CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
J0105

Project Title
A Study of Magnetohydrodynamic Propulsion and Dimensionless Numbers

Abstract

Objectives/Goals
The objective of my research is to study Magnetohydrodynamic flow of different ionic solutions varying voltage, amperage, conduit cross-section shapes and sizes, and the sizes of magnets and electrodes. The time taken for the flow to travel across the conduit and the amount of sound produced are measured, and the flow velocity and Reynolds number, a dimensionless number that enables scalability of results, are calculated.

Methods/Materials
Two Neodymium magnets are placed on the outside and two Nickel electrodes are placed on the inside of several plastic conduits so that the electric and magnetic fields are perpendicular to each other. This conduit is placed in a NaCl or KCl solution, and electrodes are connected to lead-acid batteries, which cause the ionic solution to flow. Several drops of an oil colloid are injected into the flow and the time taken by the drops to travel the length of the conduit is measured to calculate the flow velocity. Sound produced by the flow is measured by a Decibel meter. The Reynolds number is calculated based on the velocity, solution properties and conduit characteristic lengths.

Results
As voltage and current increased, the flow velocity, sound produced, and Reynolds number all increased. As the distance between the magnets increased, the flow velocity and sound produced decreased. These results were about the same for NaCl and KCl solutions. Larger magnets and electrodes also increased the flow velocity and sound produced. These results are consistent for all conduit shapes and sizes. All the relationships are linear. Since Reynolds Number includes the velocity and the cross section size, the various lines for different conduit sizes became closer, tending towards one line.

Conclusions/Discussion
When the magnetic field or electric field strengths are increased, it causes more Magnetohydrodynamic force and makes the ionic solution flow faster. This produces more noise and yields a higher Reynolds number also. When the conduit cross section is increased, or the distance between magnets is increased, the flow velocity decreases due to a weaker magnetic field. Since all these relationships are linear, these results can be extrapolated to higher voltages and Reynolds Numbers.

Summary Statement
This project studied the effect of several variables on properties of Magnetohydrodynamic flow.

Help Received
My father supervised my testing and helped me in soldering and collecting data, which required 2 people.