Project Plan / Product Specifications

Mechanical Engineering Senior Design

Team 20

Solar Powered Phase-Change Compressor

Addison Bender

Jesse Diaz

Emmanuel Ferdinand

10-11-12

I. Code of Conduct

- See report submitted on 9-20-2012.
- Defined expectations for team cooperation and individual roles.

  Team Leader – Jesse Diaz

  Treasurer / Sponsor Liaison – Addison Bender

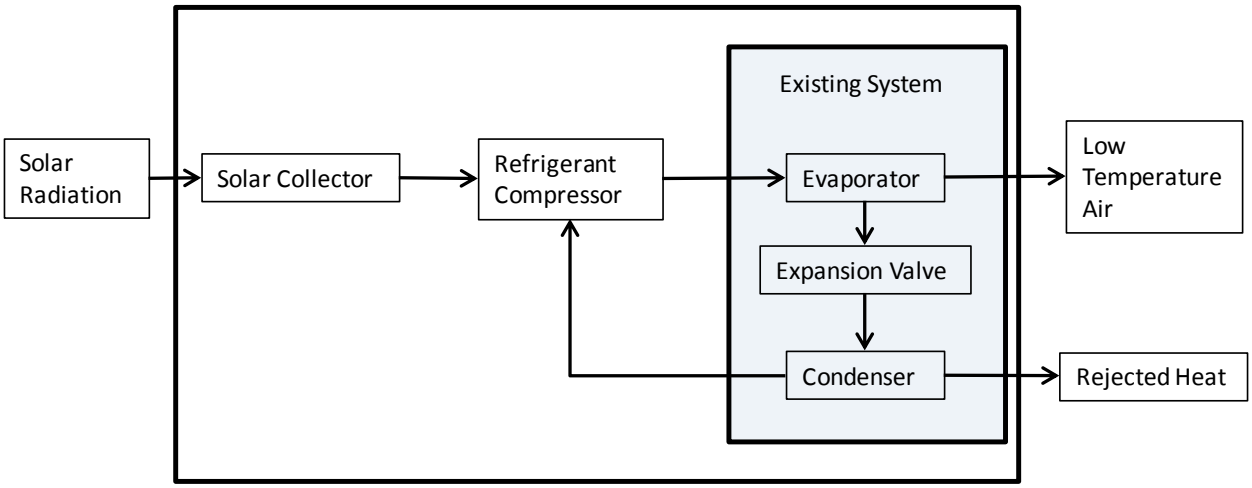
  Webmaster – Emmanuel Ferdinand

II. Needs Analysis

- See report submitted on 9-27-2012.
- Concise need statement which does not restrict potential design options:
  "Design a compressor for an HVAC application that is powered by solar energy."

III. Concept Generation and Selection

Functional Analysis:



Above is a functional diagram of the system to be designed. The system is fundamentally a vapor-compression refrigeration cycle, with the power input coming from solar radiation. The desired output is low temperature air, or heat removal from a lower temperature environment. The project will have three major component tasks, shown from left to right in the box representing the system. First, a means of collecting and concentrating solar radiation must be developed. Second, a compressor, which is the main focus of the project, will use that energy input to raise the pressure and temperature of a refrigerant fluid. Finally, this compressor must be interfaced with an existing system that includes the three remaining components of a vapor-compression refrigeration system.

Concept Generation and Research:

The leading concept for the design will be inspired by the Sponsor's (Grant Peacock) idea for a reciprocating compressor which uses expansion of a boiling fluid to compress the refrigerant. Keeping with good engineering practice, we will not immediately rule out feasible design alternatives which achieve the same goal.

Research Task 1 – Jesse Diaz

As a benchmark which the project outcome will be compared to, it will be useful to research a means of powering an air conditioning unit using photovoltaic generation. This will involve determining the power requirement of an AC unit, and the size of solar panel required to meet the power need.

Research Task 2 – Emmanuel Ferdinand

The concept I will research involves incorporating a solar collector to power a steam engine such as a Stirling engine. The steam engine in turn will mechanically power a pump which compresses the refrigerant. Looking at a rough idea of what will be needed, I will research the amount of heat required to drive a small steam engine, the scale of engine required, valves to control flow, and any items/issues I come up against.

Research Task 3 – Addison Bender

A Solar-Thermal Tri-Generation system will be researched as a possible concept of generating electricity for powering the compressor. I will research the possibility of a small scale version that Florida State University's Energy & Sustainability Center is currently developing. The general concept of the Tri-Generation system is that concentrated is used to heat circulating heat, which is then flash boiled into steam. This steam is then expanded through a small high speed turbine coupled with a generator for electric power production. This is the power the compressor will ultimately receive. Since, the system is still in its earlier stages of advancement, I will be trying to define alternative methods for generating the electricity needed to power a compressor of a ~5,000 btu A/C unit. The concept of generating the electricity is an important task, but I also will have to discover the process of taking the generated electricity and transferring it to the compressor while minimizing losses due to the transfer. Once I have conceived the process of heating the water, generating the needed amount of electricity, and then powering the compressor; I can then focus on researching the hardware needed to create the most efficient process.

Concept Evaluation and Selection:

After multiple design concepts have been researched, criteria will be developed for evaluating each concept. Criteria to be considered will include cost, manufacturing time, versatility, maintenance, and design novelty. A decision matrix will be used to evaluate and rank the different concepts.

Individual Design Tasks:

Our team has broken down the system into three main components that we feel necessary are vital to the success and future progress of our project. The method of delegating the major sections of the project will assist in each member becoming technically familiar with his component, substantially increasing the group's knowledge of the system.

Task #1 – Addison Bender

Addison will be researching the solar collector/concentrator, the heat supplier of the compressor. He will interact with Florida State University's Energy & Sustainability Center to determine small scale concepts needed in order to collect enough heat for our system. Addison will be focusing on understanding renewable energy technical journals and other research material related to solar concentrators, in hoping to become a technical expert on his delegated component of the system. He must be able to communicate with experts in the field on a technical level in order to determine the most efficient system for the phase-change compressor.

Task #2 – Jesse Diaz

Jesse will be researching the compressor and its working components. He will be in charge of understanding the thermodynamic analysis of the compressor. The pressure and temperature values of the heating fluid, as well as the refrigerant, are pertinent in obtaining values that will assist in the selection process of our hardware. The research material will comprise of understanding how the compressor will work under different conditions. Another relevant component of the compressor will be to determine whether or not a secondary heat source, such as a burner, will be utilized to additionally heat the expanding fluid.

Task #3 - Emmanuel

Emmanuel will be working on comprehending the interface of the compressor with the solar concentrator. He will be working on linking the two above components, while determining the appropriate units that we will test. Since we will be developing our own compressor, the group must select an A/C wall unit that will have a sub-standard stock compressor already installed due to the fact that we will be removing it. The overall selection process is to ultimately focus on choosing pre-constructed units that our group can experiment with while saving money. Emmanuel will also be researching the actual compression cycle; whether or not we will use an elastic membrane or a moving compression for compressing the refrigerant.

IV. Project Schedule

Team #20 Project Plan				
Fall 2012	Duration	Start	Finish	Milestone date
Code of Conduct	3 days	9/17/2012	9/19/2012	9/20/2012
Needs Assessment	6 days	9/19/2012	9/26/2012	9/27/2012
Project Scope	2 days	9/19/2012	9/20/2012	
Problem Statement	1 day	9/21/2012	9/22/2012	
Justification/ Background	2 days	9/24/2012	9/25/2012	
Objectives (Measureable Criteria)	3 days	9/24/2012	9/26/2012	
Constraints	2 day	9/25/2012	9/26/2012	
Concept Generation and Selection	12 days	10/9/2012	10/23/2012	10/25/2012
Functional Analysis	4 days	10/9/2012	10/12/2012	
Individual Tasks and Assignments	4 days	10/9/2012	10/12/2012	
Design Concepts Development	2 days	10/12/2012	10/15/2012	
Concept Evaluation and Selection	3 days	10/16/2012	10/17/2012	
Product Specifications for Hardware	4 days	10/17/2012	10/21/2012	
Performance and Functional Specs	3 days	10/19/2012	10/22/2012	
Midterm Presentation/ Report	4 days	10/19/2012	10/23/2012	
Team Evaluation Report	4 days	10/26/2012	10/31/2012	11/1/2012
Presentation to MEAC	TBD	TBD	TBD	11/8/2012
Dry Run	TBD	TBD	TBD	
Presentation	TBD	TBD	TBD	
Interim Design Review Presentation/ Report	10 days	11/1/2012	11/14/2012	11/15/2012
Ordering of Hardware, Material, and Others	11 days	11/13/2012	11/27/2012	11/29/2012
Final Design Presentation and Report	14 days	11/17/2012	12/6/2012	12/6/2012

V. Gantt Chart