Executive Summary

The goal of this project is to design a solar powered refrigeration compressor. This includes a proof of concept of the cycle's thermodynamic model and fabrication of a working model. This means adequate cooling is produced with minimal electrical energy input, allowing small standalone units to operate almost entirely off solar thermal energy. This type of vapor compression refrigeration (VCR) is vastly different than what is on the market today. Current solar refrigeration technology involves ammonia evaporation, which is highly inefficient and bulky in comparison. Typical evaporation refrigeration devices are in the range of thirty to forty percent efficient. Needless to say, it's time for a change. This new VCR cycle could serve many markets, reducing the use of non-renewable energy sources and moving towards a sustainable future. Markets such as produce transportation, biomedical refrigeration, home air conditioning, and even the familiar drink cooler could benefit from this technology. To turn this idea into a marketable, economically feasible, mechanical device would forever change the way we use our energy.

Background

Commercial refrigeration, heating, and air conditioning account for over 30% of the nation's energy consumption, there is a clear opportunity to increase the efficiency of refrigeration cycles. Today, most solar refrigeration devices on the market use absorption refrigeration to achieve the cooling effect. These absorption devices are typically in the range of 30-40% thermal efficiency and require massive heat transfer rates at high temperatures [1].

The use of vapor compression refrigeration systems in the solar thermal sector is small; even more the research into the applicability of a VCR system is quite smaller still. Our team is researching and developing a prototype of a dual piston compressor to implement in VCR. We want to determine the thermodynamic efficiency of the system and the economic feasibility of creating a VCR cycle using our low energy compressor. Our motivation is to create an economical refrigeration system that uses a thermal compression instead of the traditional thermal absorption. We need to build a VCR system prototype that can have a cooling effect that is equal to the cooling capacity of a mini-fridge. It must be small, have a low energy input, temperature boiling range from room temperature to 140^{o}F. If these specifications cannot be met, we will increase the cooling capacity and temperatures to meet those of a typical residential air conditioning unit. Our expected benefits of a thermal compression system would be- the reduction of electrical input and non-renewable energy use.

2.0 Problem Definition

2.1 Client Needs

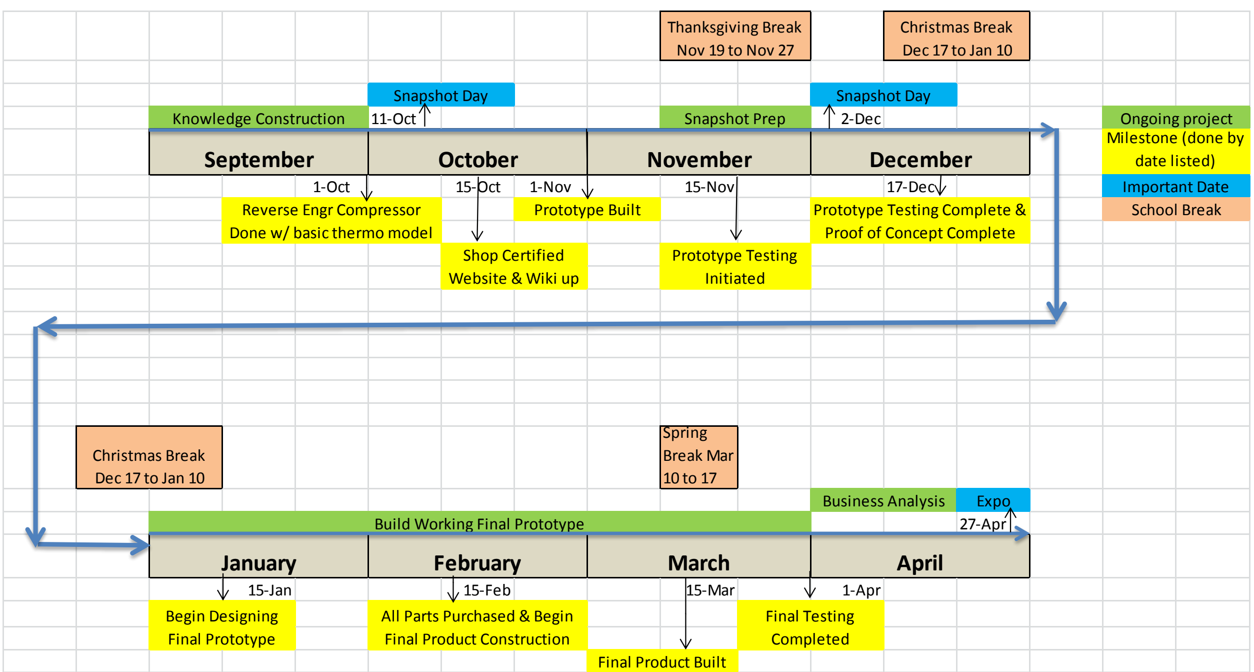
The client needs are defined below.

- Cooling effect equivalent to that of a mini fridge
- Size equivalent to that of compressors in existing mini fridge
- Minimal electrical input to the cycle
- Acceptable range of operation parameters
- Compression is achieved mechanically
- Good functionality
- Easy to fabricate
- Acquire operating data
- Modeling
- Longevity

Specs go Here

Project Plan

Schedule



To design this refrigeration compressor, we broke the research and development into two phases. Phase one involved proving the compressor would work with a thermodynamic model. We also built a prototype to test compression with this unique piston arrangement. Phase two will begin early January with beginning the final prototype design. The system will then be fabricated to fit our compressor, with a goal to finish testing by April 1.

Team Task/Responsibilities for Fall 2011:

Chris: Thermal design of the system within EES, researcher, designer

Jessie: Conduit to Mark for task updates, project organization, researcher, designer

John: Financial officer, prototype fabrication, researcher, product development

Tim: Internet guru, researcher, product development, designer

Zane: Thermal design of the system within EES, designer, researcher, product development

System Architecture

- 2 pages
- Describe the conceptual design – justify continuation
- Describe components & how they are integrated
  - Highlight our value added
  - How does each major component satisfy a requirement?
- Quantitative results

Future Work

Phase one of our project is nearly complete, and phase two will be started early next semester. Our compression testing prototype is complete, and tests will be run to determine compression in early January. Stage two of the project will be the design of a mechanical system based on our thermodynamic model which is nearly complete. Suitable component configurations and sizes will be based on values determined by our math model. Off the shelf parts will be purchased whenever possible, sized to fit our compressor specifications. The design of the compressor will determine the functionality of our system, so most of our team's resources will be put into ensuring a proficient design. Valve design, valve timing, chamber sizing, chamber sealing, mechanical lubrication, and materials used are design issues which have been investigated and will be resolved in the final prototype.

Preliminary Budget

Cast Acrylic $29.24 x2 +$10 shipping

Black Acrylic $23.66/ft x1

Allthread $6.83/3ft x1

Hardware $9

O-rings $7

Tubing $4

Connections $25

Pneumatic fittings

Hose clamps