CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)

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Project Number

J0125

Project Title

An Engine with Nothing Inside? Building a Magnetohydrodynamic Drive

Abstract

Objectives/Goals

To investigate magnetohydrodynamic (MHD) thrust, an intriguing force that can quietly power a boat without moving parts. To design, test and improve a series of MHD engines made from readily available materials. To see if an MHD engine could power a small toy boat.

Methods/Materials

-Understand the Lorentz force that creates MHD thrust and determine how to measure the thrust.
-Test magnets (NdFeB and ceramic) and metal electrodes (Al, Cu, Mo, Ti, Ta, Sn, 304 stainless steel, brass, galvanized steel, Haynes 214) for building MHD engines.
-Build prototypes (using rectangular plastic tubing, electrical tape, duct tape and an adjustable power supply), optimizing magnets, tube dimensions, electrode sizes, and wire-to-electrode contacts.
-Measure the thrust of the engines by suspending them from a pendulum (fishing line) in salt water (with salinity of seawater) and calculating thrust from deflection.
-Select the engine with the best thrust/weight ratio.
-Determine whether thrust vs. current is linear.
-Create and test MHD demos that propel small plastic spheres and a toy boat.

Results

-Thrust was proportional to current, but lower than predicted.
-The best electrodes were aluminum, because they corroded least.
-Making the electrodes shorter than the magnets produced more thrust by forcing the current through the highest magnetic field.
-Keeping the weight low is especially important due to low thrust.
-The engine produced "gunk" and gas bubbles.
-We could power a toy boat, but not very quickly.

Conclusions/Discussion

-A simple equation really did generally predict thrust as it should have:
Thrust = (current) x (engine width) x (magnetic field)
-Narrowing the electrodes to keep current flowing in the region with the strongest magnetic field significantly improved our results.
-It is exciting to see water propelled through a seemingly empty tube.
-MHD engines do work, but even with ideal performance, the thrust is limited with our power supply and magnets. We could power a small toy boat, but it did not move very quickly.

Summary Statement

We built and tested several MHD engine prototypes, found an equation that roughly predicted the thrust, measured the thrust, and discovered that despite all its advantages, MHD has the disadvantages of low thrust and pollution.

Help Received

Parents helped with physics derivations, troubleshooting problems, buying equipment, and some editing and typing. They also provided moral support.