Monitoring Sedimentation of Magnetorheological Fluids Using a Vertical Axis Inductance Monitoring System with a Low Aspect Ratio Sensing Coil

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ABSTRACT

Adaptive energy absorbers (EAs) utilizing magnetorheological fluids (MRFs) to adjust stroking load to account for severity of impact, and payload mass, are currently being investigated for a number of severe impact or shock mitigation problems. Utilizing MRFs in such EAs requires a highly stable suspension that maintains a uniform concentration. Such suspension stability can be studied using a MRF column and a vertical axis inductance monitoring system (VAIMS), as shown in Figure 1, where an inductance sensor is translated along a vertical MRF column to track the mudline, which is defined as the boundary between the clarified fluid above, and the concentrated MRF below, the mudline. The rate of descent of the mudline is typically referred to as the sedimentation rate of the MRF. Prior work used a high aspect ratio (tall) sensor coil [1-2], so that mudline location had to estimated. Therefore, key goals of this inductance sensor design were to: reduce magnetic flux leakage, apply lower magnetic flux, achieve higher spatial resolution to better locate mudline. A low aspect ratio inductance sensor was designed, fabricated and used to measure particle concentration in an MRF column. Using the low aspect ratio sensor coil, the magnetic flux applied to the MRF in the sensing volume was decreased by 20\%. Using the VAIMS with the low aspect ratio coil, the inductance was measured as a function of MRF column height, and its spatial derivative was then calculated. The spatial derivative of inductance was used to more accurately determine the mudline in the MRF column. Discrimination of the mudline facilitated using the low aspect ratio sensor coil, resulting in more accurate tracking of mudline location, and shorter transition zones due to the increased spatial resolution.

REFERENCES