Simulation of a Rotary Magnetorheological Fluid Damper

D. Harder[1], L. Fromme[1], R. Naumann[2]

[1]University of Applied Sciences Bielefeld, Department of Engineering Sciences and Mathematics, Bielefeld, Germany

[2] University of Applied Sciences Bielefeld, ISyM – Institute of System Dynamics and Mechatronics, Bielefeld, Germany

Abstract

The aim of the University of Applied Sciences Bielefeld is to design a speed-proportional rotary damper. For this purpose we want to use a magnetorheological fluid inside the damper. Magnetorheological fluids (MRF) are composed of small iron particles and a carrier liquid. MRF respond to an applied magnetic field with a change in their rheological behavior [1]. The magnetic field can be generated by a coil, therefore a control of the viscosity of the MRF can be realized. The use of this effect can be found in numerous applications, such as clutches, brakes and shock absorbers [2] [3]. Unfortunately, these applications show strongly nonlinear behavior. The simulation of the rotary MRF damper makes it possible to vary designs and properties to analyze its behavior in detail. The results help to develop control algorithms to generate a speed-proportional damping characteristic.

In this paper, the mathematical description of the MRF is implemented as a Bingham fluid model [1] in a simulation model of a rotary damper. The depending angular velocity for the Bingham model is described as an additional ordinary differential equation. The temporal change of a magnetic field on ferromagnetic materials causes a hysteresis behavior of the magnetization, which is taken into account with the Jiles-Atherton model [4]. In the simulation model, the Bingham fluid model is coupled with the electromagnetic field simulation to analyze the damping characteristic in dependence on the coil current.

The numerical results show the expected behavior, i.e. a hysteresis in the damping characteristics.

Reference

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