Blue Heron Paper Company: Oregon Mill Uses Model-Based Energy Assessment to Identify Energy and Cost Savings Opportunities

Benefits

- Identified potential annual natural gas savings of more than 608,000 MMBtu and electricity savings of about 1,000 kWh
- Identified potential annual cost savings of $2.9 million
- Found opportunities to reduce stack gas emissions and effluent temperature

Application

A Model-based Energy Assessment was conducted on the de-inking facility, paper machines, white water system, thermomechanical pulping mill, and steam system. The simulation model analyzed opportunities for effluent flow and heat load reduction, fresh water usage minimization, and process energy usage reduction at the Blue Heron pulp and paper mill.

Summary

Blue Heron Paper Company and Pacific Simulation conducted a Model-based Energy Assessment (MEA) to analyze effluent flow and heat load reduction, fresh water usage minimization, and process energy usage reduction at Blue Heron's paper mill in Oregon City, Oregon. The assessment team identified 15 projects. Of those, 14 were determined to be potentially feasible, both technically and economically. Of the 14 feasible projects, however, some were considered to be alternates to other projects. Excluding the alternates, 7 projects were ultimately considered to be the most attractive. If all 7 projects were implemented, total energy savings were estimated at 608,000 million British thermal units per year (MMBtu/yr) in natural gas and about 1,000 kilowatt hours per year (kWh/yr) in electricity. Corresponding annual cost savings would be about $2.9 million. By reducing the fuel required to supply plant steam, Blue Heron would also reduce stack gas emissions. In addition, the improvements would reduce heat load in the effluent, decreasing the energy discharged to the treated effluent stream.

Public-Private Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsored the assessment through a competitive process. DOE promotes plant-wide energy efficiency assessments that will lead to improvements in industrial energy efficiency, productivity, and global competitiveness, while reducing waste and environmental emissions. In this case, DOE contributed $60,000 of the total $120,000 assessment cost.

Plant Description

The Blue Heron Paper Company was originally known as the Hawley Pulp and Paper Mill, which began operation in 1908. Times Mirror purchased the facility in 1948, when it was known as Publisher Paper Company. Jefferson Smurfit bought the mill in 1986 and operated it for approximately 14 years. Smurfit Stone Container Corporation sold the mill in 2000 to the mill's employees and KPS, a New York City-based private equity fund, to form the Blue Heron Paper Company.

Currently, the Blue Heron mill produces about 650 tons of paper per day, making newsprint and specialty paper products on three paper machines. About 60% of the fiber furnished to the paper mill is recycled fiber from old newsprint and magazines. Residual wood chips from sawmill waste are also a primary source of fiber supplied to the thermomechanical pulping (TMP) lines, which convert them into pulp. Six natural gas-fired utility boilers produce steam for the mill.

Two lines of TMP pulping operate at Blue Heron. Each line has a primary and secondary refiner to separate wood chips into pulp fibers suitable for papermaking. When rotating plates compress the stock, they create friction, which produces heat and steam. This process steam is recovered in one of the lines and converted into clean steam using a reboiler and thermocompressor.

The de-inking pulping process consists of pulping, debris screening, and flotation de-inking. In pulping, the stock is mixed with steam-heated water to form pulp at a given temperature. Debris is removed from the pulp through screening and cleaning operations and then the pulp is washed. The pulp slurry is refined and mixed with surfactants to float the ink particles. The slurry is cleaned and screened once more to facilitate as much ink removal as possible. Water is filtered from the pulp and then sent back to the front of the de-ink process for reuse.

Assessment Approach

Pacific Simulation conducted an MEA that included the primary processes: the de-inking facility, three paper machines, the entire white water system, the TMP mill, and the steam system. The MEA analyzed opportunities for effluent flow and heat load reduction, fresh water usage minimization, and process energy usage reduction. This was accomplished by building full-mill mass and energy balances using Pacific Simulation's WinGEMS®[1] software. A full-mill balance was required because of the complex system of water and steam reuse at the Blue Heron facility.

The assessment team developed the overall topology of each major process in the simulation model from process flow diagrams and obtained agreement from mill personnel. Individual process simulations were then combined to form a full-mill mass and energy balance. The assessment team collected data for the various processes through personnel interviews and process flow diagrams, and from the mill information system. This information was used to generate a steady-state model that represented the base case.

The assessment team considered two separate situations as base cases for this study: a "summer" case and an "average" case. The summer case, based on the highest recorded incoming water temperatures for the previous summer months, was used to determine the effluent heat loading conditions. The average case was used to calculate the overall annual economic benefits from the projects being evaluated.

After the base cases were established, several possible projects were analyzed and quantified in MEA simulations. The assessment team analyzed potential projects that included use of additional heat exchangers and/or cooling towers, modification of process conditions and process flows, and process equipment modifications.

Results and Projects Identified

Fifteen projects were identified during the plant-wide assessment. Of those, the assessment team considered 14 to be potentially feasible. Of these, however, some projects were determined to be alternates to other projects. The list of projects identified in Table 1 excludes those considered to be alternates to these more economically attractive ones. A reduction in fuel required to supply plant steam would also reduce emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), and carbon dioxide (CO_2) from stack gases. In addition, the improvements would reduce heat load in the effluent, decreasing the energy discharged to the treated effluent stream.

Recycle vacuum pump seal water on paper machines No. 1 and No. 4; heat shower water

Liquid ring-sealed vacuum pumps are currently installed on all three paper machines. The heat generated by creating the required vacuum is absorbed by the vacuum pump seal water; thus providing a stream that could be recycled and used as a heat source. Because the temperature of the seal water may be increased to the point where it flashes to steam under the high vacuum, it is theoretically

[1] WinGEMS® is Pacific Simulation's software used for modeling steady-state simulations of chemical engineering processes, with emphasis on pulp and paper operations.

possible to recycle up to 90% of the water. The seal water could then be used to heat incoming filtered water for use in the paper machines, either by utilizing heat exchangers or by using a cooling tower to dissipate excess heat for additional water reuse options. This would require recycle pumps, a heat exchanger, or cooling tower for each paper machine, or a combination of components, depending on which machine is being considered for modification. Space availability is also a restriction.

Heat shower water for paper machines No. 1 and No. 4

This project involves recycling 75% of the vacuum pump seal water from the No. 4 paper machine, and routing the flow through the No. 1 paper machine for use as vacuum pump seal water. This water would then be routed to the de-ink process water clarifier showers to reduce filtered water usage and to decrease the net amount of steam required in the paper mill. The recirculated vacuum pump seal water for each paper machine would be used to heat water required for the paper machine. The costs associated with this project result from the acquisition of heat exchangers and piping for the water. The estimated capital cost is $1 million, but could be higher because of equipment logistics.

In addition to the benefits in reduced relative heat load discharge and energy cost reduction, this process alternative reduces overall effluent flow by approximately 1.6 million gallons per day (gal/day).

Table 1. Blue Heron Assessment Results

Project Description	Fuel Savings (MMBtu/yr)	Electricity Savings (kWh/yr)	Cost Savings ($/yr)	Capital Cost ($)	Payback Period (yr)
Recycle vacuum pump seal water for paper machines No. 1 and No. 4; heat shower water	NA	40	Included in total of project directly below	103,000	Included in total of project directly below
Heat shower water for paper machines No. 1 and No. 4	124,000	NA	315,000	1,000,000	3.5
Recover heat from Uhle box effluents on No. 4 paper machine	32,000	NA	100,000	110,000	1.1
Recover heat from de-ink effluent to No. 1 paper machine	37,000	NA	125,000	375,000	3
Reduce operating temperature in de-inking plant pulpers	87,000	NA	230,000	10,000	Immediate
Recover heat from vacuum pumps, Uhle boxes, and TMP waste water; cool effluent with incoming filtered water	74,000	NA	1,150,000	2,000,000	1.7
Heat shower water with reboiler steam and vacuum pump seal water; heat de-ink pulpers with TMP waste water	254,000	900	1,050,000	2,500,000	2.4
Totals	**608,000**	**940**	**2,970,000**	**6,098,000**	**2.1 Aggregate average**

Recover heat from Uhle box effluents on No. 4 paper machine

Uhle boxes help remove water from the forming felt as it travels from the forming section toward the dryer section. The Uhle box downstream and in the proximity of the steam box removes a combination of shower water and water from the sheet. The water's temperature is between 115°F and 120°F. This type of heat recovery project appears to be economical and technically feasible for the No. 4 paper machine. The capital cost is estimated at approximately $110,000 with significant heat recovery, creating a project return on investment of just over 1 year. Heat recovery is more practical when applied to the Uhle box stream coming off the felt. This stream has the steam box on it and so would have the hottest Uhle box flow.

Recover heat from de-ink effluent to No. 1 paper machine

The de-ink plant's combined effluent streams are approximately 120°F at a flow of 600 gallons per minute (gal/min). These streams could be collected, passed through a new heat exchanger in the de-ink plant, and cooled with filtered water. The warm filtered water would displace steam that heats shower water on the paper machines.

The heat exchanger itself could recover 9 MMBtu per hour (MMBtu/hr) at annual average conditions. But the benefit in steam economy is only 3.5 MMBtu/hr because some heat is lost through the effluent system, and the shower water flow is only around 300 gal/min. This stream is severely contaminated, so designing for minimal fouling risk increases the estimated capital expense to $375,000.

Reduce operating temperature in de-inking plant pulpers

The de-inking plant currently uses live steam to heat water in the pulper supply tank to a temperature of 125°F. The energy in the steam input varies from 9 MMBtu/hr in summer to 16 MMBtu/hr in winter. Almost all of this heat is added to the mill effluent.

De-ink mill staff are considering modifying operating practices to run at reduced temperatures. Each 5°F decrease in temperature could save 4 MMBtu/hr of steam use. Although little to no capital investment would be required to make this modification, there is a point of diminishing return below which temperature controls in other parts of the mill will offset these savings. That is likely to begin at around 115°F. This is an operating modification that would require considerable analysis before implementation, because temperature changes could negatively impact the quality of pulp produced.

Recover heat from vacuum pumps, Uhle boxes, and TMP waste water; cool effluent with incoming filtered water

One scenario the assessment team considered was to combine recycling and cooling of vacuum pump seal water, heat paper machine shower water with TMP hot waste water, recover heat from Uhle boxes on the No. 3 and No. 4 paper machines, and cool the effluent with incoming fresh water. Further analysis would be required before implementation to determine the project's feasibility.

Heat shower water with reboiler steam and vacuum pump seal water; heat de-ink pulpers with TMP waste water

This process alternative would involve the following operational changes:

- Preheating paper machine shower water with vacuum pump seal water on a partially closed cycle
- Heating paper machine shower water to operating temperature by direct injection of clean steam from the reboiler at 11 pounds per square inch (thus reducing power consumption in the steam compressors)
- Heating de-inking pulpers by replacing some of the white water from the central waste water tank with hot waste water from the TMP mill economizer.

This process alternative would require less equipment than any other alternative considered that has comparable energy economy, because much of the heat recovery is accomplished without heat exchangers. The effluent flow is reduced by 1.2 million gal/day. The net consumption of steam to heat stock and shower water drops to 65 MMBtu/hr. A reduction in consumption of electricity of about 900 kWh could be realized.

Project Partners

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