California Science Center

CALIFORNIA STATE SCIENCE FAIR
2001 PROJECT SUMMARY

Your Name (List all student names if multiple authors.)
Daniel L Kluesing

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S0912

Project Title (Limit: 120 characters. Those beyond 120 will be ignored. See pg. 9)
The effeect of pressure on the temperature gradient of the Ranque-Hilsch Vortex Tube.

Division
S Junior (6-8) S Senior (9-12)

Preferred Category (See page 5 for descriptions.)
9 - Fluid Mechanics/ Aerodynamics/ Thermophysics

Abstract (Include Objective, Methods, Results, Conclusion. See samples on page 14.)
Use no attachments. Only text inside these boxes will be used for category assignment or given to your judges.

The Ranque-Hilsch vortex tube confines two vortices formed from compressed air within a tube. Through an unknown phenomenon two streams of air are produced, one hot, the other cold. The vortex tube is assumed to be both adiabatic and isentropic. The goal of this experiment is to test the validity of the isentropic assumption and should it hold true, relate changes in input pressure directly to the change in temperature difference. To begin, a base of figures to predict the actions of the vortex tube were created. An equation for change in entropy specific to the vortex tube was derived and used with predictions for temperature to find the change in entropy in the tube. A vortex tube was then constructed and tested. The vortex tube produced a temperature gradient of approximately 6.5 degrees Celsius. Such a gradient illustrates that the tube does indeed function, but also suggests a great deal of inaccuracy in the design, and so these figures cannot be used to normalize the theoretical results. Using purely theoretical results the change in entropy roughly mirrors the hot-to-cold pressure ratios with the highest likelihood of the tube being isentropic occurring when the hot-to-cold pressure ratio divided by the input pressure is in the range of 0.22 to 0.56. The data shows that the change in entropy is directly related to the pressure profile of the tube. Knowing this, equations are proposed to give the internal pressure at any point within the tube. The predicted temperature gradient was found to be at its widest point when the tube is isentropic and can be predicted with a modified version of the equation derived to find change in entropy. The design of the tube is being improved with the goal of reducing the effects of turbulence and other design inaccuracies to increase the temperature gradient.

Summary Statement (In one sentence, state what your project is about.)
A study showing that the input pressure of the vortex tube is secondary to internal pressure ratios and entropy profiles in calculating the end temperature gradient of the vortex tube.

Help Received in Doing Project (e.g. Mother helped type report; Neighbor helped wire board; Used lab equipment at university X under the supervision of Dr. Y; Participant in NSF Young Scholars Program) See Display Regulation #8 on page 4.
Used compressed air equipment at San Jose Sate University under the supervision of Professor Buff Furman