CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
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Project Number
S0103

Project Title
The Robins-Magnus Effect and the Effect of Increasing the Surface Area on the Velocity of a Rotating Solid Sphere

Abstract

Objectives/Goals
The purpose of this experiment was to observe the effect of increasing the surface area of a rotating solid sphere on its velocity as it traveled through a fluid media. The sphere rolled down a ramp and traveled through the fluid in the aquarium. The sphere continued to spin as it flowed through the fluid, creating a curve in its trajectory. The sphere's trajectory was recorded and analyzed.

Methods/Materials
An aquarium was filled with water and a ramp structure was placed on top of the aquarium. The sphere rolled down the ramp and entered the aquarium vertically. The sphere's trajectory was recorded using the video camcorder. Trial repeated four times. 12 equally spaced holes were drilled into the sphere (Test B), increasing the SA. The trials were repeated. An additional 20 equally spaced holes were drilled into the sphere (Test C). The video replay was analyzed.

Results
Test A: The trajectory of a sphere without any drill holes was recorded using a digital camcorder. The avg. vertical speed of sphere A was 105-cm/sec +/- 6.7%. The avg. overall deflection for A was 2.6 cm.
Test B: 12 equally space holes were drilled into the sphere. The avg. vertical speed of sphere B was 107-cm/sec +/- 2.6%. The avg. overall deflection for B was 6.8 cm
Test C: 20 additional holes were drilled into the sphere. The avg. vertical speed of sphere C was 99-cm/sec +/- 2.2%. The avg. overall deflection for C was 8.9 cm

Conclusions/Discussion
Deflection Hyp. stated that an increase in the SA would augment the sphere's boundary layer. As the boundary layer expanded, there was more skin friction between the fluid particles and the surface. The skin friction is responsible for pulling fluid particles in the direction of the sphere's rotation. This increased the difference between the fluid pressures of the two sides. An increase in the fluid pressure difference increased the magnitude of the Magnus force, which causes the sphere to curve.
Settling Hyp. stated that as the SA increased, the vertical speed of the sphere would decrease. This was unsupported by the data. Logically, an increase in surface area would increase the amount of skin friction between the surface and the fluid, inhibiting motion. In addition, Stokes' Law illustrates that the settling velocity depends on the shape of the particulate. Due to the lack of precision of the measuring equipment (ex. frame rate)

Summary Statement
An increase in surface area increases the interaction between the sphere's surface and the fluid particles. To what extent does the SA of the sphere affect the deflection in the rotating sphere's trajectory and its settling velocity?

Help Received
No outside help was provided.