CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
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Project Number
S0206

Project Title
Thermally Accelerated Vacuum Dryer: Method for Direct Extraction of Energy from Temperature Differences in Environment

Abstract

Objectives/Goals
The purpose of this project was to investigate the potential effectiveness of a Thermally Accelerated Vacuum Dryer in saving power and time through the exploitation of temperature differences, and to ascertain whether the device and concepts behind it should be investigated on a higher level. It was hypothesized that when the intercooler chamber temperature was lowered from approximately 25±3 °C to approximately -15±3 °C temperature, the time, power, and the number of pumping cycles required to achieve full evaporation would both significantly decrease (quantitatively by >1.0 x 10^1 %).

Methods/Materials
The dryer, as constructed, consists of a chamber for the object to be dried, an intercooler/condenser chamber, and a vacuum pump, which work synergistically to utilize variation in vapor pressure resulting from temperature differences between the chambers. The vacuum pump lowers the pressure in the drying chamber enough that the relatively warm liquid on the object to be dried boils. It then draws the resulting vapor through the intercooler where it recondenses. The recondensation lowers the pressure, increasing the vacuum, and further facilitating the evaporation of the liquid in the first chamber.
Standard quantities of water were placed on an object in the evaporator chamber, and pump cycles and pump time were recorded, with and without a cooled intercooler chamber.

Results
As theory predicted and high-precision quantitative and qualitative experimentation revealed, this setup allowed an object to be dehydrated significantly more quickly and efficiently than with a traditional vacuum dryer (total time necessary decreased by 19.7% from 207±8.2 sec to 167±6.8 sec, energy necessary decreased 19.8% from 21.9±1.3 kJ to 18.5±0.82 kJ).

Conclusions/Discussion
These positive, precise results indicate that the Thermally Accelerated Vacuum Dryer and the concepts behind it are worthy of further study. It is in the conceptual power of its ramifications that the Thermally Accelerated Vacuum Dryer's strength lies, not in its specific application to vacuum drying - this scheme provides a way to make use of previously inaccessible energy present in the environment (in the form of temperature differentials, such as those over ocean thermoclines) to potentially save tremendous amounts of time and energy in vacuum drying, distillation, desalination, dehumidification, and electricity cogeneration.

Summary Statement
The Thermally Accelerated Vacuum Dryer is a device that uses a separation of temperatures (often already present in the environment) to facilitate vacuum drying, distillation, desalination, dehumidification, and electricity cogeneration.

Help Received
Father, Roger J. Cole, Ph.D, supervised, though did not perform, construction of device (drilling and epoxy).