Solar Thermal Adsorption Refrigeration System

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Abstract

The Solar Thermal Adsorption Refrigeration project started in 2012 with a partnership between the University of Dayton and Solar Alternatives and Associated Programmes (SAAP). The carbon-ethanol adsorption refrigerator operates on a solar thermal cycle. It is intended to be used in rural clinics in Bihar, India to store vaccines between 2°C and 8°C. The 2014 ETHOS group worked on the existing prototype. The group sealed the refrigerator system using different sealants. A test was performed to obtain temperature and pressure data of the operating system. Future work includes optimizing the physical design, vacuum pressure levels and operating procedure.

Introduction

- There are constant power outages in India due to unstable power supply
- Clinics struggle to effectively store vaccines
- Vaccines are wasted if temperature conditions are not maintained
- The Solar Thermal Adsorption Refrigeration project was started in 2012
- Previous ETHOS groups developed a prototype
- Main challenge: sealing the system

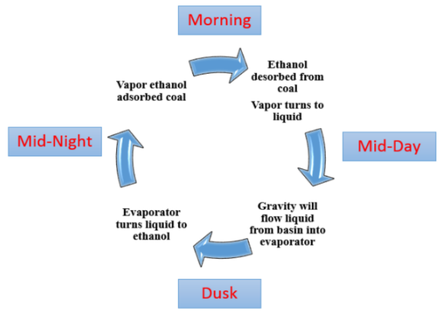

Figure 1: Daily Adsorption Cycle

Project Description

- Activated carbon-ethanol pair
- Uncommon for solar powered adsorption cooling applications
- To achieve the desired temperature range, a vacuum of -29.25 in-Hg is necessary

Table 1. Ethanol and Methanol Evaporation Data

Gauge Pressure (in Hg)	Ethanol Temperature (°C)	Methanol Temperature (°C)
-29.5	-2.55	-13.02
-29.25	6.06	-6.45
-29	11.92	-1.99
-28.75	16.35	1.39
-28.5	19.92	4.11
-28.25	22.92	6.39
-28	25.49	8.36
-27.75	27.75	10.08

Objectives for Summer 2014:

- Seal the system against atmosphere
- Run tests to evaluate the system's performance

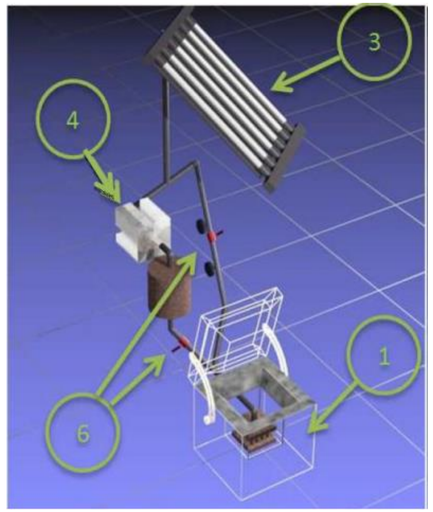

Figure 2: Sketch of the system

Results & Discussion

Several methods were used to seal the system. Each sealant worked well for specific applications.

Table 2: Knifing Paste and Natural Fiber Performance

Time Elapsed (hr)	Vacuum Pressure (in Hg)
0	26.5
7	26.25
23.5	27
52	26.5
102	26.5
167.5	27
457.5	27.25

Figure 3: Knifing Paste and Natural Fiber Test

Table 3: Sealants used to seal the system

Sealant	Application
Knifing Paste and Natural Fiber	Threaded pipe unions
M-seal	Pinhole leaks in welds
Yellow Teflon	Gauge Adapters

- Test was run for 82 hours
- A cycle of warming and cooling was achieved, but at an unexpected time
- A temperature of 21.7 °C was achieved
- Condenser (50 ft) is twice as long as needed

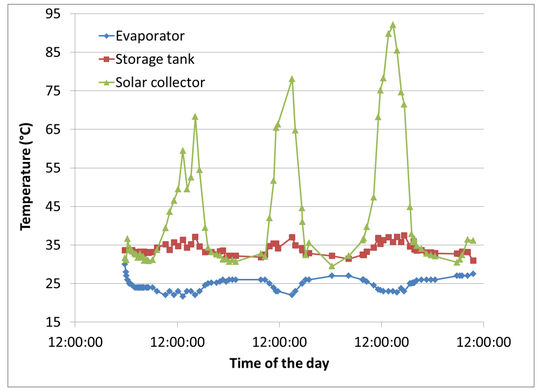

Figure 4: Temperature data collected during test

Results & Discussion

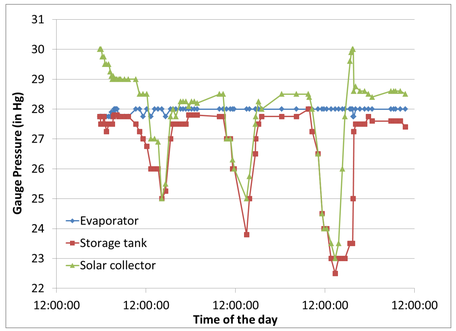

Figure 5: Pressure data collected during the test

Recommendations

- Redesign condenser
- Run longer tests on operational fridge to gather more performance data
- Investigate sealing methods for plastic tubes
- Test long-term performance of sealing methods
- Evaluate possibility of achieving desired
- pressure with current vacuum pump

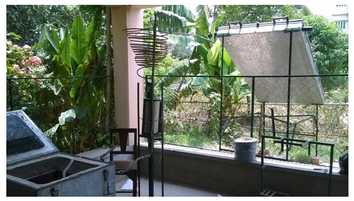

Figure 6: Overview of the prototype in Patna, India

Acknowledgements

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