CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Braeden C. Benedict

Project Number

J1302

Project Title

Effect of Material Composition on Shear Strength Yield Point of Magnetorheological Fluids

Abstract

Objectives/Goals

Magnetorheological (MR) fluids increase their apparent viscosity when exposed to a magnetic field due to the presence of iron in the mixture. The purpose of my experiment was to determine the optimum ratio of iron powder to mineral oil and lithium grease mixture for the MR fluid. The best MR fluid would behave as a liquid while non-magnetized and have the greatest change in its shear strength yield point between its magnetized and non-magnetized states.

Methods/Materials

My setup consisted of two acrylic plates with inward-facing ridges cut into them. MR fluid was poured between the plates. The top plate slid on a track when pulled by a cup of pennies linked to a pulley. In repetitive runs, the number of pennies needed to reach the yield point (the point at which the top plate slid) was recorded for each MR fluid composition. This was conducted both with and without a magnet for eight different mixtures, ranging from 0% to 70% iron powder by volume.

Results

The 70% composition had the greatest change in yield point. As expected, the 0% composition (my control) had no significant change. As the amount of iron increased, change in the yield point between magnetized and non-magnetized states increased steadily. However, 70% (the highest percentage of iron tested) is not the ideal fluid because in its non-magnetized state, it did not behave as a fluid. The 60% composition did behave as a liquid and had the next highest change in yield point. Another interesting pattern I noticed in my data was that the yield point for all variable levels increased by a similar factor between their non-active and active states.

Conclusions/Discussion

I concluded the 60% composition is the most ideal MR fluid. My results can be used to create optimum MR fluids for their many real-world applications including seismic dampers, shock absorbers, clutches, brakes, and prosthetic limbs.

Summary Statement

My experiment tested how changing the percentage of iron in a magnetorheological (MR) fluid affected its performance as measured by the increase in its shear strength yield point between its non-magnetized and its magnetized states.

Help Received

My dad taught me how to use the tools needed to build my testing rig. My science teacher taught me about the scientific method and how to properly complete a science fair project.