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Assessment Case Study

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

Appleton Papers Plant-Wide Energy Assessment Saves Energy and Reduces Waste

Summary

A plant-wide energy survey of the Appleton Papers, Inc., West Carrollton paper mill resulted in twenty-one recommendations for projects to reduce energy consumption and waste production and improve process efficiency. Initial estimates indicate that implementation of these recommendations will save nearly $3.5 million annually with a project cost of only $2.4 million. An average payback period of about 1.2 years per project is expected. Another recommendation to install a fluidized-bed boiler could result in additional annual savings of over $2.6 million.

Company Background

Appleton Papers, Inc., was founded in 1907 and is headquartered in Appleton, Wisconsin. The company is a wholly-owned subsidiary of Arjo Wiggins Appleton. Appleton produces carbonless, thermal, security, and specialty engineered papers, and is renowned globally for its capabilities in microencapsulation and coating. Appleton has five facilities located across the Midwest and Northeast and operates eight distribution centers and over seventy sales offices across North America. The company has about 2,800 employees and has over $1 billion in annual sales.

PAPER MACHINE AT APPLETON'S WEST CARROLLTON PAPER MILL

BENEFITS

- More than 4.8 million kilowatt-hours (kWh) estimated annual electricity savings
- Nearly 150,000 million British thermal units annual natural gas savings
- Decreased waste disposal costs and increased paper production
- Potential to further reduce natural gas consumption, burn waste sludge, and allow use of cheaper high-sulfur coal through installation of fluidized-bed boiler

APPLICATIONS

A team of energy assessment experts examined the large energy-using equipment and systems at the Appleton Papers, Inc., West Carrollton paper mill. The team conducted a comprehensive assessment covering energy, waste, and process-related improvements. The team's goal was to identify significant opportunities for cost savings, quality improvement, and productivity enhancement.

The Appleton Papers mill in West Carrollton, Ohio, was built in 1946. The facility has a workforce of about 450 employees and manufactures approximately 182,000 tons of carbonless paper every year. Primary manufacturing operations include recycling, materials preparation, paper production, roll finishing, shipping, and distribution. Up to 400 tons per day of wastepaper is processed into bleached pulp. Three paper machines are capable of producing up to 500 tons of paper per day. The mill uses two coal-fired and one gas-fired boiler to produce up to 5 million lb/day of process steam for paper manufacturing and recycling operations. A generator supplies almost 40 percent of the mill's electrical requirements. The wastewater treatment facility treats 7 million gallons per day of water.

Assessment Overview

The plant-wide assessment team elected to employ a comprehensive assessment methodology that considered energy, waste, and process-related improvements. The team examined all large energy-using equipment and systems for potential savings. They compiled a waste inventory and investigated the potential for waste reduction or improved disposal/recycling. The team also examined manufacturing processes for potential improvements, and emerging technologies were assessed for potential contributions to efficiency improvement.

The project team included Appleton Papers, The Edison Materials Technology Center (EMTEC), Ohio's Office of Energy Efficiency, Mid-West Building Diagnostics, the International Center for Water Resource Management, CSGI, and Energy Information Systems. The U.S. Department of Energy's (DOE) Office of Industrial Technologies (OIT) co-sponsored the assessment. OIT supports plant-wide energy efficiency assessments that will lead to improvements in industrial efficiency, waste reduction, productivity, and global competitiveness in OIT's Industries of the Future strategy.

Assessment Implementation

Energy systems

As part of the company's energy management program, Appleton uses data from operations and from utility bills to identify trends, anomalies, and billing errors. Personnel also analyze energy consumption, production trends, and operating costs. This data was used in the plant-wide energy assessment to compare Appleton's utility costs, energy consumption, average power factor, and average load factor to industry averages, and to develop assessment recommendations. Appleton's focus was to identify and minimize end-use loads. The utility distribution system was also examined for inefficiencies and for savings potential. The assessment team examined electrical systems, coal- and gas-fired boilers, lighting, motor-driven systems, vacuum pumps, and process heating.

Pollution prevention

The team examined options for waste stream elimination, recycling, product substitution, and efficiency improvements. Specific areas addressed during the assessment included recycling, sludge reduction, methods for early detection of changes in fly ash concentration, use of alternative scrubbers, reuse of waste products or changes in waste product production, reusable shipping containers, and methods to reduce NOx emissions.

Manufacturing process improvements

The assessment team identified process improvements by dividing the production process into discrete steps, and then assigning measures of productivity to each step. In this way, the assessment team could identify production inefficiencies, defects, and inventory requirements. The team evaluated inventory and material requirements, material flow, process automation, setup and changeover processes, quality control, preventive maintenance practices, and production bottlenecks. The team also identified and evaluated emerging technologies that could improve process efficiency while reducing waste and emissions.

Results and Recommendations

On the following page, Table 1 summarizes specific recommendations identified during the plant-wide assessment. These projections of savings and capital costs are initial estimates identified during the assessment and have not been validated through rigorous engineering analyses. Table 2 shows estimated savings and costs associated with the recommendation to add a fluidized-bed boiler.

Overview of Specific Actions Identified in the Assessment

There were twenty-two separate recommendations resulting from the plant-wide energy assessment. The six recommendations that had estimated cost savings of more than $200,000 each are summarized below.

Recover Heat from Paper Machine Vents

Three paper machines produce paper from wet pulp. The primary drying process required for paper-making is carried out with drums heated by steam. The paper machines also use a large amount of hot air for pocket ventilation. In some cases, gas-fired burners are also used to supplement the steam heat. The paper machines require ventilation to maintain the necessary humidity levels and for operator comfort. Currently, steam heat is used for space heating for the plant air handlers, for heating the plant areas, and for the paper machine vents. The assessment team recommended that recovery of the vent heat be used for heating the plant air during winter months. Cross-flow heat exchangers can be used to recover heat from the paper machine vent exhaust gas, delivering hot air for plant heating.

The following actions are recommended for thirteen exhaust stacks selected to meet a 50 percent investment rate of return criteria:

- Install a heat exchanger between the existing exhaust fan and the vent stack
- Install a low-pressure fan to circulate ambient air through the heat exchanger
- Install insulated ducts to deliver heated air to the plant air handlers.

Recover Usable Fiber from Low-Consistency Screen Rejects

The recycling plant has de-inking and bleaching operations that process 400 tons of post-industrial grade paper per day. Recovery of usable fiber from these operations would not only decrease the cost of waste disposal, but would also result in increased paper production. Reduction in fiber loss is possible at the low-consistency screens and at the centrifugal forward cleaners located downstream of the bleaching section.

Table 1. Assessment Recommendations and Estimated Savings

Recommendation	Annual Savings ($)	Project Cost ($)	Simple Payback Period (years)
Recover heat from paper machine vents	1,015,000	1,500,000	1.5
Recover fiber from low-consistency screen rejects	572,634	110,000	0.3
Install oxygen and carbon monoxide monitoring equipment to control boiler combustion	474,694	200,000	0.4
Reuse uhle-box seal water	288,185	132,600	0.5
Reduce silo temperatures	212,310	None	Immediate
Combine “good” and “bad” batches of post-industrial pulp	177,728	50,000	0.3
Use direct-fired water heating for de-inking operation	162,164	135,000	0.8
Use high temperature exhaust from flotation ovens to heat pocket ventilation air	141,372	127,576	0.9
Use dryer heat to heat vacuum pump seal water	88,900	11,980	0.2
Reuse centrifugal pump seal water	80,080	20,000	0.3
Recirculate vacuum pump seal water	51,857	25,000	0.5
Use well water to cool paper machines	48,273	45,000	0.9
Feed dryer vacuum pump seal water to paper machine silos	40,407	2,000	0.1
Reduce compressed air costs	37,962	8,750	0.3
Recover heat from steam decurling shower exhaust	21,590	27,600	1.3
Maximize electricity production in winter	17,706	None	Immediate
Use condenser water for steam makeup	12,995	10,000	0.8
Reclaim waste heat from air compressors	8,466	6,000	0.8
Insulate blow-through steam header piping	2,729	6,466	2.3
Install ambient air intake for air compressors	2,352	1,500	0.7
Use MotorMaster+ for motor analysis	946	3,193	3.4
Total	**3,458,350**	**2,422,665**	**0.9 (average)**

Table 2. Estimated Savings for Recommendation to Add a Fluidized-bed Boiler

Recommendation	Annual Savings ($)	Project Cost ($)	Simple Payback Period (years)
Add fluidized-bed boiler	2,638,398	23,000,000	8.7

A tertiary screen rejects tank could be installed to retain the pulp from the low-consistency screen rejects. High-density impurities would settle at the bottom of the tank in the underflow water and the pulp would be recovered. The scalped pulp would be sent back to an additional screen for further washing to remove low-density impurities. Fresh make up water would then be added to the pulp before sending it to down-stream units for further processing.

Install Oxygen and Carbon Monoxide Monitoring Equipment to Control Boiler Combustion

Three boilers produce 250,000 pounds per hour of steam for several heating and drying processes. Currently, two coal-fired boilers are used as the primary base load for steam production. The coal-fired boilers have conventional controls for steam pressure and temperature and for coal and air input. An additional boiler is natural gas-fired, and operators use it in standby mode to supply steam when the demand exceeds the generation capacity of the coal-fired boilers. Oxygen in the flue gases is manually adjusted by controlling the under-fire airflow. The existing control system does not provide continuous measure-ment, monitoring, or control of combustion air.

The assessment team recommended installation of an oxygen and carbon monoxide measuring, monitoring, and control system on the coal-fired boilers. Because the two boilers operate near rated capacity, improved control of the oxygen in the excess combustion air would probably result in substantial savings. Flue gas oxygen content can be reduced by:

- Reducing airflow to the boiler while maintaining fixed fuel flow. This slightly increases steam production because of increased reaction temperature and higher heat transfer rates.

- Maintaining the current level of combustion airflow and increasing fuel input to consume additional oxygen. This results in a lower oxygen concentration in the flue gas, which in turn increases the reaction temperature and the amount of heat released in the boiler, enhances heat transfer, and increases steam production.

Recovery of Usable Fiber from Low-Consistency Screens

A gain of one percent in overall boiler efficiency can be expected because of improved heat transfer. Additionally, increased steam production in the coal-fired boilers will eliminate or reduce the need for the gas-fired boiler.

Reuse Uhle-Box Seal Water

Uhle-box seal water, or water removed from the press section of the paper machines, contains synthetic felt hair, fiber, ash, and fillers. Closing the system around the press section would allow proper reuse of uhle-box seal water, yielding benefits such as:

- Reducing fresh water consumption and pumping costs
- Reducing chemical consumption for water softening
- Reducing water heating costs
- Reducing waste streams and improving environmental compliance.

The assessment team recommended that partially recycled uhle-box seal water be used in the de-inking and bleaching units.

Reduce Silo Temperatures

Steam is injected into the dilute pulp mixtures in the paper machine silos to heat the mixtures from about 107° F to 110° F. The temperature of the pulp mix leaving the silo may be reduced from 110° F to 109° F. The assessment team estimates energy savings from the temperature reduction at more than $212,000 annually.

Add a Fluidized-Bed Boiler

West Carrollton mill personnel are considering the installation of a 60,000- to 100,000-pound-per-hour fluidized-bed boiler and a 3 megawatt turbine generator set to supplement the operation of the current coal- and gas-fired boilers. Table 2 shows the savings summary associated with this project. Advantages of the proposed fluidized-bed boiler include reducing the amount of natural gas consumed, burning some of the sludge generated in the mill, and burning cheaper high-sulfur coal. Because the implementation costs and payback period of this project are high ($23 million and 8.7 years), this project is not considered a likely candidate for immediate implementation.

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.

Project Partners

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The Edison Materials Technology Center (EMTEC)
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Ohio's Office of Energy Efficiency
Columbus, OH

Mid-West Building Diagnostics
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The International Center for Water Resource Management
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