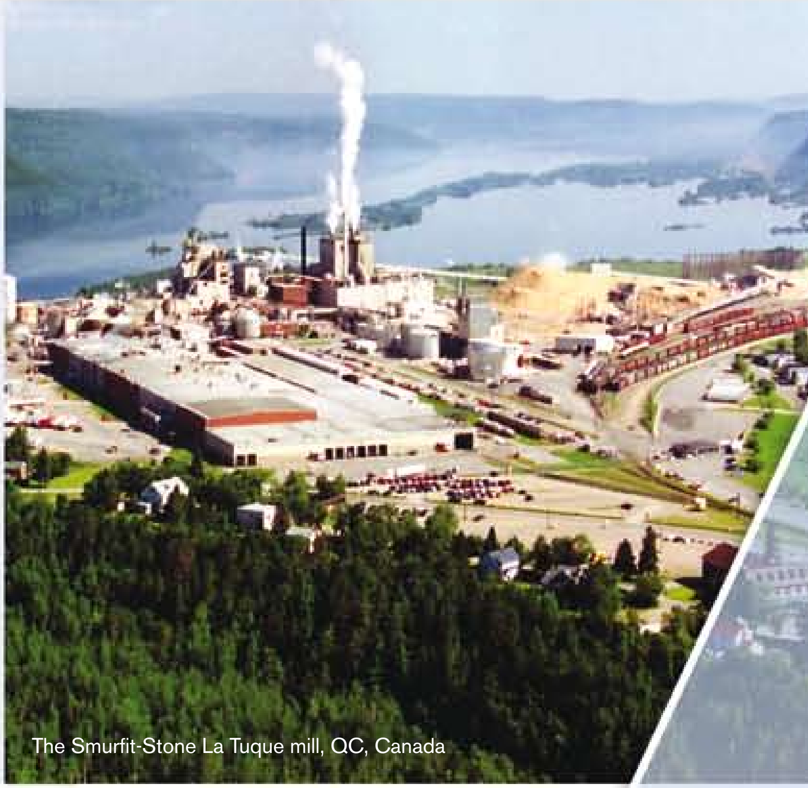
PULP & PAPER | CASE STUDY

PROCESS INTEGRATION

HIGHLIGHTS

- 15% reduction in the mill's fossil fuel consumption
- Steam savings of 37 tonnes/hour
- Energy savings of CAN$ 6,000,000/year
- Payback period of less than 10 months for most of the heat recovery projects
- Reduction of CO_2 emissions of 50,000 tonnes/year
- Potential mill effluent reduction of 6,000 m^3/day
- Reduction of effluent temperature of 3°C



The Smurfit-Stone La Tuque mill, QC, Canada

HEAT RECOVERY OPPORTUNITIES AT THE SMURFIT-STONE MILL IN LA TUQUE

SUMMARY

The Smurfit-Stone mill in La Tuque (QC, Canada) is a large integrated pulp and paperboard mill producing white-top board, fully bleached board and food board. An analysis of the mill's energy and water systems using a Process Integration approach identified heat recovery and wastewater reduction opportunities. These have the potential to reduce the mill's purchased thermal energy by 15% and effluent temperature by 3°C with a simple payback period of less than ten months for most of the heat recovery projects.

Process Integration methodologies such as Pinch Analysis used in this study are also suitable for any industrial facility with complex steam/water networks and that consumes a large amount of thermal energy.

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BACKGROUND

Following a five-year intensive energy saving programme, during which significant reductions in fossil fuel consumption were achieved, it became apparent that the La Tuque mill's energy consumption was still very high compared with that of similar paperboard mills. New energy saving projects became more and more difficult to find and it appeared that a global analysis of the entire mill was necessary to identify new energy conservation measures. In November 1999, the La Tuque mill requested the assistance of CETC-Varennes to conduct a systematic and global analysis of its energy and water systems to identify ways of reducing energy consumption.

MILL OVERVIEW

The Smurfit-Stone mill in La Tuque is an integrated pulp and paperboard mill producing white-top board, fully bleached board and food board. It comprises a large kraft pulping section, two elemental chlorine-free bleaching lines, a black liquor recovery section and two paperboard machines (see Figure 1). At the time the study was undertaken (year 1999), the mill employed approximately 750 workers and produced about 1,200 tonnes/day of product. Three black liquor recovery boilers provided 65% of the steam requirements and two oil/gas boilers supplied the remaining 35%. The mill's specific fresh water consumption was approximately 95 m^3/tonne of product. The effluents produced were grouped into two categories: non-contaminated (38,000 m^3/day) and contaminated (85,000 m^3/day). Contaminated effluents produced at the mill are collected, cooled and treated in a centralised treatment system.

HEAT INTEGRATION OVERVIEW

The approach used in the La Tuque mill study consisted of a systematic and global analysis of the energy systems to identify heat recovery opportunities, and Pinch Analysis was used to improve heat integration. This was conducted in parallel with an analysis of the possibilities to better use fresh water and re-use white water (process water containing fibres) within the mill, which generally have an impact on the energy balance.

In this study, a process simulation software was used to obtain a detailed energy and mass balance of the mill. Stream data relevant to the Pinch Analysis were then extracted from the mill simulation. The main hot streams requiring cooling and cold streams requiring heating were identified and used to build "hot" and "cold" composite curves for the entire mill. This representation shows the site heat availability in the hot streams and the heat required by the cold streams on the same graph (see Figure 2). In other terms, the composite curves plotted in a temperature versus heat load diagram represent the cumulative heat sources and demands in the system. The overlap of the composite curves determines the maximum heat recovery, while the remaining hot and cold demands represent the residual utility needs required by the process.

By specifying a minimum temperature driving force for heat transfer from hot to cold streams (ΔTmin) of 25°C, selected according to the process constraints and investment criteria of the mill, the comparison of these minimum utility consumption values with actual mill purchased energy revealed a theoretical potential saving of about 45% in oil/gas boiler steam production. Due to physical and financial constraints, only part of this potential is achievable.

The analysis of the composite curves also pinpointed inappropriate heat exchanges between cold and hot streams and suggested ways to improve heat recovery.

Analysis of the water distribution network showed that the allocation of several water streams was unsuitable from an energy perspective; water redistribution projects were therefore suggested. White water re-use opportunities were also identified, reviewed and discussed with specialists from the Pulp and Paper Research Institute of Canada (PAPRICAN) and an engineering firm specialised in pulp and paper processes.

Following discussions with key mill personnel, projects were selected for further investigation. These projects were incorporated in the simulation model of the mill to predict the impact of their implementation on overall operating conditions.

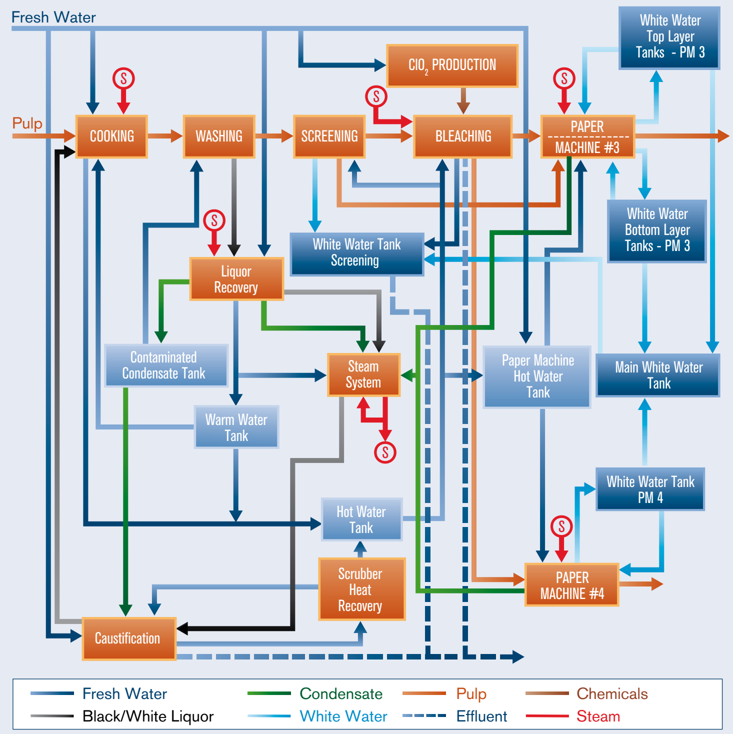

Figure 1 Simplified process flow diagram

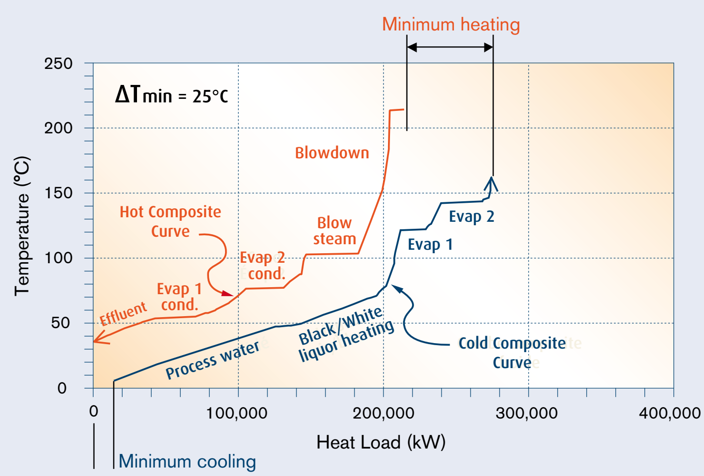

Figure 2 Simplified composite curves based on some of the mill hot and cold streams

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SAVING OPPORTUNITIES AND ECONOMICS

A total of nineteen potential energy saving opportunities were identified during the study. Of these, twelve projects were selected by the mill personnel as the most feasible to attain the energy consumption objectives. Implementing these selected projects will enable the mill to reduce its steam consumption by 37 tonnes/hour and its overall annual fossil fuel usage by 850 TJ representing approximately 15% of the 1999 oil/gas consumption. Associated with this energy saving is a reduction of 50,000 tonnes/year in accountable CO_2 emissions and a reduction of CAN$ 6,000,000 in annual energy costs (based on an energy cost of CAN$ 6.99/GJ) resulting in an expected simple payback period of less than ten months for most of the heat recovery projects.

Selected water re-use projects are responsible for approximately 10% of the overall energy-related benefits and would enable the mill to reduce its effluents by 6,000 m^3/day. When those projects are evaluated only on the basis of water saving, profitability is generally very low because of low freshwater costs. However, the energy savings related to these water re-use projects make them economically viable even if the payback period is longer than that of other heat recovery projects. Furthermore, these projects constitute an important step towards the closure of one biological treatment cell, which would lead to additional appreciable savings.

Other water re-use projects that could lead to additional savings of 20,000 m^3/day were also identified but they require a more detailed technical evaluation, including some pilot tests.

Table 1 summarises the projects that were identified and selected by the mill. Fifteen months after the study, selected projects corresponding to 80% of the identified savings were already implemented and others are still to be approved for capital expenditure by the management board.

CONCLUSIONS

At the Smurfit-Stone mill in La Tuque, the use of Process Integration methodologies, together with process simulation tools and knowledgeable mill engineers, proved to be a successful combination in addressing the problem of reducing energy consumption without any major change to the process and equipment. Moreover, when energy requirements and fresh water consumption are linked as in the pulp and paper industry, it makes sense to analyse water conservation and energy efficiency projects simultaneously.

APPLICATIONS

Process Integration approach can be applied to any industrial facility that uses a large amount of thermal energy and has complex steam and water networks. Pinch Analysis that matches the entire site heat sources and demands generally leads to the identification of substantial energy savings.

Table 1 Energy efficiency and water conservation projects at the Smurfit-Stone La Tuque mill, QC

SELECTED PROJECTS

Heat Recovery Projects

- Increase of condensate return to boilers
- Increase in heat recovery through existing heat exchanger
- Increase of paper machine thermocompressors efficiency
- Improvement of batch digester blow scheduling
- Replacement of fresh water with warm water for cooling requirements
- Segregation of effluent streams according to temperature levels
- Installation of new heat exchangers for heat recovery

Effluent Reduction Projects

- White water treatment and re-use at paper machine showers
- White water re-use at the broke thickener
- Segregation of non-contaminated water from white water

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