GLASS

BestPractices
Assessment Case Study

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

Anchor Glass Container Corporation Plant-Wide Energy Assessment Saves Electricity and Expenditures

Benefits

- Approximately 220,000 million British thermal units (MMBtu) fossil fuel savings
- Nearly 4 million kilowatt-hours (kWh) in electricity savings

Applications

Producing glass is an energy intensive process. Efficient use of energy is necessary to assure that glass manufacturers remain competitive. Measures have been identified at Anchor Glass Container's Warner Robins and Jacksonville plants to increase utilization of waste heat, optimize the application of premium efficiency motors and variable speed drives (VSDs), measure in-plant energy consumption, and reduce compressed air use.

Summary

Plant-wide energy assessments at the Anchor Glass Warner Robins and Jacksonville plants revealed opportunities that could result in significant annual energy savings. The assessment team estimated the total potential savings at approximately 220,000 million British thermal units (MMBtu) per yer for fossil fuels and approximately 4 million kilowatt-hours (kWh) per year for electricity, if all projects were implemented. The associated capital required to achieve the fossil fuel savings was estimated at approximately $800,000, while that required to achieve projected electricity savings was estimated at $250,000. Average simple payback periods calculated for the primary recommendations ranged from 1 to 2 years.

Company Background

Anchor Glass Container Corporation is the third largest manufacturer of glass containers in the United States. Anchor produces a diverse line of flint (clear), amber, green, and other colored glass containers of various types, designs, and sizes. The Company manufactures and sells its products to many of the leading producers of beer, liquor, food, tea, and other beverages. Because glass production takes so much energy, all of the company's manufacturing facilities personnel must be aware of energy efficiency and energy cost reduction measures for Anchor to remain competitive in its markets.

Damper-Controlled Stack Ejector Fan

The team conducted assessments of the Anchor Glass facilities in Warner Robins, Georgia, and Jacksonville, Florida. The Warner Robins facility has two furnaces and eight bottle-forming machines that produce over 4 million bottles per day, approximately 360 days per year. The 860,000 square foot plant is comprised of 336,000 square feet for bottle production and packing, 500,000 square feet for the finished goods warehouse, 12,400 square feet for plant utilities and support areas, and 19,000 square feet for office and miscellaneous space. Typical electric and gas loads are approximately 12.5 megawatts and 4 million cubic feet per day, respectively. The Jacksonville, Florida plant has been reduced in size in recent years and consequently consumes approximately half as much energy as the Warner Robins plant. Both facilities produce similar products. The principal materials used in Anchor's manufacturing facilities are sand, soda ash, limestone, cullet, and various corrugated packaging materials.

Assessment Overview

Anchor's furnaces, which are primarily gas-fired with electric booster heat, melt more than 800 tons of glass per day. The furnaces are equipped with heat recovery regenerators that recover a portion of the waste energy from the 2,800° F furnaces using a cycling air flow system. Fluctuations in the temperature differential between the heat recovery masses and the air streams during each 20-minute cycle limit the effectiveness of the heat recovery process. In addition to the furnaces, equipment that uses notable quantities of electricity include air compressors and vacuum pumps (7,900 horsepower (hp) total, typically 6,050 hp operating), cooling and furnace air blowers (3,200 hp total), and lighting. The cooling water system, conveying and packing machinery, raw materials handing equipment, and a limited amount of space conditioning equipment also consume energy.

Minimization of waste and continued environmental compliance are essential goals for Anchor. Environmental regulations associated with the glass manufacturing process include the disposal of checker slag, or furnace residue usually removed during furnace rebuilds, furnace bricks containing chromium, and production waste. Additional regulations concern the discharge of water used to clean machines and cooling water, dust produced by the batch mixing process, and air emissions from the furnaces.

INLET LINE TO AIR COMPRESSOR

The assessment review team consisted of representatives from Anchor Glass Container Corporation's Warner Robins and Jacksonville plants and from Sterling Energy Services, LLC. 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

The Anchor assessment team used a systems approach to conduct a comprehensive plant-wide energy efficiency review. The team identified, evaluated, and prioritized opportunities for energy savings. Maintenance and operating procedures were also reviewed for their impact on energy efficiency. Although the Warner Robins plant was given priority for the assessment, a more limited review of the Jacksonville plant was conducted to assure effective benchmarking of Anchor's plants. Three areas were considered in the energy assessment: inputs to plant processes, plant process efficiency, and process outputs including waste and heat products.

The team completed a detailed audit of plant facilities, with emphasis on processes and systems determined to have the greatest energy savings potential. These processes and systems include:

- Cogeneration—Installation of gas turbines with waste heat recovery systems
- Waste heat recovery—Recovery and reuse of waste heat from furnaces
- Motor analysis—Motor efficiency improvements
- Compressed air systems—Operations and maintenance, leakage, improper use, and distribution and storage of compressed air systems
- Lighting systems—Cost-effective lighting improvements
- VSD (Variable Speed Drive) analysis—Installation of VSDs on selected process equipment, particularly blowers.

Results and Recommendations

Table 1 summarizes selected examples of energy savings that the team identified in the plant-wide assessment for both the Warner Robins and Jacksonville plants. These projections of savings and capital costs are preliminary, based on data collected and analyzed in the energy efficiency review. They have not yet been validated through definitive engineering analyses and field testing, which are ongoing for specific measures.

Table 1. Potential Energy Savings Summary

Action	Energy Savings Estimate	Simple Payback on Capital Required (years)
Increasing heat recovery	220,388 MMBtu/year	1.0
Compressed air	2,056,250 kWh/year	1.2
VSD cooling water pumps	524,600 kWh/year	1.8
VSD furnace air blowers	808,400 kWh/year	1.7
VSD machine cool blowers	560,720 kWh/year	1.8

Overview of Specific Actions Identified in the Assessment

Thermal Cycle Efficiency Improvement Options

Tremendous amounts of heat energy are required in the glass manufacturing process to melt and refine the raw glass material. At Anchor, this heat is introduced to the glass furnace in two ways: direct natural gas or other fuel firing over the glass melting tank, and electric booster heat arcing between electrodes immersed in the glass melt. Direct firing uses lower cost fuels, but the over-melt firing process is much less efficient, at 50 to 60 percent, in delivering heat to the melt. While the electric arc is practically 100 percent efficient in delivering heat to the glass melt, the cost of the electricity is high relative to other fuels.

To recover some of the heat lost through the inefficiency of the direct firing process, the glass furnaces use checker brick regenerators to capture and return some of the waste heat. The regenerators are characterized by their fluctuating effectiveness over the charge/discharge cycle. The regenerators are more effective at the beginning of the cycle because of greater air/regenerator temperature differences, but performance decreases significantly toward the end of cycle. The effectiveness of the regenerators aside, a significant amount of heat is lost up the stack, providing an opportunity to further improve the process efficiency.

Possible approaches to improving the efficiency of the glass melting process include:

- Generate steam from the stack gas waste heat to drive a turbine
- Recover stack gas waste heat into the incoming air through air-to-air or intermediary heat exchangers
- Optimize charge/discharge cycle times to improve the regenerator effectiveness.

The team considered recovery of the waste heat from the furnace stacks, either to produce steam driving a turbine-generator and/or to preheat incoming furnace combustion air. Analysis showed that the best way to recover this energy is by incorporating an air-to-air heat exchanger that would transfer part of the heat between the air streams exiting and entering the regenerators.

HIGH-PRESSURE BLOWER FOR MOLD COOLING AIR

The team also identified an opportunity to improve the regenerators at the Warner Robins plant by modifying or repairing them if necessary, and possibly incorporating shorter cycle times to optimize their heat recovery.

Compressed Air System Efficiency and Improvements

The Anchor plants use significant amounts of compressed air at two different pressures in their container production processes. High-pressure air (~100 pounds per square inch (psi)) is used for operating typical air-powered controls and tools, while low-pressure air (~50 psi) is used in the bottle-blowing process machinery. The Warner Robins plant has a flow rate of approximately 16,000 cubic feet per minute (cfm) of high-pressure air; the Jacksonville plant has a flow rate of about 11,000 cfm.

The energy assessment revealed that the high-pressure system operates at between 97 and 103 psi in the compressor room at the Warner Robins plant. A refrigerated dryer rated at 11,000 cfm provides air-drying. The air supply in the plant supply header ranges from 82 to 85 psi. A limited inspection estimated that air leaks account for more than 20 percent of total air consumption; thus, renewed efforts were recommended to reduce or eliminate leaks to minimize air use.

The high volume of air flow causes a high pressure drop through the air dryer. This accounts for most of the pressure drop from the compressor discharge headers to the plant supply header. In addition, the dryer is incapable of properly drying the total flow; the purchase of a replacement dryer is under consideration.

A significant opportunity exists to improve the efficiency of the high-pressure system. Among the recommended improvements are:

- Remove system bottlenecks and add a higher-pressure storage system to reconfigure the compressor room to a lower supply pressure
- Provide advanced system controls to optimize compressor operations and energy efficiency
- Reduce leaks in the system to lower the flow requirements.

Adding the recommended higher-pressure air receiver storage capacity will allow sufficient air storage so that a trim compressor can totally shut down for 10 to 20 minutes when unloaded, rather than cycling between loaded and unloaded modes.

Motor Management and Efficiency

Review of the application and operation of electric motors resulted in the following recommendations:

- Economic guidelines should be in place so that initial cost does not drive repair versus replace decision-making
- Larger motors that are sometimes underloaded for their application and are less efficient should be replaced with premium efficiency motors when a payback of 2.5 years or less is possible
- Develop an overall motor inventory and replacement plan
- Energy-efficient motors should be used for all new or replaced motors where expected annual operating time will be greater than 4,000 hours.

Pump and Blower VSD Application

The Warner Robins and Jacksonville plants use pumps and blowers for various process functions, but three general applications were considered in the assessment: cooling water pumping, process cooling blowers, and furnace air blowers. These pumps and blowers currently run at constant speed, with either no flow control or with valves for pumps and variable inlet vanes for blowers.

Recommendations include:

- Consider the use of VSDs on the cooling tower water pumps to control pump speed and to modulate tower water flow and pressure
- Consider using VSDs on the glass furnace air and stack draft blowers to control blower speed as a means of modulating airflow
- Consider using VSDs on the glass forming and hot glass handling machinery air cooling blowers to control blower speed as a means of modulating air flow.

Evaluations of these opportunities are ongoing. Trial installations are being conducted before full implementation takes place.

Plant Lighting

Recommendations for improvements in efficiency of plant lighting systems include:

- Provide for expanded use of natural lighting
- Where convenient, consider converting the plant's outdoor lighting from utility-supplied lighting to wall packs or plant-supplied lighting
- Install motion sensors in equipment rooms, warehouse facilities, and other plant areas that are not frequently occupied
- Have lighting performance contractors conduct no-cost reviews of plant lighting to identify possible improvement opportunities.

Plant Energy Purchase Optimization

With the extreme volatility of natural gas and electricity prices in the past year, the assessment team evaluated the potential for fuel substitution, including load management on the electric boost in conjunction with real-time electricity prices and operational considerations. Break-even guidelines were recommended for consideration of energy purchase optimization and fuel substitution to permit better management in the volatile markets.

INDUSTRY OF THE FUTURE—GLASS

In April 1996, several organizations representing the glass industry signed a compact with the Department of Energy (DOE) in an effort to encourage technological innovations that will reduce energy consumption, pollution, and production costs in the industry. The glass industry published a report entitled ***Glass: A Clear Vision for a Bright Future,*** *which articulated the industry's vision of its future. This compact set the foundation for collaborative efforts between the industry and the Federal government. Signed by both key industry players and Department of Energy officials, it was a formal commitment to align DOE'S limited resources to meet the challenges identified in the vision.*

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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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