Synthesis and Optimization of MR Fluid for Damper in Automotive Suspension System

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***Abstract*— The necessity is the mother of invention. In past decades, the automobile industry became very sensitive about the riding quality as well as the vehicle handling quality of the vehicle. But it is nearly impossible to have both things in the suspension system. To have these qualities together the magneto-rheological fluid plays very important role in the vehicle suspension system.The following synthesis and characterization of MR fluid by using different carrier fluids and micro sized iron particles mainly focused on dynamic characteristics of the fluid. Obtained characteristics of the fluid will help us to have clear mindset about choosing the right fluid for requirements in semi active suspension system. Among different types of MR fluid, a fluid which has better characteristics is selected for damper testing on the setup.**

***Keywords*— Magnetorheological fluid, Electrorheological, Bingham plastic**

I. INTRODUCTION

In today's world the Automobile market became buyers' market. With increase in quality of life, each and every consumer require comfort while riding vehicle. Vehicle has to undergo through various road conditions such as speed breakers, pothole, vibrations, different shocks, side thrust during steering vehicle etc. So, it become necessity to have better suspension system for riding comfort.

In earlier days, the passive suspension system is widely used in automobile. Passive suspension system consist of simple spring-mass damper system. But it results friction between linkages. It signifies less damping properties. So, passive suspension system was much replaced by Electrorheological and Magnetorheological (Semi-active) suspension system. Electro-rheological(ER) suspension system requires high power supplyit uses ER fluid contains polymers, SiO_2, Zeolites etc. Because of such requirements ER suspension system is costlier one. To have better riding comfort in less cost MR suspension system is preferable. It uses MR fluid containing Iron particles with additives such as AP3 grease, Mustard oil etc. When electric supply is supplied i.e. under excitation state, MR fluid behaves like semi solid i.e. Bingham plastic. It has maximum yield stress up to 100 KPa. and has density 3-5gm/cc. In passive state, fluid is in liquid state. The advantage of semi active suspension system is when magnetic field collapses, it acts as passive suspension system.

II. FLUID PREPARATION

MR fluids samples were prepared in chemistry laboratory by using the following procedure:-

1. Firstly carrier fluid with some amount of grease was stirred at about 900-1200rpm using magnetic stirrer.
2. Pre-decided amount of grease was added at regular interval while the fluid was continuously stirred.
3. The fluid was allowed to be stirred for about 10-15min after the complete grease was utilised.
4. At last pre-decided amount of carbonyl iron powder was added at regular intervals.
5. The whole process took about 4-5hrs each depending upon the quantity used.

The amount of each element in MR fluid compositions are mentioned in the following table I.

TABLE I

Composition of MRF samples developed

Sample no.	Carrier liquid(% by Weight)	Iron particles (% by weight)	Grease by (% by Weight)	Type of carrier liquid	Size of iron particles
MRF1	71.42	17.85	10.71	Castor oil	5µm
MRF2	75	18.75	6.25	Castor oil	5µm
MRF3	78	22	12	Honge oil	5µm
MRF4	78	22	5	Honge oil	5µm
MRF5	60	40	6	Fork oil	5µm
MRF6	65	35	6	Paraffin oil	5µm
MRF7	78	22	5	Castor oil	5µm
MRF8	78	22	5	Mustard oil	5µm

III.RESULTS

A. *Sedimentation Analysis*

Settling down of metal particles is the practical problem with MR fluid. Sedimentation in simpler words is the settling down of the particles at the bottom of the container holding the fluid. For sedimentation test, prepared samples of fluid are poured into tube shaped glass tubes upto height of 10ml for 104hrs. As a result of sedimentation homogeneity of MR fluid is affected causing the particles to settle down leaving oil in the top layer which is named as supernatant (clear) liquid (HS). By visually observing the position changes of boundary between clear (supernatant) and turbid part of carrier oil sedimentation is measured. On the basis of this sedimentation ratio(R) is calculated. Sedimentation ratio in simple words is defined as the ratio of length of clear to turbid(muddy) part of MR fluid as shown in equation below:

$$R[\%] = \frac{p}{p+q} * 100$$

Where,

R[%]-sedimentation ratio,p-length of supernatant(clear) liquid, q-length of turbid liquid.

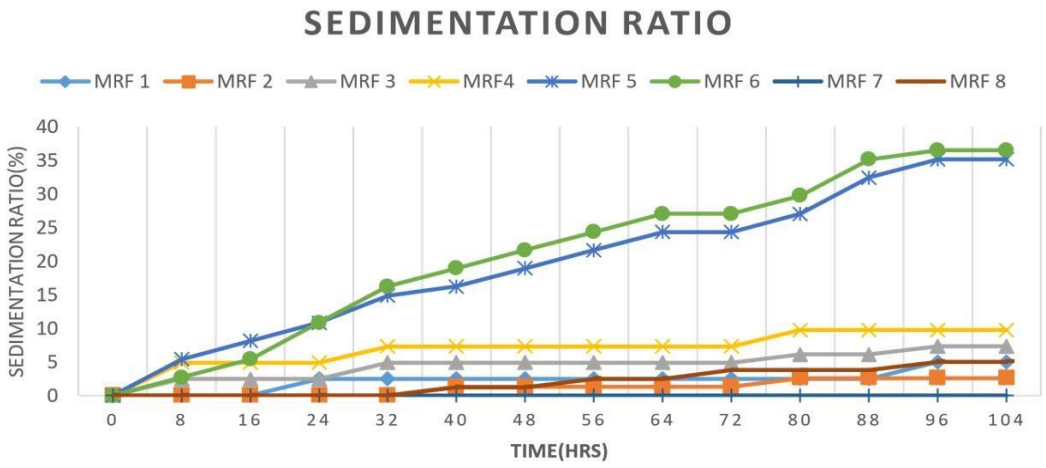

Fig. 1Sedimentation curves of all seven fluid sample.

From fig. 1 it can be seen that the sedimentation ratio is highest for MRF-5 and MRF6.From fig. it can be deduced that the grease has an important role in sedimentation ratio of MR fluids. The sedimentation is decreased by decreasing the amount of grease. From these observations it can be deduced that by increasing the percentage of additives the stability of MR fluid can be increased.

From the above graph, we can see that MRF 7, MRF3, MRF5, MRF8 show the least sedimentation. Hence, we selected these four MRF's for further testing.

IV.CONCLUSION

The damper plays very crucial role in the suspension system. Neither the damper nor the MR fluid alone give the best results but combination of this will give us the best results. We can see that MRF7, MRF3, MRF5, MRF8 show the least sedimentation. Hence, we selected these four MRF's for further testing. Further important properties of fluid such as viscosity, magnetic flux, yield stress, dynamic range etc. tested in laboratoryat National Chemical Laboratory Pune (NCL).

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