Needs Assessment

Project #17: Shuttle Valve

Deliverable #1

Group Members:

Ryan Laney –Team Leader

Billy Ernst – Team Webmaster

Samantha Zeidel – Team Treasurer

Sponsor:

Verdicorp Inc.

Robert Parsons

Faculty Advisor:

Dr. A. Krothapalli

Date Submitted:

Friday, September 27, 2013

Contents

Needs Assessment 1
Project Statement 1
Justification/Background 1
Objectives 2
Methodology 2
Constraints 3
Expected Results 3
References 4

Needs Assessment

Renewable energy, also known as “green” energy, has been the focal point for many present day industries. There are many ways of achieving this goal, including modifying existing technologies in order to improve their efficiency. Verdicorp Inc. is one such company that is at the forefront of developing next generation clean technologies for existing systems [1]. The objective of this project is to increase the efficiency of the Organic Rankine Cycle (ORC) system developed by Verdicorp Inc. This will be achieved by decreasing the parasitic losses within the system by removing the pump and replacing it with a shuttle valve system.

Project Statement

The purpose of this project is to design a shuttle valve to be used in ORC systems. These systems are used for producing electrical energy from waste and low grade heat. The concept for the shuttle valve is to transfer liquid from the low pressure side of an ORC to the high pressure side without the aid of a pump. The end goal will be to design a simple, inexpensive system that can be incorporated into existing ORC’s. The benefit of a successful outcome will be to decrease the energy consumption of the existing systems and increase the efficiency and overall profit for the consumer.

Justification/Background

Verdicorp Inc. has improved a revolutionary power generation system (Figure 1) that converts low grade waste heat into electrical energy. 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.

Verdicorp Inc. uses the environmentally friendly refrigerant 245fa. The refrigerant is heated from the waste heat 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. The design team is to mitigate this effect with the insertion of the shuttle valve system.

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

Objectives

- Design a shuttle valve system to replace the pump within the ORC.
- Maintain the continuous flow of liquid within the ORC.
- With the use of solenoid valves and the aid of gravity, adjust the pressure inside the vessels up and down by balancing the gas pressure.
- Transfer the liquid from the low pressure side of the system to the high pressure side.
- Minimize parasitic losses in the system, i.e. use a very small pump or no pump at all, effectively minimizing the electrical consumption of the system.
- Confirm on a final design concept by mid-October 2013.

Methodology

The design process for our team should follow a particular schedule. The early stages of our design should include a full understanding of every element of the system we are analyzing and modifying. This should include research on the ORC, the properties of refrigerant 245fa, and different types of valves and flow regulators. After research is done, each team member should come up with their own theoretical design. Our sponsor specifically asked for a decision matrix, consisting of at least one design concept from each member. This decision matrix should be used to choose a final design. We were asked by our sponsor to decide on a final design by mid-October.

Once we have decided on a design, we should then come up with the appropriate measurements in order to simulate it. We will do this by building a model using CAD Software. Once we construct and simulate our design with CAD Software, we should purchase the required

materials and build a physical prototype. Using the prototype, we can test our system, enabling us to analyze any relevant data. In order for consistency in data analysis, we will conduct any required tests several times. Once our data shows that our objectives have been completed, our project will be ready to present to our sponsor who expects to incorporate this prototype into their marketed physical systems.

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.
- 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 vessels which contribute to the constant flow rate. A system containing only one vessel 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 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.

Expected Results

The final prototype must be incorporated into the existing ORC system in place of the original pump. The prototype must maintain a constant flow rate of 3 gallons per minute through the use of multiple storage vessels. It should sufficiently decrease the amount of electrical waste compared to the original pump. The physical model will use water, but the calculations will be based on both water and refrigerant 245fa since the ORC system will use the refrigerant. The overall expectation of the end product is to increase the efficiency of the existing ORC system.

References

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