Restated Project Scope/Plans

Project #17: Shuttle Valve

1st Spring Deliverable

Group Members:

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Billy Ernst – Team Webmaster

Samantha Zeidel – Team Treasurer

Sponsor:

Verdicorp Inc.

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Instructor:

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Date Submitted:

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Contents

Project Overview

Project Scope

Verdicorp Inc. has improved a revolutionary power generation system (Figure 1) that converts low grade waste heat into electrical energy. [1] Organic Rankine Cycle systems can best be described as a refrigeration cycle running backwards. Instead of using electrical energy to produce cooling, this system takes heat from a low grade source and turns it into electrical energy. The power is then phase matched to meet the local electrical grids.

Figure 1. Picture of one of Verdicorp's Organic Rankine Cycles.

Verdicorp Inc. uses the environmentally friendly refrigerant 245fa in their ORC systems. The refrigerant is heated from the waste heat of a low grade source in a series of heat exchangers and sent into a turbo generator. The refrigerant spins a turbine blade which turns an electrical generator, producing electrical power. Once the fluid passes through the turbine it then goes through a condenser and back to the pump to be recirculated through the system. The pump is a parasitic loss which consumes electrical energy and lowers the overall efficiency of the ORC. Our sponsor has tasked our design team with the requirement to mitigate this effect with the insertion of the shuttle valve system.

Project Goal

The final prototype of the shuttle valve system must resemble a system which can be incorporated into the existing ORC system in place of the original pump. The ORC is capable of producing ~125 kW of power, but due to parasitic losses in the system that consume ~20 kW of the power produced, it is limited to a surplus of ~105 kW of useful power. The pump accounts for half of these parasitic losses, ~10kW, so replacing the pump with our team's shuttle valve design should basically eliminate half of the parasitic losses, thus increasing the overall efficiency of the system. The prototype must maintain a constant flow rate of 3 gallons per minute through the use of multiple storage tanks. It should sufficiently decrease the amount of electrical waste compared to the original pump. The prototype will use water, but future calculations will be based on both water and refrigerant 245fa since the actual ORC system uses the refrigerant. The overall expectation of the end product is to increase the efficiency of the existing ORC system by reducing electrical consumption.

Project Objectives

- Finish any modifications to the final design of the shuttle valve system.
- Maintain the continuous flow of liquid within the prototype (~3 gpm).
- With the use of control valves and the aid of gravity, adjust the pressure inside the tanks up and down by balancing the gas pressure.
- Transfer the liquid from the low pressure side of the system to the high pressure side.
- Finish purchasing the remaining design components found in the procurement.
- Begin constructing the prototype of the final design by January 21st, 2014.
- Test and troubleshoot the prototype upon completion of its individual segments.
- Final prototype completion and presentation to MEAC Open House on April 17th, 2014.

Project Constraints

- The overall design budget is limited to $2000.
- The prototype developed by the senior design team must use water in place of refrigerant 245fa, which is the fluid used in the actual system. Our design team is prohibited to use this product by the FAMU-FSU College of Engineering because of its possible health hazards, which may include irritation and dizziness when exposed.
- The fluid within the system must maintain a constant flow rate, with an approximated flow rate of 3 gallons per minute.
- The design must be as small as possible, with a 2 meter height restriction in place.
- The system must contain numerous tanks which contribute to the constant flow rate. A system containing only one tank would be considered a failed prototype to the sponsor company.
- The modified system must use minimal, to preferably no, electricity.
- The system must be completely closed to prevent any losses in the amount of refrigerant 245fa used in the actual system.
- The system must contain pressure gages to indicate the changes in pressure within the system; when and where the pressure is changing.
- The overall change in pressure within the system is restricted to a total of 50 psi.

Midcourse Changes/Modifications

The design team must modify the design to allow a pocket of air to be available within the top of the holding tanks per request by the team sponsor. This will be achieved by incorporating two extra control valves to govern the flow of liquid from the condenser to the holding tanks. There will also be two more sensors positioned at the top of the holding tanks to signal when the tanks will change phase, instructing the control valves to change position. The top and bottom heads of the holding tanks will be made from square aluminum stock and attached with 3/8 inch threaded rod. The heads will be sealed by machining grooves in them to be fitted with rubber O-rings. When the nuts are tightened on the threaded rods, the O-rings will compress, thus sealing the holding tanks.

Procurement and Budgeting

Purchased

- All PVC piping and fittings
- 6.5 gal oil extractor (boiler)
- Electrical relays (supplied by Verdicorp)
- Air compressor (supplied by Verdicorp)
- Pneumatic control valves
- Condenser tank
- **Total cost: $345.65**

To Be Purchased

- Liquid control valves
- Stainless steel tubing (pressure lines)
- Acrylic tubing (holding tanks)
- Aluminum stock (holding tanks)
- 3/8 inch threaded rod
- 3/8 inch nuts
- Magnet material (float sensors)
- Styrofoam (float sensors)
- **Estimated cost: $510.94**

Total Expenditure: $856.59

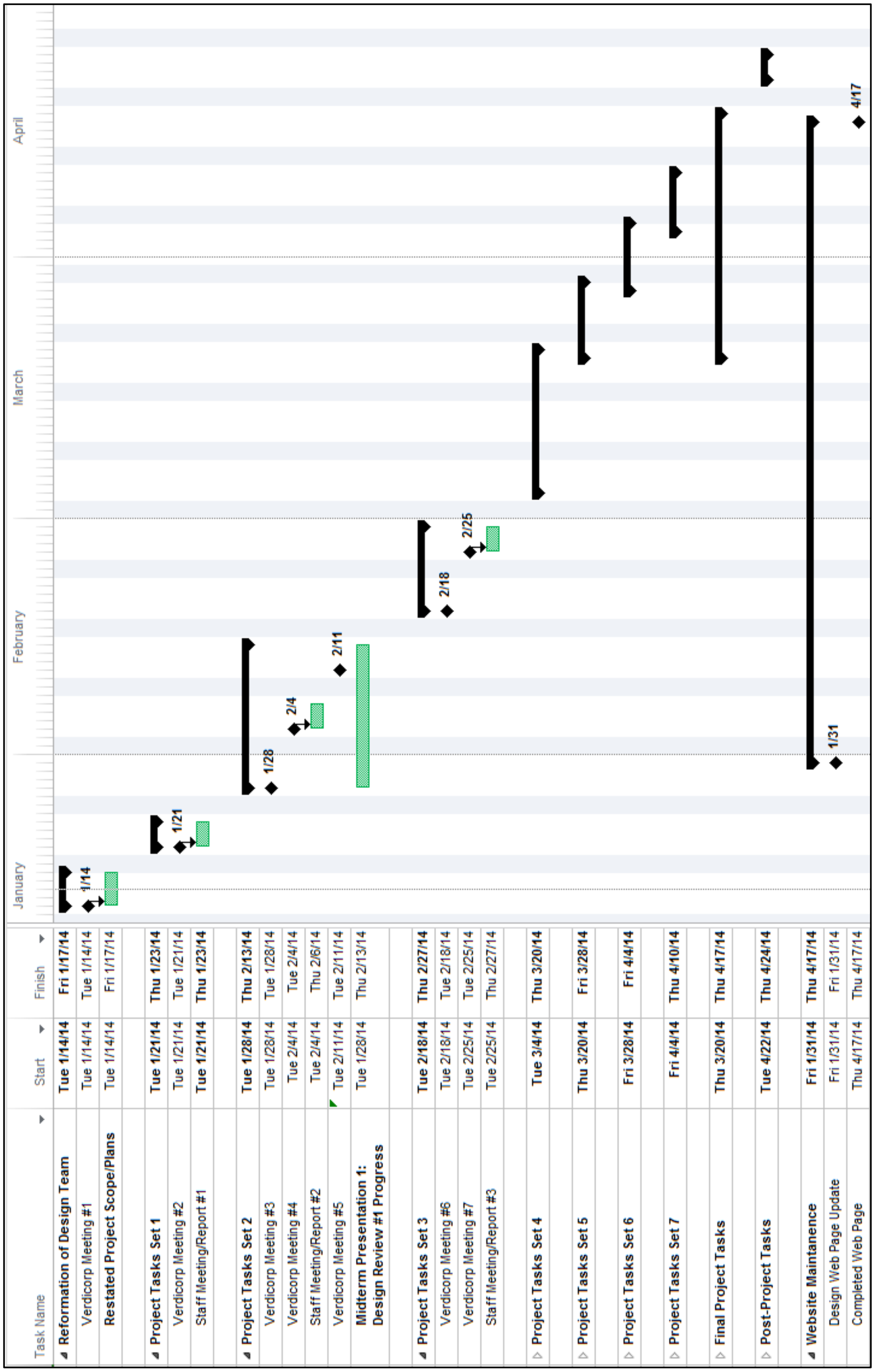
Allocated Budget: $2000

Remaining Budget: $1143.41

Future Plans

At the start of the 2014 Spring Semester our design team will commence the building and testing of segments of the prototype. Any items from the bill of materials that have not been acquired will be in route to our possession. Also, any components that must be constructed or machined will be done in the Verdicorp machine shop which will begin January 21st, 2014. The team members will make any necessary engineering drawings for the machinist at Verdicorp to start machining. The team has been assigned a large office in Verdicorp's building where they will build their prototype. Once a prototype segment is built, tests will be run to insure that the system performs to the sponsor's expectations. From there, the team will analyze the prototype's performance and make any warranted changes or modifications to ensure optimal process execution.

Gantt Chart



Task Name
Start
Finish
January
February
March
April
Reformation of Design Team Tue 1/14/14 Fri 1/17/14
Verdicorp Meeting #1 Tue 1/14/14 Tue 1/14/14
Restated Project Scope/Plans Tue 1/14/14 Fri 1/17/14
Project Tasks Set 1 Tue 1/21/14 Thu 1/23/14
Verdicorp Meeting #2 Tue 1/21/14 Tue 1/21/14
Staff Meeting/Report #1 Tue 1/21/14 Thu 1/23/14
Project Tasks Set 2 Tue 1/28/14 Thu 2/13/14
Verdicorp Meeting #3 Tue 1/28/14 Tue 1/28/14
Verdicorp Meeting #4 Tue 2/4/14 Tue 2/4/14
Staff Meeting/Report #2 Tue 2/4/14 Thu 2/6/14
Verdicorp Meeting #5 Tue 2/11/14 Tue 2/11/14
Midterm Presentation 1: Design Review #1 Progress Tue 1/28/14 Thu 2/13/14
Project Tasks Set 3 Tue 2/18/14 Thu 2/27/14
Verdicorp Meeting #6 Tue 2/18/14 Tue 2/18/14
Verdicorp Meeting #7 Tue 2/25/14 Tue 2/25/14
Staff Meeting/Report #3 Tue 2/25/14 Thu 2/27/14
Project Tasks Set 4 Tue 3/4/14 Thu 3/20/14
Project Tasks Set 5 Thu 3/20/14 Fri 3/28/14
Project Tasks Set 6 Fri 3/28/14 Fri 4/4/14
Project Tasks Set 7 Fri 4/4/14 Thu 4/10/14
Final Project Tasks Thu 3/20/14 Thu 4/17/14
Post-Project Tasks Tue 4/22/14 Thu 4/24/14
Website Maintanence Fri 1/31/14 Thu 4/17/14
Design Web Page Update Fri 1/31/14 Fri 1/31/14
Completed Web Page Thu 4/17/14 Thu 4/17/14
1/14
1/21
1/28
2/4
2/11
2/18
2/25
1/31
4/17

References

[1] "Verdicorp Environmental Technologies," Verdicorp INC., [Online]. Available: http://verdicorp.com/. [Accessed 18 September 2013].