well as loss modulus decreases with increase in strain percentage

• Storage modulus is always higher than the loss modulus over the frequency range and it is leading the elastic properties of MR sample.

Jain D, et.al., observed in "*FABRICATION AND TESTING OF LOW COST MAGNETO- RHEOLOGICAL FLUID BRAKE TESTING MACHINE"* that a completely new approach is there to create the magnetic field inside the cavity of brakes and iron cores can be used to concentrate the magnetic field lines so that brake torque can be increased. Finally, different samples of MR fluids are prepared in the laboratory and brake torque is calculated by filling them in brake apparatus. This machine can be used for comparing the torque characteristics of different MR fluids.

3. PREPARATION OF MR FLUID AND EXPERMENTATION:

For the preparation of 175ml MR fluid following constituents are required with specified quantity as follows:

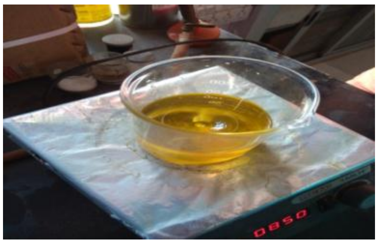
Carrier oil	Magnetic particle	Additives
Soybean oil	Carbonyl iron powder	White lithium grease.

Constituents	Quantity
Low viscosity soyabean oil	81.2gm
Iron particle (10 microns)	220gm
White lithium grease	12.22gm

3.1 Preparation procedure for MR fluid:

For the preparation of MR fluid two accessories are required as mechanical stirrer and beaker with above constituents. Following are the steps for preparation of MR fluid.

STEP 1. First take the low viscosity soyabean oil and grease (white lithium grease) with correct quantity in a beaker.



STEP 2. Stir this improper mixture of low viscosity soybean oil and white lithium grease with the help of mechanical stirrer for proper mixing.

STEP 3. Then wait for 2hrs so that grease gets completely soluble in soybean oil.

STEP 4. After that add iron particles of 10 micron size in above mixture and again stir it with the help of mechanical stirrer for 15 to 20 min. for proper mixing. In the preparation of MR fluid white lithium grease is added into

low viscosity soybean oil to avoid settlement of iron particle. Following figures shows the prepared MR fluid.

3.2 EXPERIMENTAL SETUP AND MR FLUID TESTING:

Experiments were performed to study the responses of the MR fluid samples along the field direction. The specimen MR fluid contained in its original bottle was shaken and de-gassed in a vacuum before its use. A specific MR fluid quantity was taken onto the lower plate using a clean syringe. Elevation to the lower plate is then made to form a gap of 1 mm between the plates, which was monitored by the laser sensor. Pre-shearing was produced by revolving the upper plate with 2.2 s_1 was applied to the MR fluid for10 min to ensure good dispersion. To start with, the readings for the load cell under no field and zero shear strain conditions were recorded for the first 3 min. The desired field was then applied and the normal force data were captured from the load cell with a sampling rate of 10 Hz for 30 min. The experiment was carried at a constant shear rate of 100 s_1 which is imposed on the MR fluid by a motor. The normal force was first recorded for 5 min. After the experiments, the MRF was demagnetized by applying an inverse impulse magnetic field. The experiment was repeated for other magnetic fields.

4. RESULTS AND DISCUSSIONS:

4.1 PROPERTIES OF MR FLUID:

Shear rate:
Shear rate is the rate of change of velocity at which one layer of fluid passes over an adjacent layer.

Example- consider that a fluid placed between two parallel plate that are 1cm apart, the upper plate moving at a velocity of 1 cm per second at lower plate is fixed.

Shear stress:
Shear stress is amount of force per unit area perpendicular to axle of the number. When you stopped on the wooden stick value really hard, the impact load on the stick caused two type of stress.

Magnetic flux density:
Magnetic flux density is defined as amount of magnetic flux in an area taken perpendicular to the magnetic fluxes direction an example magnetic flux density is a measurement taken in Tesla.

Magnetic field strength:
Field strength is one of two ways that the intensity of magnetic field can be expressed. Technically, a distancing is made between magnetic field strength H, measured in A/m, and magnetic flux density B, measured in NM/A also called tesla (T).

4.2 STUDY OF PERFORMANCE PARAMETRES:

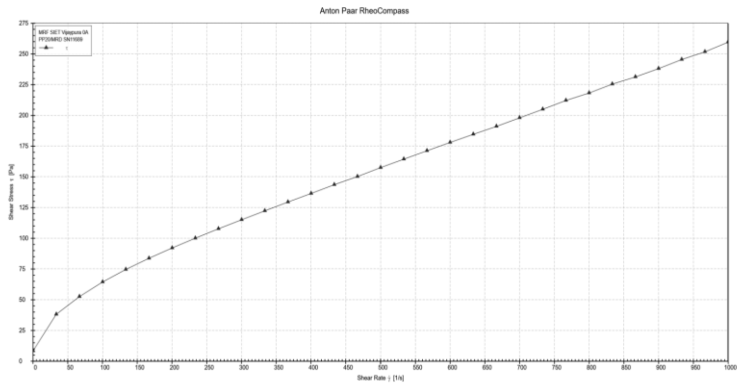


FIG.1. shear stress vs shear rate (0A current)

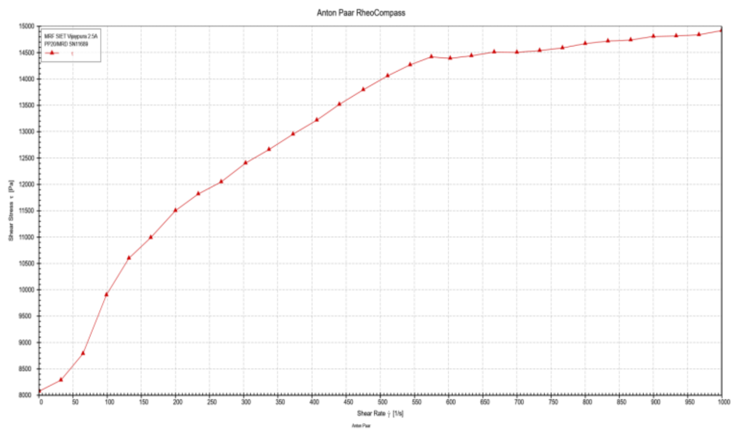


FIG.2. shear stress vs shear rate (2.5a current)

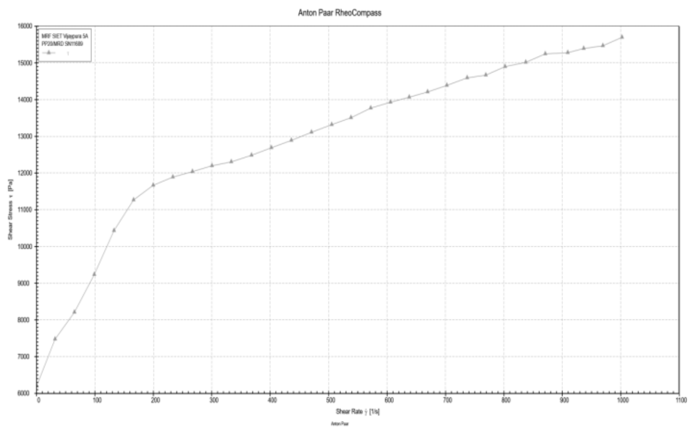


FIG.3 shear stress vs shear rate (5A current)

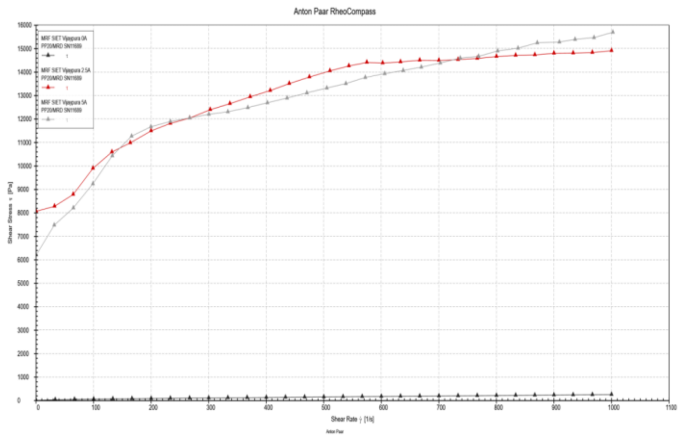


FIG.4 shear stress vs shear rate (0,2.5,5A currents)

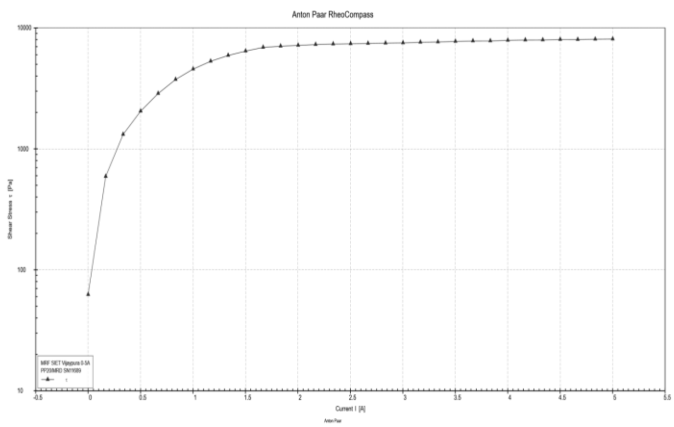


FIG.5 shear stress vs current

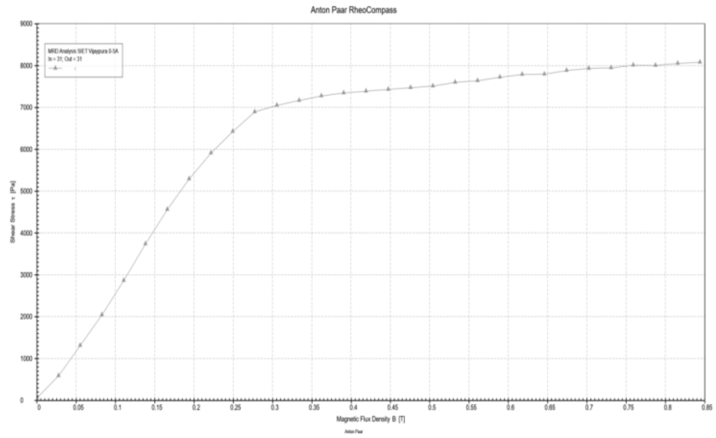


FIG.6 shear stress vs magnetic flux density

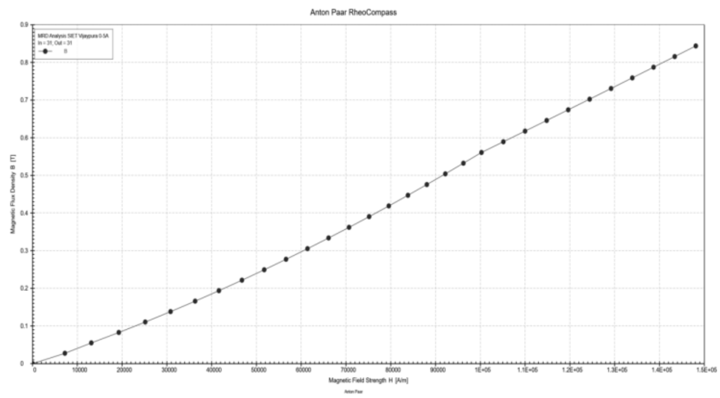


FIG.7 flux density vs magnetic field strength

5. CONCLUSION:

The main aim of this project is to prepare a low cost (economical) MR fluid by using soybean oil. According to experimental result, the prepared MR fluid shows good efficiency in presence of external magnetic field.

The MR fluid is tested in parallel plate rheometer, which shows that the shear stress and shear rate property of the prepared fluid varies between 0-2A. After this range, fluid shows the properties same as the 2A.

Finally, we conclude that soybean oil can be used as carrier oil for the preparation of the MR fluid, which is available in the market with low cost.

REFERENCES

[1] Mr. Vaibhav R. Sawalkar, Mr. Chetan S. More, Prof. T. B. Patil, “PREPARATION AND TESTING OF MAGNETO RHEOLOGICAL FLUID,” International Journal of Technical Research and Applications, Volume 3, Issue 2 (Mar-Apr 2015), PP. 237-240.

[2] Zhou Feng, Luo Yiping, Ren Hongjuan, "Study of sedimentation stability of magnetorheological Fluid", Advances in Materials, Vol. 4, No. 1, 2015, pp. 1-5.

[3] Bhau K. Kumbhar, Satyajit R. Patil, "A Study on Properties and Selection Criteria for Magneto rheological (MR) Fluid Components", IJCRGG, Vol.06, PP. 3303-3306, 2014.

[4] Vikram G. Kamble, Shreedhar Kolekar and Chetan Madivalar, "Preparation of Magnetorheological Fluids Using Different Carriers and Detailed Study on Their Properties," Current Research in Nanotechnology, Volume 6, Issue 1, Pages 7-15.

[5] Jain D, Avchare KR, "Design, Fabrication and Testing of Low Cost Magneto- Rheological Fluid Brake Testing Machine", RRJOMS, Volume 4, Issue 2, June-2016.

BIOGRAPHIES

Mr. **Shashikant K Nimbalkar**, working as Assistant Professor in Department of Mechanical Engg., SECAB. Institute of Engg & Technology, Vijaypur(KA).

Mr. **Mahammadrafeeq N Manvi**, working as Assistant Professor in Department of Mechanical Engg., SECAB. Institute of Engg & Technology, Vijaypur(KA). Pursuing Ph.D. in VTU.

Mr. **Basavaroodh A Badiger**, working as Assistant Professor in Department of Mechanical Engg., SECAB. Institute of Engg & Technology, Vijaypur(KA).

Mr. **Shashir S Kenganal**, working as Assistant Professor in Department of Mechanical Engg., SECAB. Institute of Engg & Technology, Vijaypur(KA).

Mr. **Sarfarazal Khazi**, working as Assistant Professor in Department of Mechanical Engg., SECAB. Institute of Engg & Technology, Vijaypur(KA).

Mr. **Sachin Pandey**, working as Assistant Professor in Department of Mechanical Engg., SECAB. Institute of Engg & Technology, Vijaypur(KA). Pursuing Ph.D. in VTU.