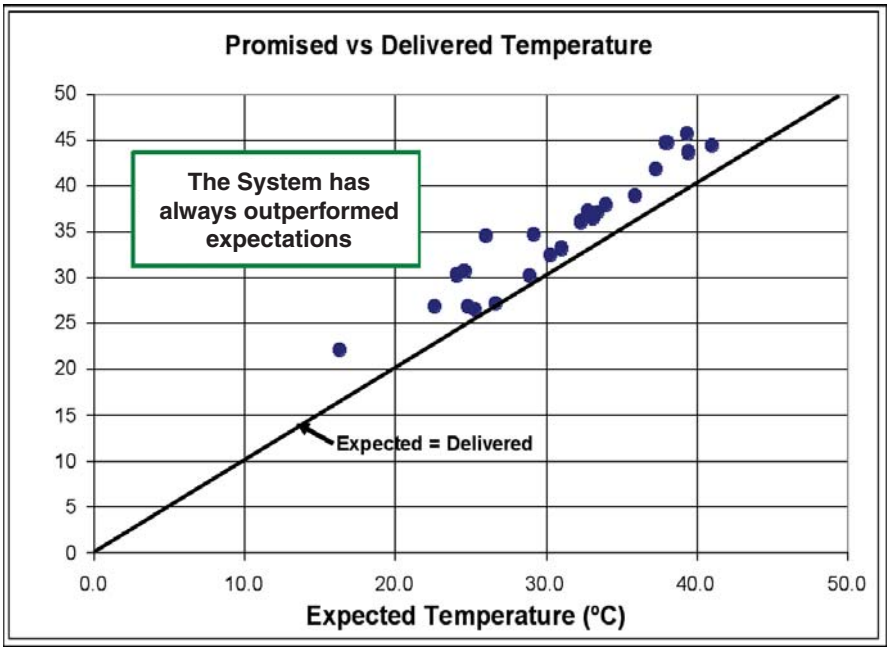
Drain-water heat recovery saves energy in food processing plant

By Gerald Van Decker

As part of the food processing, at the Unilever facility in Peterborough, Ontario, hot water is used for cleaning bottles and jugs and as part of the cooking process. Excess water falls into a drainage system and is pumped into a tank, filtered and then sent to the sewer. The steam is produced in a boiler using city water and it must remain potable water at all times to be used in a food product.

The company wished to reduce the energy required by the boiler. The drain water from the process was still quite warm; however, the energy could not be recovered by a traditional heat exchanger because of concerns regarding cross-contamination, clogging and fouling.



The solution

In order to reduce the energy consumption by the boiler, a Power-Pipe® drain-water heat recovery system was installed in the plant. This system is a specialized heat exchanger manufactured in Canada by RenewABILITY Energy Inc. (REI). Based on the falling film phenomenon, where water flowing down a vertical pipe clings to the inside surface, the heat exchangers efficiently recover heat from wastewater streams without clogging or fouling. This allows for heat to be recovered in many applications where it would be impractical with conventional types of heat exchangers.

In addition, because the Power-Pipe employs a double wall vented design, it is approved for use with potable water, allowing it to be used to preheat the boiler water which must be potable water since it comes in contact with the food product.

As with any type of heat exchanger, a simultaneous flow was required. The Power-Pipe heat exchangers require the wastewater to fall vertically through the drainpipe. In the case of Unilever, an available drop of 10' existed to install the system.

The situation

The plant operates, on average, 20 hours a day, 4 days a week, 32 weeks a year. The drainwater flow is typically 45-50 gpm at a temperature of 50-55 °C. The water heating efficiency was about 80%. The freshwater flow to the boiler was only 17 gpm and varied from 2°C in the winter to 18°C in the summer. The resulting ΔT was 37°C to 48°C. The calculated theoretical source of energy was 6100 GJ/year.

In order to accommodate the large flow rate of drain water, a Power-Pipe unit incorporating four pipes was installed. The drain water flow is split using a specially designed manifold to keep the falling film of drain water thin enough to effectively lose its heat to the fresh water stream. The warm drain water is piped from a weir to inlet of this manifold, while the fresh water flows through the coils of the heat exchangers.

The units can recover most of the heat from the warm drain water without slowing or affecting the flow. The result is an average heat recovery effectiveness of 70%, which will yield a reduction of approximately 43,000 m^3/year in natural gas demand.

The fresh water is preheated to an average of about 29.6°C by the system before entering the boiler. Less energy is then required for the boiler to heat the hot water to the desired temperature. In addition, the effective capacity of the boiler is increased, as it can reach the desired temperature more quickly.

Economics

The incremental cost for the heat recovery system was $25,379, including the heat exchangers, piping and labour. The system was expected to save the plant 43,000 m^3/year of natural gas, representing annual savings of about $16,000 and a simple payback period of 1.6 years. In the first year only, the Power-Pipe has outperformed, saving Unilever $26,136 and reducing CO_2 emissions by 130 tonnes.

These heat exchangers require little or no maintenance, which keeps operating costs to a minimum, and provides a long service life in excess of 30 years. If required, cleaning can be performed without shutting down, thus avoiding costs associated with downtime.

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