Magnetorheological Fluid Based Braking System Using L-shaped Disks

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Abstract

This paper presents a new design of multi-disks Magnetorheological braking system (MR brake) for automotive application considering the magnetic saturation in both electromagnetic core and MR fluid. A one dimensional analytical model is developed to calculate the braking torque of the proposed system. The geometry of the system, which is created in of elements near the AutoCAD®, is discretized using a finite number of triangular elements. The magnetic analysis of the proposed configuration is carried out using AC/DC Module in COMSOL Multiphysics® software. The Finite Element Method (FEM) used to solve the magnetic field distribution and magnetic flux density onto MR fluid and electromagnetic core. The novel design of disks, which manufacturing feasibility has been considered, resulted an improvement compared to previous works considering same dimensional limitations, when the lower current density is applied; however, a fundamental change is required to build a possible automotive MR brake to fully stop the standard size vehicle.

Use of COMSOL Multiphysics®

Magnetic field (mf) interface in AC/DC Module is used to simulate the system when J was defined as a parameter for current density of the coil. Non-linear relationship between magnetic field and magnetic material for magnetic parts is added to the material definition. External current density has been added to the simulation module to enable the magnetic field. Finally Amper's law is used to compute the magnetic field and magnetic flux for both MR fluid and magnetic parts in the system.

Remarks on COMSOL

One of the advantages in using COMSOL is material definition which gives us flexibility to define non-linear relationship between Magnetic flux and Magnetic field, B-H curve.

Surface integration tool helped us to compute the magnetic flux on the core surface and MR fluid which led us having 2D graph which illustrates magnetic flux density on the disks.

Having the option to change the size of the elements in Mesh section would be named as another advantages of COMSOL so the elements for crucial boundaries set to be smaller for accuracy in result.

Finally, COMSOL LiveLink™ for AutoCAD® allowed us to edit the design and simultaneously update the model on COMSOL to simulate the MR brake system.

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Figures used in the abstract

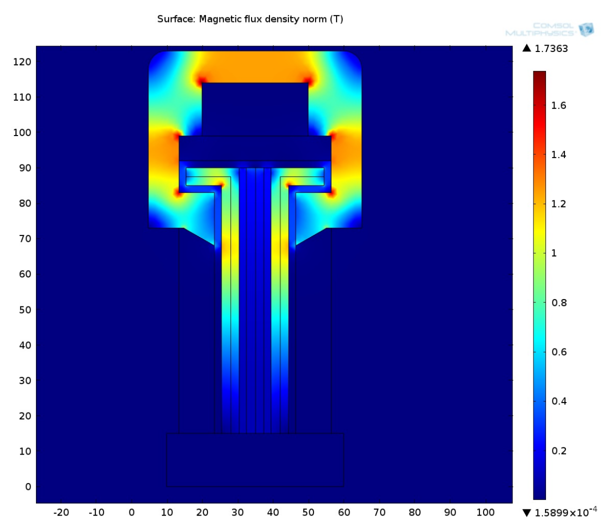

Figure 1: Magnetic flux density for J=10E5.

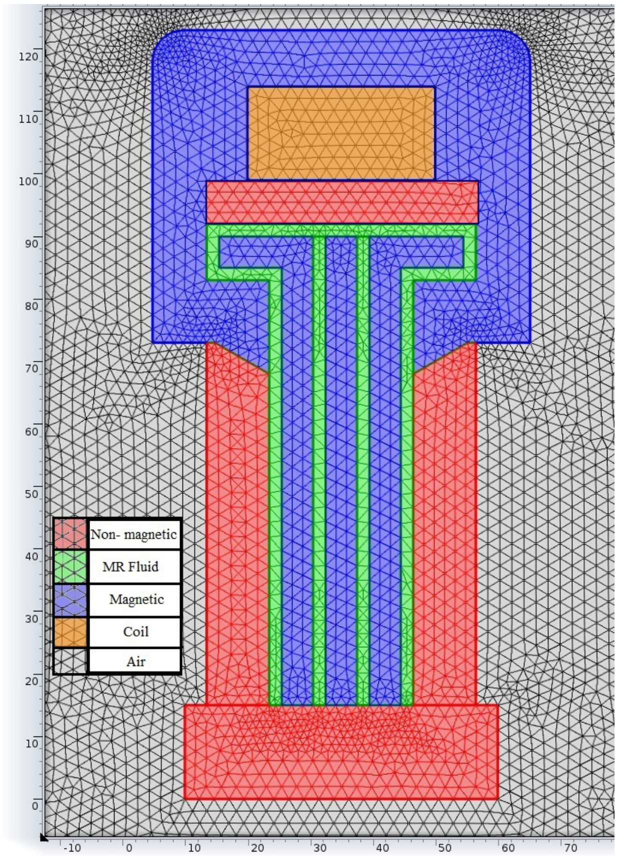

Figure 2: FEM mesh used for the MR braking system using small size triangular element.

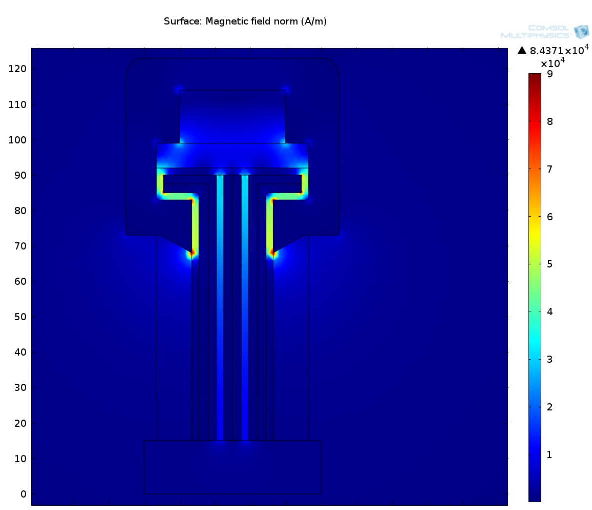

Figure 3: Magnetic Field onto MR fluid for J=10E5.

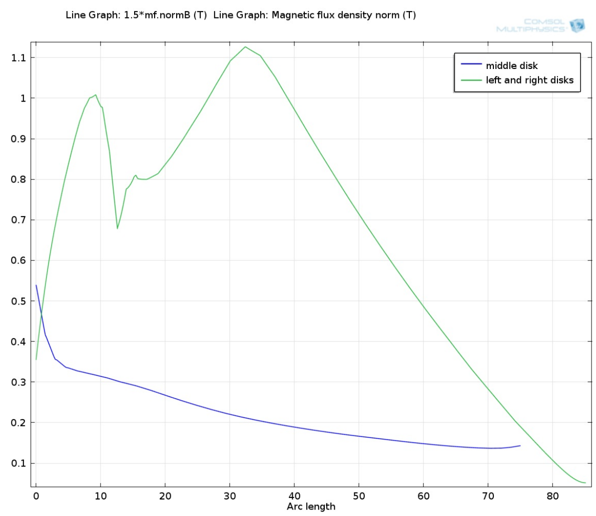

Figure 4: Magnetic flux density on disks for J=10E5.