FOREST PRODUCTS

BestPractices
Technical Case Study

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OFFICE OF INDUSTRIAL TECHNOLOGIES
ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY

BENEFITS

- Estimated annual fuel cost savings of $175,500, or 5,250 megawatt-hours (MWh)
- Decreased energy losses resulting from pump operations
- Simple payback periods as low as 2 months
- Significant reductions in maintenance

APPLICATIONS

The pulp and paper industry uses pump systems for a wide variety of operations including cleaning, de-inking recycled newsprint, and boiler operations. Unless a sophisticated control system is already in place, it is impossible to continually optimize the energy-wasteful operations that result due to changes that occur in the plant over time. Therefore, it is important to review pump operations and identify ways to conserve energy; this will frequently lead to energy savings, reduced maintenance, and improved reliability.

Four Equipment Upgrade Projects Reduce System Energy Losses at Augusta Newsprint

Summary

The Augusta Newsprint Company performed a plant-wide energy assessment that focused on many processes operating in their Augusta, Georgia mill. The implementation of the 4 projects involving pumping systems presented in this study is projected to reduce energy consumption by over 5,200 megawatt-hours (MWh) per year.

Plant Overview

The Augusta Newsprint mill is part of a joint partnership between Abitibi Consolidated and the Woodbridge Company, Ltd. The mill produces up to 440,000 metric tons of standard newsprint each year from southern pine and recycled newspaper and magazines. The mill has 2 paper machines and employs 380 workers.

Abitibi-Consolidated is a global leader in newsprint and uncoated groundwood papers with ownership interests in 27 paper mills in Canada, the United States, the United Kingdom, and Asia (including its 50 percent interest in Pan Asia Paper Company). The company also has ownership interests in 22 sawmills, 2 re-manufacturing facilities, and a market pulp mill. Abitibi-Consolidated employs approximately 18,000 people and supplies products in nearly 100 countries.

Project Overview

This study presents 4 projects that have several features in common. In each, the project engineers sought to improve pumping systems that were routinely operated in a less-than-optimized manner. Each system had excess pumping capacity that worked against itself, such as pressure and flows; this excess capacity often caused accelerated wear of mechanical components and premature failures. In spite of the shared issue of excess capacity, each project resulted in a unique solution.

Project 1—Primary Fan Pump

In 1995, Augusta Newsprint installed a new cleaner system on the #1 paper machine. The new cleaner system required a significantly lower feed pressure and this reduced pressure requirement created an opportunity to reduce energy consumption by resizing the 1,250-horsepower (hp) primary fan pump motor.

At first, company engineers considered optimizing the system to leverage on the lower system pressure requirements, but capital funds were not available to replace the motor or the rotating element in the primary fan pump. In 1996, engineers considered trimming the pump impeller to reduce the energy loss; however, paper machine #1 and paper machine #2 shared a single spare impeller and the high cost of a new impeller could not be justified.

The engineers then conducted a decision analysis, taking into consideration that the existing motor was 30 years old. Due to age, there would be additional reliability and maintenance-related benefits in changing over to a new, more appropriate motor for the application. The engineers decided that a slower pump would result in lower maintenance costs and increased pump life, and that the packing and bearings would require less maintenance. A slower impeller would also result in less damage to the internal pump surfaces.

Project 2—Transfer Pump

In the course of performing a mill-wide evaluation of inefficient pumping applications, Augusta Newsprint identified a Thermal Mechanical Pulp (TMP) transfer pump as a candidate for improvement. The transfer pump was a constant-velocity design with a flow that had to be restricted by a control valve. A 200-hp, 1,800-revolutions-per-minute (rpm) motor was directly coupled to the constant velocity pump, and operators throttled a 10-inch control valve in the pump discharge line to maintain a set level in the TMP low-density #2 storage chest. Operators often had to nearly close the control valve due to process demands; this practice resulted in pipe damage, valve damage, excessive wear, and pump cavitation. The motor often operated at full load and, at times, against a dead head, or no-flow, condition.

Using the 10-inch valve in the discharge to control the flow was an inefficient method of regulating flow. Engineers conducting the evaluation decided to install a motor controller that would be able to monitor system parameters and adjust motor and pump speed accordingly so that a set level would be maintained in the TMP low-density #2 storage chest.

Project 3—Fan Pump Impeller

The Recycled Newsprint Plant at Augusta Newsprint produces pulp that is comprised of 80 percent old newsprint and 20 percent old magazines. The pressurized de-inking modules (PDM) remove ink and other materials from the pulp. The PDM system is comprised of 2 parallel banks of cells, known as banks A and B. Each bank consists of 4 in-line cells, each with a large 400-hp fan inlet pump and hand-operated inlet valves for flow balancing. The operator adjusts the position of the inlet valves to control retention time and flow rate through each cell.

The mill-wide evaluation of inefficient pumping applications found that the impellers used in the PDM fan inlet pumps were not the optimum size. The impellers produced excess pressure that hand and control valves had to dissipate. If operators set the valves in this type of application to more than one-fourth closed, the result is a loss of significant amounts of power. Therefore, the project engineers decided that the best option would be to convert to size-optimized pump impellers, which would effectively lower the horsepower requirements.

Project 4—Boiler Efficiency (Re-circulation Scrubber)

Augusta Newsprint performed an energy review of the operating efficiency of their boilers. The review showed that efficiency could be improved in one instance by controlling the flow to the boiler's re-circulation scrubber. The company found that controlling the flow closer to the State of Georgia's certified minimum flow rate would significantly reduce heat losses. The scrubber used an 1,100-rpm pump; however, the driver was a faster 1,800-rpm motor (75-hp, 460-vac, 3-phase). The flow from the pump was approximately 2,300 gallons per minute and operators could adjust it only by changing a sheave.

The review found that this pump application presented an ideal application for a variable speed drive (VSD) that would allow for control of the scrubber re-circulation flow rate. The engineers selected a VSD that uses a magnetic drive system rather than the more conventional, all-electronic, inverter-based systems. Engineers based the selection on minimum cost and consideration of the location of equipment controls. The magnetic drive consists of 2 independent mechanical drive components that have no physical contact (see text box).

Adjustable Magnetic Coupler

This VSD system relies on the principle of induced electrical eddy currents in a clutch plate assembly. A precision rotor assembly, containing high-energy permanent magnets, is mounted on the load shaft. A conductor assembly with copper disks is connected to the motor shaft. Relative motion between the magnets and copper disks causes the magnetic field to induce eddy currents in the copper. The eddy currents create their own magnetic fields, which interact with the magnetic fields of the permanent magnets to transmit torque. Varying the width of the gap changes the coupling's force, producing a controlled and continuously variable output speed.

This type of magnetic drive has certain advantages over more conventional electronic pulse width modulated (PWM) VSDs. The new system is rugged, easily installed and aligned, and does not induce harmonics. PWM drives produce harmonics that can reduce motor life unless more expensive VSD-rated motors are used. Furthermore, utilities are requiring expensive harmonic filters in VSDs.

Project Implementation

Project 1—The project team purchased two identical 800-hp, 720-rpm primary fan pump motors and arranged for one of the new motors to replace the existing 1,250-hp, 900-rpm motor, with the other motor serving as a spare.

Project 2—The project team purchased a "smart" pump controller and arranged for its installation. The team also installed pressure transducers in the pump suction and discharge lines, a flow sensor, and a temperature transducer in the motor casing. The controller analyzes the signals from these transducers and adjusts pump flow rate accordingly.

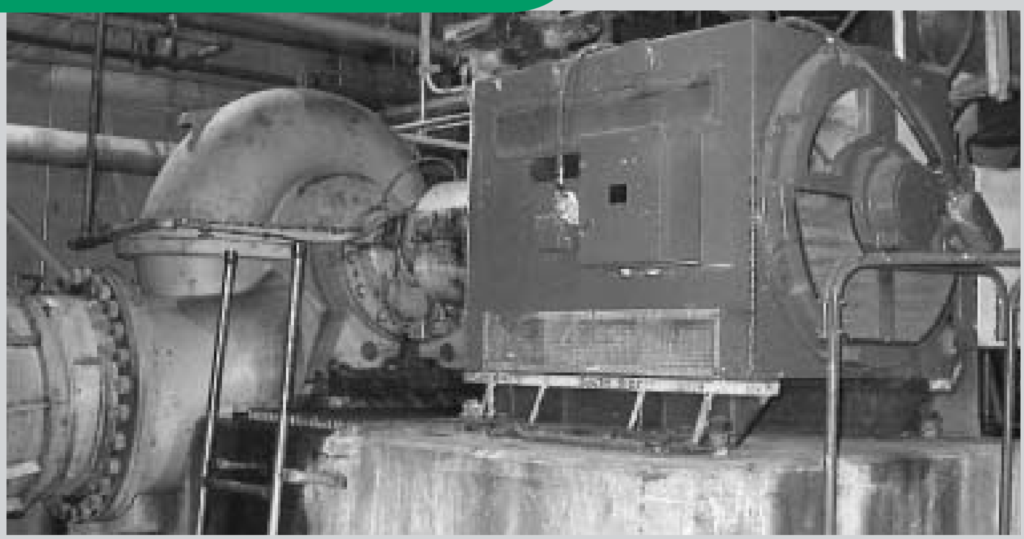
Project 3—To more efficiently reduce the excess pressure being developed in the de-inking modules, project engineers purchased size-optimized pump impellers and arranged for their installation in the fan pumps for banks A and B.

Project 4—Workers installed a VSD to control the flow rate in the boiler re-circulation scrubber system. The VSD relies on a magnetic drive system and eddy current forces to transmit torque. The company also ensured that the boiler maintains a negative pressure so that no steam can be lost and cause damage. Workers also set the control of the flow to the boiler re-circulation scrubber to minimize any risk of the boiler going to a positive pressure.

Results

Project 1—The new, lower-rpm, primary-fan pump motor reduces actual power consumption from 1,023hp to 523hp. This 500-hp reduction results in a savings of about $85,000, or 2,540 MWh annually. The total cost of this project was $123,500, mostly associated with the purchase of 2 identical 800-hp, 720-rpm motors. Therefore, the simple payback period is 17 months.

PRIMARY FAN PUMP MOTOR (PROJECT 1)



SENSORS FOR SMART CONTROLLER (PROJECT 2)

Project 2—By reducing and maintaining necessary flow control, the newly installed pump controller saves approximately 100 hp per year. This results in an energy savings of approximately $17,000, or over 500 MWh annually. The “intelligent” flow control significantly reduces energy usage and permits the removal of the control valve, eliminates associated control valve maintenance and repairs, and reduces pump maintenance by eliminating pump cavitation. The total installed cost of this project was $17,500, resulting in a simple payback period of slightly more than 1 year.

Two Views of Transfer Pump Motor Controller (Project 2)

Project 3—Because the Augusta Newsprint staff installed size-optimized impellers in the de-inking module pumps, the impellers have been able to operate within a 10-foot head adjustment band, and operators no longer need to use hand valves in the control scheme. The total estimated power reduction is 404 hp per year. This results in a savings of about $69,550, or 2,080 MWh annually. The total cost associated with the pump upgrades was about $12,000, resulting in a short simple payback period of only 2 months!

De-Inking Module Pumps (Project 3)

Project 4—The new motor control system maintains a more consistent and optimized flow in the scrubber system. As an added benefit, operators are now able to increase the pump speed to compensate for the loss of flow due to pump wear. The new motor control results in a power reduction of 20 hp per year. This results in a savings of about $4,000, or 114 MWh annually.

BOILER RE-CIRCULATION SCRUBBER PUMP (PROJECT 4)

INDUSTRY OF THE FUTURE—FOREST PRODUCTS AND AGENDA 2020

*In November 1994, DOE's Secretary of Energy and the Chairman of the American Forest and Paper Association signed a compact, establishing a research partnership involving the forest products industry and DOE. A key feature of this partnership was a strategic technology plan-**Agenda 2020: A Technology Vision and Research Agenda for America's Forest, Wood, and Paper Industry**. Agenda 2020 includes goals for the research partnership and a plan to address the industry's needs in six critical areas:*

- *Energy performance*
- *Environmental performance*
- *Capital effectiveness*
- *Recycling*
- *Sensors and controls*
- *Sustainable forestry*

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BestPractices is part of the Office of Industrial Technologies' (OIT's) Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices emphasizes plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

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