

MRF Technology

Principle

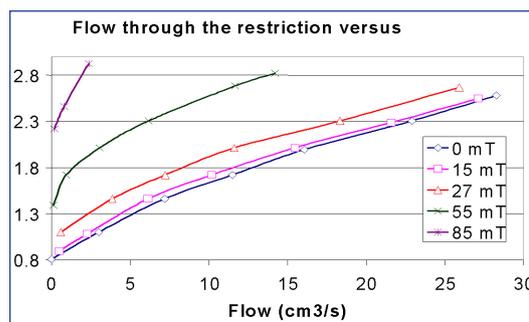
The MRF Actuators are new electromechanical components using Magneto Rheological Fluids (MRF). These smart fluids are characterized by their capability to change their rheological properties, especially their viscosity, versus applied magnetic field. With high enough field, they can switch from a liquid to almost solid body. This effect is reversible. It operates in few milliseconds.

This effect can be used for generating controllable damping or braking capabilities, which can be used for making special electro-fluidic actuators.

Design issues

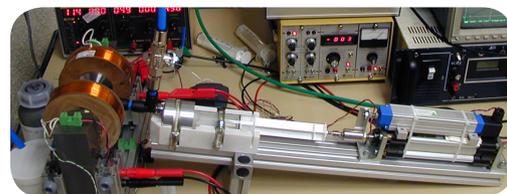
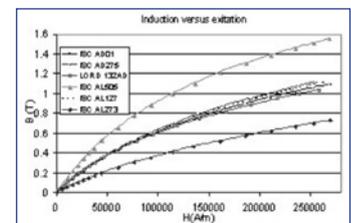
Magneto Rheological Fluid (MRF) Actuators are complex structures needing a careful design, which can benefit of FLUX FEM software for magnetics and CFD FEM for computing flow dynamics. Selecting the MRF and performing an appropriate devices design implies also a good characterization of the MRF magnetic and rheological properties. There are several ways of using MRF:

- Flow mode : In flow mode, the MRF fluid is flowing in a restriction. Applying a magnetic field in the restriction reduces the flow because of increased viscous forces. With high enough field, there is no more flow. This is used for making controllable flow valves without moving parts.
- Shear mode : In shear mode, the MRF fluid is static and placed between two surfaces with a relative motion. Applying a magnetic field in the MRF fluid increases the tangential forces between the two surfaces because of increased viscous force. This is typically used in clutches.
- Damping effects : Thanks to these properties, MRF may be used to provide controllable damping forces that require only a relatively small amount of magnetic energy. Typically the damping coefficient can be increased by 3 to 5 when the field is applied. These possibilities are used in semi-active dampers and controllable shock absorbers.



Pressure vs Flow @ different B-field of a MRF.

Magnetization curves B(H) of various MRF fluids.



CEDRAT TECHNOLOGIES test bench of MRF in a flow mode (active valve mode).

Performances

Typical performances are given in the MRF actuator leaflet. This table is not exhaustive as many other actuators can be rapidly designed by CEDRAT TECHNOLOGIES using its design tools, lab facilities and technological know-how. The following MRF actuator (see here below) can be operated either as a self locking linear brake or as a semi active damper. Without power supply it offers a strong braking force F_{max} holding at rest the out shaft all along the stroke. Increasing the DC current applied to the actuator reduces the force up to less than 5% of F_{max} rendering the output shaft free to move. As the braking force can be electrically controlled, this MRF actuator can also be used as a semi active damper or a semi active shock absorber, requiring low power for managing large damping forces.

References	Unit	A-MRF
<i>Notes</i>		
Stroke	mm	30
Max blocking force @ 0 A	N	100
Max blocking force @ 1.6 A	N	5
Total weight	g	580
Diameter	mm	43
Height (without stroke)	mm	94
Max current	A	1.6
Electrical interface		1 coils = 2 wires
Winding resistance	ohm	1.5
Winding inductance	mH	4.3
Time response	ms	3 (tbc)
Dissipated power in blocking state (@0A)	W	0
Dissipated power in free state (@1.6A)	W	4

Applications

MRF Actuators find applications as semi active dampers, smart shock absorbers, clutches, and brakes...

They are used in automotive industry, civil engineering and are considered in a variety of applications in aircraft, space craft, machine tools, and even consumer goods.

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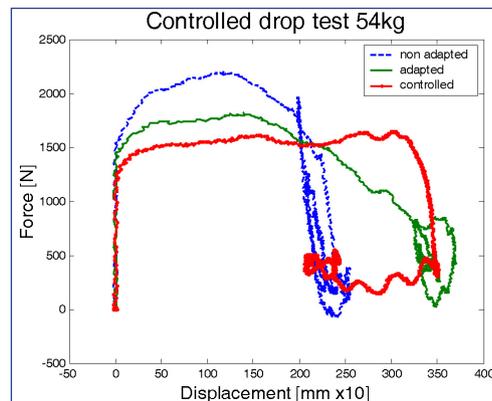
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Collaborations, Supports

CEDRAT TECHNOLOGIES has been partner of the FP6 EC ADLAND (Adaptive Landing Gear) project with EADS, FhG-ISC, MESSIER DOWTY, IFTR, Institute of Aviation, USFD, PZL Mielec. CEDRAT TECHNOLOGIES is presently partner of the Eureka project HYDROSMART (Hydrostatic Bearings For Precision Machinery Lubricated With Ferrofluids And Active Valves) with DANOBAT, IDEKO, KRAFFT, MGEP, CNRS-LPMC.



ADLAND semi-active shock absorber under drop test (Courtesy of IFTR, IA & ADLAND project).



Test results without and with control (Courtesy of IFTR, IA & ADLAND project).



MRF actuator.