APPLICATIONS OF MAGNETORHEOLOGICAL FLUIDS

Florin CIOFU, Lecturer PhD.Eng.
***University "Constantin Brâncuşi" of Târgu*-Jiu, florin.ciofu@utgjiu.ro**
Alin NIOAŢĂ, Lecturer PhD.Eng.
***University "Constantin Brâncuşi" of Târgu*-Jiu, nalin@utgjiu.ro**

Abstract: The magnetic and magnetorheological liquids – the liquids M and MR – are chracterized by the fact that their energizing is performed by means of an exterior magnetic field; most of the times, between the two fluids it is made a confusion by the ones who aren't specialists, both of them being intelligent fluids. The difference between these materials is concretized at the level of the dimensions of the solid particles, the magnetic fluids having solid particles of the maximal order of the hundreds of Armstrong,while the magnetorheological fluids have solid particles of the order of the thousands of microns.

KEY WORDS: magnetorheological fluid, control, damper

1.INTRODUCTION

Detroit, January 2002. The stand presents the improved version of Cadillac Seville STS, which, behind the old design hides a recent technique, Delphi brand: Magnetic Ride Control. It's the first suspension magnetorheological dampers installed on a production model.

A magnetorheological fluid (MR fluid) 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.

2.APPLICATION

2.1. MR linear damper control

Product of Rheonetic, controllable linear MR damper ensures effective compensation of shocks in a wide range of applications using MR fluids. Power consumption, low driving voltage and response time of milliseconds imposed the use of this type of damper on interfacing mechanical elements with electrical control structures. Simple structure, quick installation, high efficiency, no noise operation are just some of the advantages of the damper which has already attracted numerous customers.

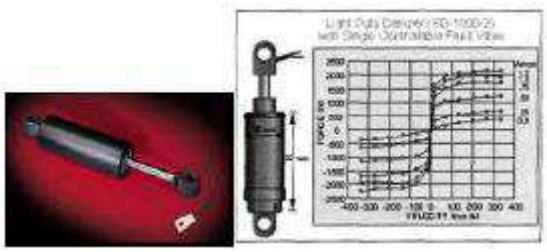

Fig. 1. Damper MR

Automotive suspension from agriculture, transport and transit operations are greatly enhanced by using this type of silencer.

On the outside, it looks like one magnetorheological damper monotub usual, but if you have the curiosity to take it down, you'll notice two unusual things: lack valves controlling fluid flow and the absence of moving parts.

This is possible because of magnetorheological fluid properties.

What essentially is a solution based synthetic hydrocarbon populated with particles of soft magnetic material (magnetized and demagnetized easily).

The liquid flowing freely through the holes "dug" into the damper piston, as long as not requiring a blur of shock act. When the wheel reaches a bump or is affected by a mass damper reacts by applying a variable electrical current, forming thanks solenoid piston mounted in a magnetic field.

Fig. 2. Damper MR auto (operating)

Mufflers to protect buildings from earthquakes protects buildings both initial shock and post earthquake shocks. Lord company produces dampers of this type, as shown in the figure with the power of 180 kN amortization.

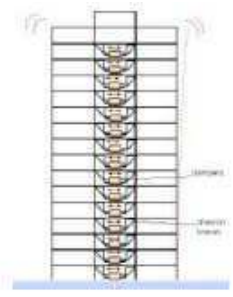

Fig.3. Using MR dampers to protect buildings

2.2. MR electrically controllable braking device

This brake power produced by Rheonetic is also based on MR fluids, providing opportunities for fine control proportion, requiring a much lower energy consumption than any braking implementation to date.

The control voltage, can be done with relative ease makes and areas of application are extremely varied: from use in the construction of automobile construction gymnastics apparatus.

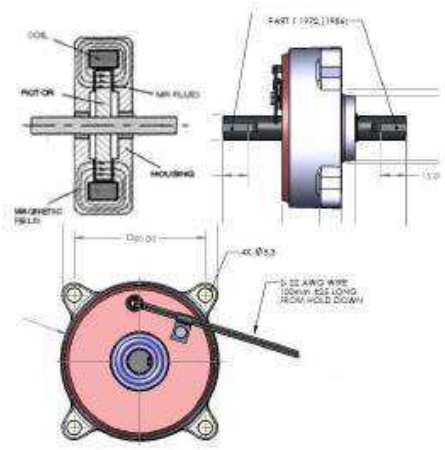

Fig. 4. MR electrically controllable braking device

2.3. MR controllable clamping devices and harmonic balancer

These devices, based on MR fluids can achieve real-time control of vibration attenuation, while providing a controllable grip strength.

Encompassing simple structure already previously mentioned characteristics of structures with MR fluid, leading to wide use of such devices.

Studies conducted to date on ER and MR fluids were concentrated in fluid control applications such as smart shock absorber, neglecting studying the behavior of these fluids in applications such as valve-stop or fluidic controller.

Addressing this issue will open new perspectives on the applicability fluid intake smart construction equipment with intensive knowledge and

information. Attempts to use these liquids in such applications were made empirically based on type control ON / OFF.

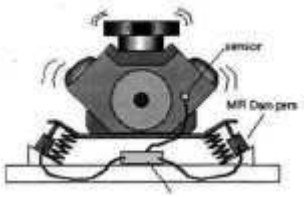

Fig. 5. MR clamping device and vibration damping.

2.4. MR fluid seal rotor shaft

The simple, traditional FFS building consists of a permanent magnet with two magnetic rings ruling. The space between the rotor and the pole is filled with fluid (ferrofluid) via syringe. This procedure executed by syringe is not easily accessible.

After filling pole semiautomatic operation resulting rings bumps on the interior surface. Ferrofluid is held in the space between poles between swelling in non-operational mode. This space is considerably larger than the radius formed between police work and rotor to be filled. Inserting magnetic rotor system and thus causes allocation ferrofluid magnetic flux is attracted to the area.

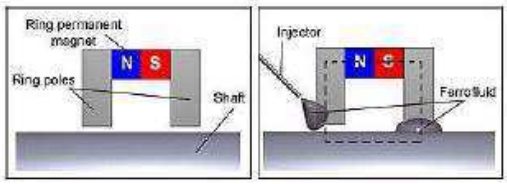

Fig.6. MR fluid sealing structure of the rotor shaft.

2.5. The mathematical model of the valve stop

Most structures using controllable fluids can be classified as having either fixed poles (valve-mode) or poly relative movement (direct-shear mode). Examples of valve structures include servo valves, dampers. Examples of structures relative motion of the poles are brakes, clutches, clutch structures.

The pressure drop developed a valve structures can be divided into two components: an independent component and a component of viscosity behavior induced viscosity. These pressures can be approximated as:

$$\Delta P_n = \frac{12\vartheta QL}{g^3 w} \qquad \text{respectively}$$

$$\Delta P_\tau = \frac{cL}{g}\tau$$

(1)

Note: It should be remarked that this study can easily extrapolate the circular valve structures, noting that expression affected interzones distance for rectangular valve is g, while the cylindrical valve distance is:

$$\pi \cdot d = 2 \cdot \pi \cdot r \qquad (2)$$

The parameter g has a value between a minimum of 2 (pentru $\Delta P_\tau / \Delta P_\vartheta < 1$) up to a maximum 3 (pentru $\Delta P_\tau / \Delta P_\vartheta > 100$).

The pressure drop is about the sum total of the two components $\Delta P_\tau \; si \; \Delta P_\vartheta$.

$$\Delta P = \frac{12\vartheta QL}{g^3 w} + \frac{cL}{g}\alpha H^m \qquad (3)$$

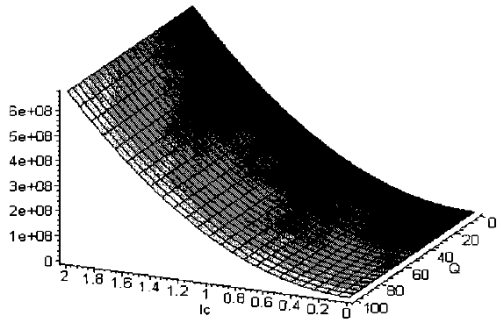

Fig.7. Dependence pressure, flow and current flowing through the coil.

3. CONCLUSIONS

- The properties of magnetically controlled fluid application adjusts the size and volume fraction of the magnetic component $10^0 – 10^4$ nm;

-Saturation magnetization of FM extends an order of magnitude in the case of composite magnetizable fluids $10...7x10^3$G;

-Dimensionless interaction energy covers a very wide area $0,5...10^8$;

-Magnetorheological effect $\Delta\eta / \eta$ is adjusted by the fluid composition $10^{-1}...10^3$;

- Implementation controllable magnetic fluids, industrial production;

REFERENCES

1. Maria Brojboiu – Electrotehnologii. Ed.Orizonturi Universitare Timişoara 2002
2. Gheorghe Floriganţă – Echipamente şi instalaţii pentru prelucrări neconvenţionale. Ed. Sitech 1998
3. Mircea Ivănescu, Viorel Stoian, ş.a. – Sisteme neconvenţionale pentru conducerea roboţilor. Ed.Universitaria 2002
4. George Paicu – Tehnologii electrice speciale. Casa de editură Venus. Iaşi 2006
5. http://www.wikipedia.com
6. http://www.howstuffworks.com