CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
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Project Number
S0227

Project Title
Adding Turbulence to the Kutta-Joukowski Lift Theorem

Abstract

Objectives/Goals
The objective of this project was to show how well the Kutta-Joukowski Lift Theorem explains Magnus Force on spinning cylinders. This was achieved by comparing theoretical lift to measured lift for various spin frequencies, wind velocities, cylinder diameters, and degrees of turbulence.

Methods/Materials
To achieve my objective, I built a wind tunnel. I used a variable DC power supply to drive the spin motor, a laser tachometer for measuring spin frequency, an anemometer for measuring wind velocity, an electric leaf blower for the wind source, a digital scale for measuring lift, and different cylinder surface materials to vary the turbulence.

Results
I collected and graphed the data. The graphs show that the Kutta-Joukowski Lift Theorem does, in fact, explain the linear relationships between lift and spin frequency, lift and wind velocity, as well as the square relationship between lift and cylinder diameter. I also demonstrated that lift in each case increases as turbulence decreases.

Conclusions/Discussion
My project taught me many math and science skills. I first learned about the origins of Magnus Force and the Kutta-Joukowski Lift Theorem. I learned some basic fluid dynamics, including Bernoulli's Principle, viscosity, laminar air flow, and turbulent air flow.

Summary Statement
I designed and constructed a wind tunnel to measure transverse forces on spinning cylinders, and compared those forces to the predictions of the Kutta-Joukowski Lift Theorem under different conditions of turbulence.

Help Received
My parents supported, guided, and encouraged me when working on my science project. My father helped me in the construction of my wind tunnel, and my mother helped me in the design of my board.