CASE STUDY - THE CHALLENGE: IMPROVING THE EFFICIENCY OF A BREWERY'S COOLING SYSTEM

Project Profile	
Industry:	Malt Beverages
Process:	Glycol Cooling System
System:	Pump
Technology:	Impeller Trimming

Summary

To reduce energy consumption and improve the performance of its beer cooling process, the Stroh Brewery Company analyzed the glycol circulation system used for batch cooling of beer products at its Heileman Division brewing facility in La Crosse, Wisconsin. By simply reducing the diameter of the pump impeller and fully opening the discharge gate valve, cooling circulation system energy use was reduced by 50 percent, resulting in savings of $19,000 in the first year. With a cost of $1,500, this Motor Challenge Showcase Demonstration project realized a simple payback of about one month. This case study demonstrates how an industrial company can achieve significant energy and cost savings through low cost system improvements.

Company Background

Stroh Brewery Company, the fourth-largest brewer in the United States, purchased the G. Heileman Brewing Company, the nation's fifth largest brewer, in July 1996. As part of the agreement, Stroh Brewery took over Heileman's five breweries, located in La Crosse, Wisconsin; Baltimore, Maryland; Portland, Oregon; Seattle, Washington; and San Antonio, Texas. The Heileman brewery in La Crosse was the site of this Showcase Demonstration project.

Project Overview

To optimize performance of the plant's glycol cooling system, facility management at the La Crosse brewery hired a consulting engineering firm to perform a feasibility analysis and make performance optimization recommendations. This decision followed a preliminary screening by the Energy Center of Wisconsin. The project called for the consultant to document the systems, analyze and evaluate the energy saving opportunities, implement cost-effective projects, and conduct follow-up measurements to confirm savings.

Brewing at the La Crosse facility is conducted on a weekly cycle beginning Sunday night, though not all tanks are cycled each week. After brewing is completed, the beer is cooled in a heat exchanger to 54°F and moved to storage tanks. The beer is further cooled in the storage tanks by a glycol cooling system. A solution of water and 36 percent propylene glycol is pumped through a 400-ton chiller that uses ammonia from the central refrigeration plant to cool the solution to 22°F to 24°F. The glycol solution is then channeled through an intricate piping and pumping system in order to cool the beer storage tanks. This pumping system was the focus of the feasibility study.

The original glycol pumping system consisted of three parallel pumps, directly coupled to three 150-hp electric motors. Originally, each pump had an impeller diameter of 17 inches. Prior to this project, one impeller was trimmed to 14.75 inches in diameter and its motor was replaced with a 75-hp unit. The 75-hp motor, however, could not handle the pumping load under all conditions, and therefore was no longer in use. To compensate, one of the 150-hp pumps operated continuously. In order to prevent the motor from exceeding its rated amps, the gate valve on the discharge was closed substantially.

Stroh Brewery Company	
SIC:	2082
Products:	Various Beer Products
Location:	La Crosse, Wisconsin
Showcase Team Leaders:	Don Schaller, Heileman Division; David Waffenschmidt, Michaels Engineering; Michael J. Herro, Northern States Power; Ken Wroblewski, Energy Center of Wisconsin

Project Team
In addition to plant engineering staff at the La Crosse facility, the Showcase Demonstration project team consisted of Michaels Engineering Inc. (conducted a feasibility study and provided implementation assistance); Michaels Fluid Balancing Inc. (provided flow measurement services and instrumentation); Northern States Power Company (provided utility assistance in demand-side management for energy efficiency improvements); and the Energy Center of Wisconsin (provided performance optimization services, funding, and expertise).

The Systems Approach
In order to improve the energy efficiency and performance of its beer cooling system in an environmentally-conscious manner, the Stroh Brewery project team developed a feasibility study based on the systems approach.

The project consisted of the following eight steps:

1. Review system documentation, field verification, and discussion of systems operation with brewery staff;
2. Prepare a detailed description of the system;
3. Prepare a measurement plan, identifying measurements (flow, temperature, pressure, kW, etc.) to be taken and under what conditions;

4. Measure system operation according to the measurement plan;
5. Evaluate current system performance by comparing measured data to design information (e.g., pump curves);
6. Identify technical options to increase system efficiency and, if possible, ability to meet production needs;
7. Analyze each technical option to establish feasibility, estimate cost and energy savings, and determine cost effectiveness; and
8. Prepare a report summarizing the results of the analysis.

In addition, brewery staff conducted follow-up metering after implementation to verify projected savings and ensure that system operation was satisfactory.

Project Implementation

Following a thorough examination of the facility's glycol cooling system, three optimization measures were evaluated and considered for implementation: (1) trimming the pump impeller, (2) installing a new pump that matched the existing system, and (3) installing a new pump with a variable speed drive. Based on measured data and calculations, the team concluded that the first measure presented the greatest return for the least cost. This decision was based on the team's finding that approximately 70 percent of the 300 feet of head produced by the pump was being consumed by the substantially closed gate valve on the pump discharge. Coupled with the finding that the system only required 90 feet of head and 1,200 gallons per minute (gpm) to operate at peak system pressure drop (maximum required flow), the team concluded it could significantly improve the system's performance and move it closer to its best efficiency point by simply reducing the size of the impeller.

The project team used a seven-step procedure to trim the impeller. The steps, which took an estimated 15 hours to accomplish, were as follows: isolate pump and drain down casing, remove top half casing, remove rotor, set up and trim impeller on shaft, deburr and grind trailing edge of vanes, balance rotor, and re-assemble pump.

This adjustment had been previously attempted unsuccessfully, and the team found that the earlier attempt did not trim enough from the diameter of the impeller. Trimming the impeller to 14.75 inches in diameter had failed to provide the necessary conditions for the gate valve to be fully opened. Furthermore, with the smaller motor - 75-hp as compared to 150-hp - the flow rate decreased to 1,000 gpm. By trimming the impeller to 11.75 inches, however, the discharge valve could be completely opened, and a normal constant flow rate, either equal to or greater than the flow rate achieved with a 150-hp motor and 17 inch in diameter impeller, could be maintained.

Results

Field measurements conducted by brewery personnel after the impeller was trimmed to 11.75 inches in diameter confirmed the success of the adjustment. Not only did the new system's flow rate increase by 15 percent, from 1,200 gpm to 1,380 gpm, but the smaller motor reduced electricity demand by more than 50 percent, from 112 kW to 54 kW. Extrapolating these results shows that the system's annual electricity consumption will fall from 981,000 kWh to an estimated 473,000 kWh.

This relatively minor adjustment resulted in substantial cost savings for the facility. With demand charges for electricity of $6.26 per kW/month and energy charges of $0.0288 per kWh (these rates are based on a blend of on- and off-peak hours), the adjustment cut $19,000 from the original annual energy cost of $36,700, a savings of more than 50 percent. Project costs, consisting primarily of labor to trim the impeller, were estimated at $1,500. Based on the annual savings of $19,000, the simple payback for the adjustment is about one month.

Performance Improvement Summary	
Energy and Cost Savings	
Project Implementation Costs	$1,500
Simple Payback (years)	0.1
Annual Energy Savings (MWh)	508,000
Total Annual Emissions Reductions	
CO_2	634,000 lbs
Carbon Equivalent	173,000 lbs
SO_2	1,800 lbs
NO_x	2,100 lbs
PM-10	80 lbs
VOC	10 lbs
CO	90 lbs

Lessons Learned

The first lesson learned as the result of this project concerns the initial insufficient trimming of the impeller. While past analysis of the system was successful in pinpointing the source of inefficiency, all aspects of the system were not taken into account when deciding upon a course of action. As a result, the decision to trim the impeller to 14.75 inches did not improve the system's efficiency, since the accompanying 75-hp motor could not handle the system's load under certain conditions. Facility management at Stroh's Heileman Division also learned that systems with valves that are always partially closed often offer further energy saving opportunities. Finally, as evidenced by the relatively small investment required, this project demonstrates that large capital outlays are not a prerequisite for significant cost and energy savings.

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