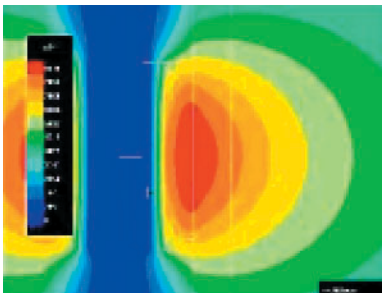
Magnetorheological (MR) Devices

CSA Engineering

MR fluids. You've heard about them, maybe seen the description of an application. Now you're wondering if an MR fluid device could work for your application. CSA Engineering offers design and development services, and prototype and small quantity manufacturing of magnetorheological (MR) and electrorheological (ER) devices.



Magnetic fields are modeled to optimize device performance

The unique feature offered by these "smart" fluids is the ability to instantly vary yield stress or effective viscosity by controlling magnetic field, usually through application of an electric current.

What does this mean? Viscous devices (shock absorbers, hydraulic dampers, clutches, etc.) depend on the viscous forces in a fluid to absorb or transfer energy. The ability to rapidly vary effective viscosity allows nearly instantaneous control over these forces. The result can be simple and cost effective means for:

- Active Suspension
- Variable Torque Transfer
- Controllable Damping
- Force Feedback
- Energy Management
- Frictionless Braking

Why choose CSA Engineering? CSA possesses the necessary tools, equipment and engineering skills to offer a complete active or passive rheological solution. While the operation of a rheological device is fundamentally simple, correct implementation is very complex. Most customers have weight, power, form-factor, durability, accessibility and other competing constraints that drive design. Effective, fast and responsive control of the device is also important. The internal field must be sufficient in density and strength while meeting time response requirements. CSA draws on these capabilities in rheological device development:

- Fabrication and rapid prototyping
- Magnetic field analysis and design optimization
- Proven control algorithms
- Embedded control based on microcontrollers or DSPs
- Full testing and characterization capabilities

A fast-responding MR fluid shock absorber

Some organizations have a familiarity with rheological fluids. Others have experience in device design. CSA brings together all the necessary tools to create MR fluid devices that meet the most demanding requirements.

CSA utilizes established backgrounds in magnetic design, damping, control, and valve design in the development of rheological fluid devices. This experience set ensures a design is optimal for its application. Regardless of the size or type of application, CSA can develop MR fluid devices that make full use of the beneficial characteristics of the controllable fluid. We offer a complete MR capability, from innovative concept to working device.

Small quantity custom electromagnets

Contact Eric Anderson to discuss your MR fluid device needs.

Magnetic Design Services

CSA Engineering

Comprehensive Magnetic Design Services

Magnetic devices are often used in vibration suppression systems, both active and passive. CSA offers a comprehensive suite of services for designing, prototyping, and testing devices such as magnetic actuators and eddy current dampers. Services include magnetic field analysis, mechanical design, fabrication, assembly, and dynamic testing. With a proven track record in the aerospace industry, CSA's engineering team has extensive experience in developing and applying magnetic devices for structural dynamic applications. Whether a project requires a new concept, analysis of an existing design, or a second opinion, CSA offers the necessary expertise.

Magnetic Analysis and Implementation

CSA uses the Magneto and Amperes software packages from Integrated Engineering Software, Inc. Both employ boundary element methods to develop and solve integral equation formulations for magnetic fields. Using either package, CSA can model linear and non-linear magnetic materials as well as a variety of boundary conditions, such as potentials, derivatives of potentials, and impressed fields. Output includes scalar and vector field distributions, force on current carrying conductors, self and mutual inductance, and stray magnetic fields. Proprietary software and methods are used to develop eddy current dashpot models using the field solver results as input. Custom translators permit further data postprocessing in Matlab.

During early phases of a magnetic analysis project, CSA works closely with the customer, reviewing performance requirements, material selection and specifications, operating environment, and design constraints. CSA can carry the design through CAD drawings, prototype hardware, and functional testing as required.

Integration of Magnetic Components in Dynamic Structures

With a history of success in structural dynamics, CSA offers expert capability in defining requirements for magnetic devices and for predicting and measuring the behavior of dynamic systems utilizing such devices. Analyses may include finite element models using NASTRAN and I-DEAS or Matlab models of structures that employ active vibration control. Routinely involved in large, multidisciplinary development projects, CSA can also offer expertise in systems engineering and requirements definition when structural dynamic performance must be balanced against other figures of merit.

Test Capability

CSA's laboratory is fully equipped with state-of-the-art dynamic text equipment, including several multi-channel digital spectrum analyzers, Hall probes, Gaussmeters, and magnetometers. Extensive instrumentation for excitation and sensing is available for measuring performance of magnetic devices. Custom fixturing and test rigs are routinely designed, constructed, and used for specialized developments. Dynamic testing capabilities include modal testing, component testing of actuators or dampers, and test verification of vibration isolation systems or components. Much of CSA's test equipment is portable, so that measurements can be made at remote facilities.

Vibration Isolation Design Using Magnetic Damping

Well-versed in technologies for vibration suppression, CSA has developed vibration isolation systems that employ eddy-current losses to introduce damping to structural systems. The principle behind CSA's magnetically damped isolators and damping devices involves a conductor, such as a coil, disk, or cylindrical sheet, moving in a spatially non-uniform DC magnetic field, such as that created by rare earth magnets. Eddy currents induced in the moving conductor produce a drag force proportional to velocity. Inductance in the conductor reduces the effect at higher frequencies.

Because eddy-current damping effects diminish with increasing frequency, magnetic designs permit high damping of low frequency suspension modes of the isolation system without producing large force transmission at higher frequencies. Because magnetic dampers can be tuned to produce a force/velocity ratio that varies in a controlled way over the stroke of the device, they are useful for controlling impact forces or deployment of spring-loaded mechanisms.

Magnetic damping technologies provide several advantages over other passive damping approaches, such as those involving multi-particle impact damping (MPID), viscoelastic materials (VEMs), vitreous enamels, or viscous liquids. Unlike MPID designs, magnetic dampers can be noncontacting and frictionless with linear, predictable behavior. Unlike VEM, vitreous enamel, and fluid dampers, magnetic designs are all metal, offering low outgassing and low temperature sensitivity.

Contact David Kienholz for more information.