MRF Actuators !

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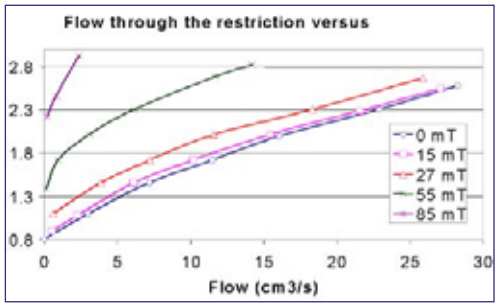
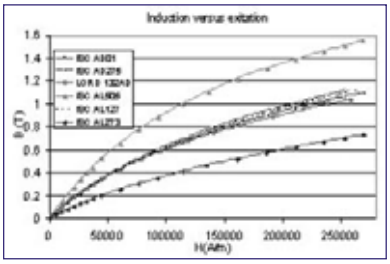
The The MRF Actuator is a new electromechanical component using Magneto Rheological Fluids (MRF). The benefit of these smart fluids is their capability to alter their rheological properties – their viscosity in particular – compared to applied magnetic field. With high enough field, they can switch from a liquid to an almost solid body. This effect is reversible. It operates in a few milliseconds.
This effect can be used to generate controllable damping or braking capabilities, to make special electro-fluidic actuators.



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



Magnetization curves B(H) of various MRF fluids.

Design issues

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

- Flow mode: In flow mode, the MRF fluid flows in a restriction. Applying a magnetic field to the restriction reduces the flow because of increased viscous forces. With high enough field, there is no 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 relative motion. Applying a magnetic field to 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 3 to 5-fold when the field is applied. This is called semi-active damping. This solution is used in semi-active dampers and controllable shock absorbers.

Performances

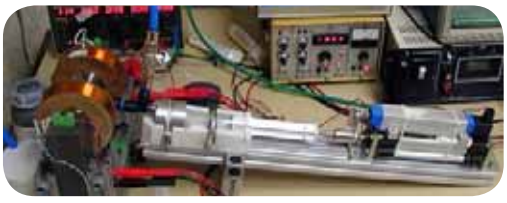
Typical performances are given in the table below. This table is not exhaustive as CEDRAT TECHNOLOGIES can rapidly design many other actuators using its design tools, lab facilities and technological know-how. The MRF actuator shown below can be operated either as a self-locking linear brake or as a semi-active damper. Without power supply it offers a strong braking force Fmax holding the out-shaft all along the stroke at rest. Increasing the DC current applied to the actuator reduces the force down to less than 5% of Fmax allowing the output shaft to move freely. 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 to handle substantial damping forces.

Applications

MRF Actuators are used as semi-active dampers, smart shock absorbers, clutches, brakes, etc…
They are used in the automotive industry and civil engineering and are considered in a variety of applications in aircraft, space craft and machine tools design and even consumer goods.

Collaborations, supports

CEDRAT TECHNOLOGIES was a 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.



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

References	Unit	A-MRF
Notes		
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 stoke)	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

MRF actuator.