HEAT RECOVERY FROM SMELT DISSOLVING TANK VENTS TO REDUCE OIL CONSUMPTION AT KRAFT PULP MILLS

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ABSTRACT

Maximizing energy efficiency is an overriding priority in many sectors, no less so in the pulp and paper industry. In many cases, energy managers have exhausted conventional heat recovery measures making further efficiency gains more challenging to identify and implement within the mandated return on investment.

This paper describes a unique project delivered by Thermal Energy International Inc. (TEI) to recover waste heat from a smelt dissolving tank vent with a return on investment of less than two years.

A FLU-ACE® condensing heat exchanger was installed on a smelt dissolving tank vent at the Fraser Papers Ltd. pulp mill in Thurso, Quebec. Waste heat recovered from the exhaust was used to preheat boiler makeup water resulting in a reduction in the mill's consumption of No. 6 fuel oil and a reduction in greenhouse gas and other emissions.

With an average heat recovery rate of 12 GJ/h, the project delivers significant energy cost savings as well as the added benefit of an 85% reduction in the visible plume produced by the smelt dissolving tank vent exhaust.

PROJECT DESCRIPTION

In 1958 the Thurso Pulp and Paper Company opened a 200 ton per day pulp mill in Thurso, Quebec. Now owned by Fraser Papers Ltd., the mill produces 700 tons per day of bleached hardwood kraft pulp.

The mill has undertaken a number of measures to reduce their dependency on fossil fuel including the implementation of the smelt dissolving tank heat recovery project that is the subject of this paper.

The project was implemented on a turn-key basis by TEI and was completed on budget and on schedule with the system going into commercial operation in April 2008.

Heat Source

The heat source for the heat recovery project was the smelt dissolving tank vent gas from one of the mill's two recovery boilers.

In the chemical recovery process, molten smelt formed in the recovery boiler is fed to a dissolving tank where the smelt is dissolved in weak wash to form green liquor. Before mixing with the weak wash, the smelt stream is broken into droplets with steam shatter jets.

The high temperature of the smelt as it comes into contact with the weak wash releases a large amount of heat in the form of water vapor. This hot vapor and the steam injected through the shatter jets are exhausted through the smelt dissolving tank vent.

Typically, the smelt dissolving tank exhaust is passed through a wet scrubber to reduce the emission of particulate composed mostly of sodium compounds entrained in the exhaust. The exhaust leaving the scrubber is saturated with water vapor and cooled to roughly 80°C.

Despite the relatively low temperature and flow (approximately 7000 Nm^3/h in this case), the exhaust carries a considerable amount of energy out the stack. The amount of energy recoverable is a function of the temperature to which the exhaust is cooled (see figure 1).

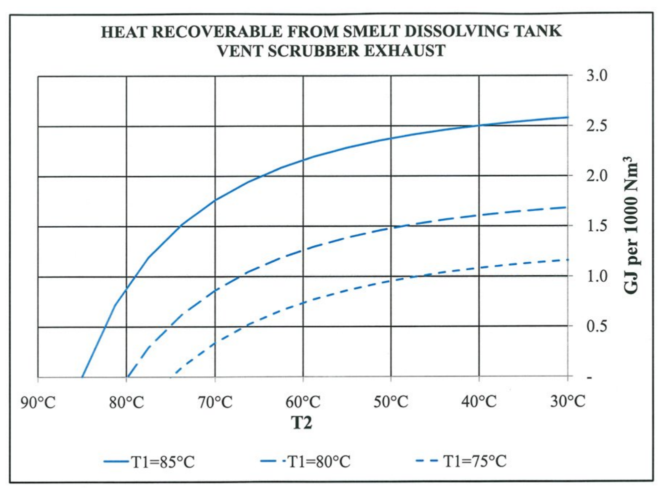

Figure 1

As the saturated exhaust is cooled, water vapor is condensed releasing its latent heat of vaporization of roughly 2260 kJ/kg.

Unlike sensible heat recovery, more heat is recovered in the first degree of cooling than from the next, and so on. Cooling a saturated exhaust from 80°C (T1) to just 60°C (T2) will recover approximately 1.25 GJ per 1000 Nm^3 of dry gas.

Heat Sink

Any heat user below 60°C could be considered for a smelt dissolving tank heat recovery application. These include:

- process makeup water;
- boiler makeup water;
- white water circuit;
- building / machine makeup air; and,
- boiler combustion air.

In this case, boiler makeup water was chosen for its relatively low seasonal temperature profile of 35°C to 55°C. Also, the average flow of over 2000 L/min was sufficient to use all of the heat recoverable from the smelt dissolving tank vent.

The boiler makeup water was heated through a secondary plate and frame heat exchanger installed on the FLU-ACE® water circuit (see figure 2).

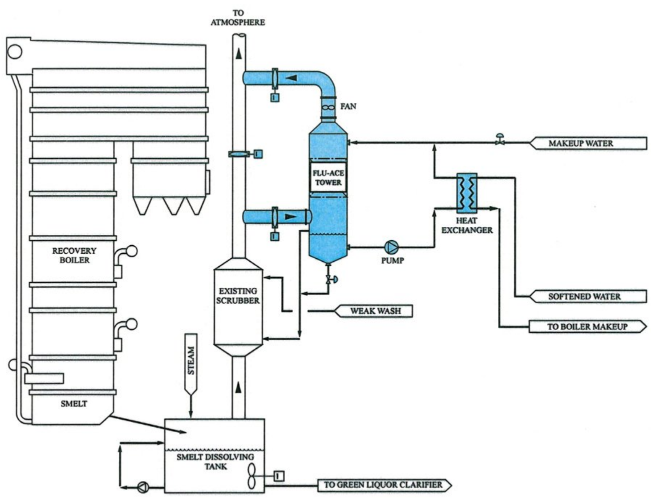

Figure 2

System Maintenance

The possibilities of corrosion and/or the formation of scale due to pH levels and the residual sodium salts in the scrubber exhaust were carefully considered in the design of the heat recovery system.

An analysis of the anticipated water chemistry was done in consultation with Hercules, the mill's chemical supplier.

The results of the analysis pointed to a low risk of slow scaling in the system. Conservatively, allowances for manual and chemical cleaning of heat exchange surfaces were made.

An inspection of the FLU-ACE® internals was conducted after six months of operation and the wetted heat exchange surfaces showed no signs of fouling. Based on the operation of the system to date and periodic water sampling, it is anticipated that any maintenance (if required) can be accommodated during regular scheduled plant maintenance shutdowns. Based on this first inspection, regular packing cleaning may not be necessary at all.

Installation

All mechanical and electrical tie-in work was executed during the mill's planned maintenance shutdown.

The tie-in to the smelt dissolving tank scrubber exhaust was done by replacing a section of the existing stack with a prefabricated double-tee section. The new section was installed with an automated diverting damper between the inlet and outlet connections and two manual FLU-ACE® isolation dampers.

Similarly, a prefabricated section of pipe with diverting and isolation valves was installed in the boiler makeup water line downstream of the existing water softeners and upstream of the de-aerator.

Due to the space restrictions associated with this retrofit project, the FLU-ACE® heat recovery tower was fabricated and installed in several sections spanning the 6th, 7th and 8th floors of the recovery boiler building.

These floors and mezzanines provide access for maintenance around the sump area, diverting and isolation dampers, tower internals section and exhaust fan.

The liquid-to-liquid heat exchanger was installed on the ground floor of the boiler plant alongside the new water circulating pumps.

Instrumentation and major equipment were selected to meet the mill's standard in order to facilitate maintenance and make use of existing spare parts inventories.

Commercial Terms

This project was implemented under TEI's Thermal AUD™ (Alternate Utility Delivery) Program.

Under this program, the equipment is owned and operated by TEI over a term of several years. Over the term of the agreement, the recovered heat is metered and charged on a $/GJ rate basis that provides a significant energy cost saving to the user.

Under this program, the project delivers an immediate benefit to the user without having to spend any internal capital.

RESULTS

Operation and Performance

The system was put into commercial operation on April 11th 2008 and in its first nine months of operation the system has operated reliably and to specification.

The smelt dissolving tank vent exhaust is being cooled to within 2°C of the boiler makeup water temperature resulting in an average heat recovery rate of 12 GJ/h or 1.7 GJ per 1,000 Nm^3 of exhaust.

The system has operated with only the regular required maintenance associated with a circulating pump, exhaust fan, and instrumentation common to pulp mill operation.

Conclusions

Provided there is a liquid or air stream at or below 60°C that can benefit from incremental heating, Thermal Energy International Inc. can provide a heat recovery solution around the smelt dissolving tank vent exhaust.

Fouling (corrosion and scaling) can be controlled and managed, if not eliminated.

Heat recovery rates of up to 2.5 GJ per 1,000 Nm^3 of exhaust are achievable at a return on investment of less than two years.