Thermal Balance Analysis & Optimization

Monash Industry Team Initiative (MITI) & Warrnambool Cheese & Butter Factory (WCBF)

Thomas Lobley, Varsha Naidoo, Richard Waid, Stephanie Wong

Project Goals

- The project goal was to optimize the operational efficiencies of several systems at the WCBF. It consisted of:
  - Reviewing piping and instrumentation diagrams
  - Analyzing the heat recovery system
  - Reviewing the reliability and efficiency of on-site boilers
  - Investigating biogas utilization onsite

P&ID Review

- Piping and Instrumentation Diagrams (P&ID) are essentially blueprints of process systems. They allow engineers to better understand a process and can significantly reduce the time required to maintain, modify, fix, or improve a system. Thus, up to date P&IDs are important.

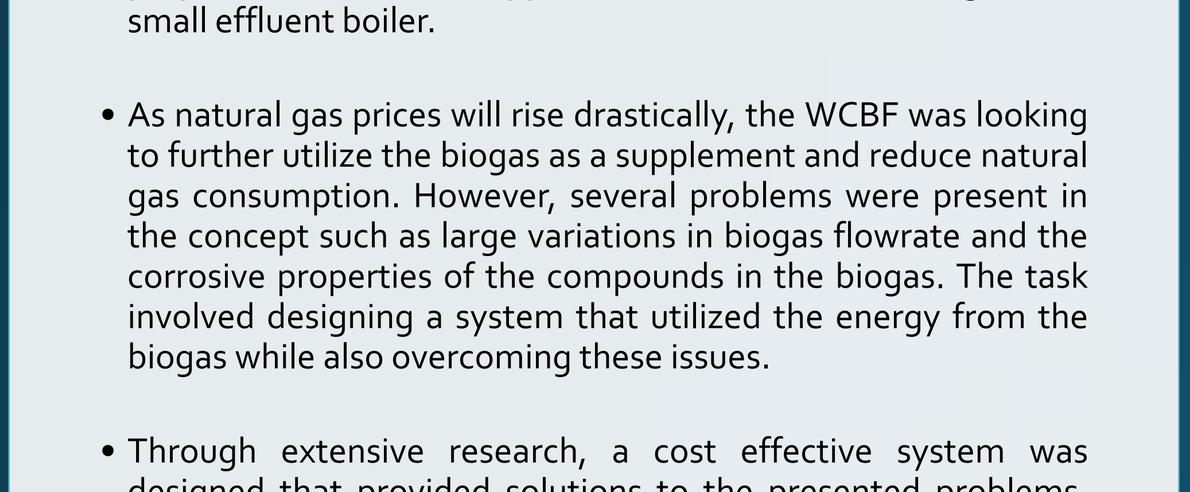
- The P&IDs of systems involving steam and water boilers were reviewed and updated as necessary. As the steam boilers on site were several decades old, their P&IDs did not exist and were therefore created.

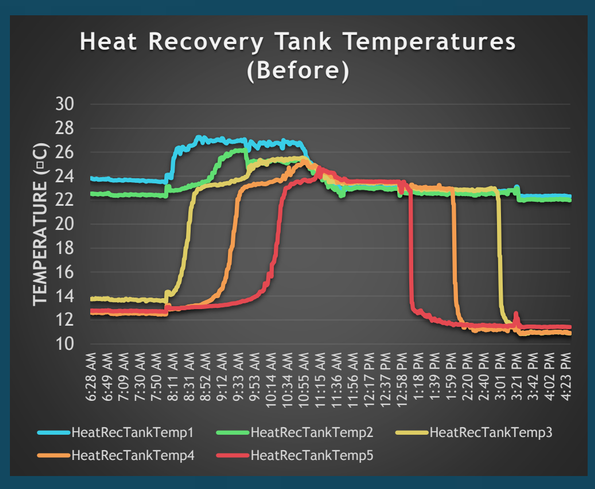
Investigation into Biogas Utilization

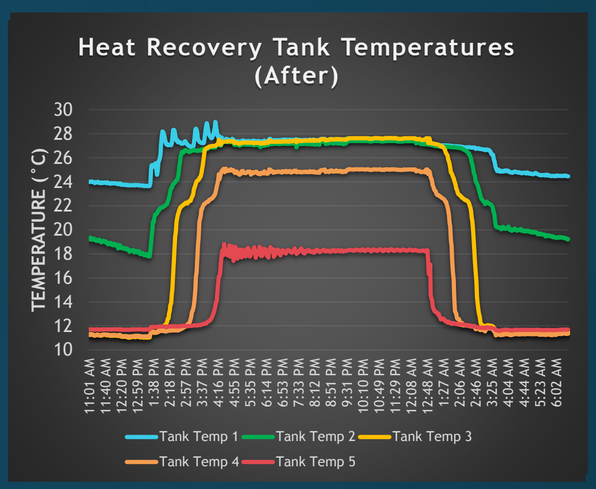
- The WCBF uses a large anaerobic digester to process dairy waste. As a by-product, large quantities of biogas is produced which contains methane and CO_2 as well as moisture and hydrogen sulfide. A majority of the biogas is flared while a small proportion is used to supplement the use of natural gas in a small effluent boiler.

- As natural gas prices will rise drastically, the WCBF was looking to further utilize the biogas as a supplement and reduce natural gas consumption. However, several problems were present in the concept such as large variations in biogas flowrate and the corrosive properties of the compounds in the biogas. The task involved designing a system that utilized the energy from the biogas while also overcoming these issues.

- Through extensive research, a cost effective system was designed that provided solutions to the presented problems. For example, scrubbing technology was recommended to reduce the corrosivity and innovative designs allowed the biogas to be utilized in other boilers while sustaining a reliable flow of gas. Ultimately, the design was economically and environmentally viable and presented large potential savings.







Analysis of Heat Recovery System

- The heat recovery system on-site supplied heating and cooling to both the cheese and whey production plants. The system required reviewing as the production output had increased from its initial output causing the system to deviate from its original operation and give rise to inefficiencies.

- One issue identified involved the convergence of water temperatures in the heat recovery tank but the original operation was designed to have a discrete temperature gradient. This inefficiency was minimized by making changes to the automation code and the results can be seen in the figure above.

- Temperature fluctuations were also observed in the system when it progressed from one stage of operation to another. This was the result of product flow fluctuations and insufficient automation control. To stabilize the fluctuations, a cascade loop was implemented in the automation code and the improvements can be seen in the figures below.

- These improvements resulted in reduced heating and cooling requirements which in turn reduced gas and electricity consumption.