EXCEEDING THE CORPORATE STANDARD FOR ENERGY EFFICIENCY AND SUSTAINABILITY AT SAINT-GOBAIN'S ALBION, NEW YORK FACILITY

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ABSTRACT

Saint-Gobain, the world's largest manufacturer of building materials, prides itself on having a strong commitment to sustainability and has therefore set ambitious goals for energy reduction at its North American locations. In 2012 Saint-Gobain's Albion, NY facility initiated efforts to develop a comprehensive energy management and sustainability program to improve energy efficiency and reduce GHG emissions and water consumption. The 220,000 square foot Albion facility operates 24/7. Primary process utility support systems include rotary-screw air compressors, process ventilation and exhaust systems, fire-tube steam boilers, and a RTO to eliminate VOCs from process exhaust streams. Total annual consumption for this facility is about 7.3 million kWh electric, 1.7 million therms gas and 4.9 million gallons water for a total cost of over $1.25 million. Utilizing outside assistance from industrial energy experts CHA Consulting, Saint-Gobain was able to obtain state funding from the NYSERDA to cost-share 2 investment grade energy studies; focused on identifying ECMs to improve efficiency of the compressed air, process exhaust & makeup air, and boiler plant & steam/condensate systems. After thorough review of the systems, recommendations for comprehensive system improvements strategies were assembled and are now in the process of being implemented at the plant. Anticipated savings for the planned projects are of 857,200 kWh in electricity; 362,000 therms of natural gas, and 1 million gallons of water, for a total of $251,400 in annual savings.

CORPORATE PHILOSOPHY & BACKGROUND

Saint-Gobain is the world's largest building materials company with over 265 locations across North America alone. With a strong commitment to sustainability, Saint-Gobain has set ambitious targets for reducing carbon dioxide emissions at its locations across North America. This includes a reduction in energy consumption and greenhouse gas emissions at service buildings by a factor of four by 2040 under the Saint-Gobain CARE:4® program. There is also a corporate-wide, global target to reduce CO2 emissions by 6% (2% each year) from 2014-2016, as well as a target to reduce water usage 6% over the same three years. The company also aims to have "zero landfilled waste."

Saint-Gobain's Adfors division manufactures fabric-based reinforcement products for a variety of construction applications. Their wide range of technical fabrics reinforce a variety of products including concrete, sail cloth, flooring, roofing shingles, paintable wall coverings, insect screens and drywall joint tape.

SAINT-GOBAIN'S ALBION, NY FACILITY

Saint-Gobain's Adfors manufacturing facility in Albion, NY is approximately 220,000 square feet, operates 24 hours per day, 7 days a week with approximately 200 employees.

Baseline Energy Consumption

Baseline utility consumption for the facility was initially established for the period of June 2012 through May 2013. For this timeframe, total annual electric consumption at the Albion facility was approximately 7.3 million kWh, with a peak electric demand of over 1,100 kW, and annual cost of $433,000. Natural gas annual consumption was approximately 1.7 million therms at a cost of $794,000. The facility also utilized approximately 4.9 million gallons of water at a cost of $29,000 annually. Chemical treatments for boiler plant makeup water cost an additional $10,000 per year.

Process Utility Equipment

The primary process utility support systems at the Albion plant include compressed air, process exhaust and makeup air, and steam. These systems are essential to plant operations and consume the vast majority of electric, natural gas and water utilities.

Compressed Air System
The plant's compressed air system is comprised of four oil-flooded, air-cooled, rotary-screw compressors with a total rated capacity of 941 CFM and 200 HP. All compressors operate under load/no-load controls with cascading pressure setpoints for lead, lag and backup compressors. Target discharge pressure to the system is 110 psig. Three of the compressors are located in the boiler room, where summertime temperatures can reach over 100°F. Air drying is performed by two refrigerated air dryers with a total of 650 CFM rated capacity. Three air receivers provide a total of 640 gallons of storage volume.

Process Exhaust & Makeup Air Systems
Saint-Gobain's processes require large volumes of continuous exhaust and subsequent makeup air. Air is exhausted by a multitude of rooftop exhaust fans and over 30 process exhaust stacks. Additionally, a 50,000 CFM regenerative thermal oxidizer (RTO) is used to eliminate volatile organic compounds (VOCs) from process exhaust streams to a 99% purity level.

Building makeup air is mechanically provided by eight ceiling-suspended steam coil air handling units (AHU), one indoor floor-mounted steam coil AHU and an outdoor direct-fired Rapid-Air makeup air unit (MAU). Overall, the building is largely lacking in adequate makeup air and is severely negative in pressure. Therefore, additional passive makeup air is provided through wall louvers and open doorways and overhead doors.

Boiler Plant & Steam/Condensate Systems
The facility utilizes a pair of 400 HP fire-tube boilers to provide 115 psig steam for process and building heating needs. The boilers were installed in 1975 and are equipped with basic controls such as a single point jack-shaft linkage system and constant speed combustion air fan blower for fuel and air supply. Chemical readings are taken periodically and levels adjusted manually with continuous surface blowdown.

Three 20 HP base-mounted centrifugal pumps provide feed water to the boilers via on/off operation based on boiler water level. A single condensate receiver tank also functions as the boiler feed water and makeup water tank. Condensate return lines feed into the top of the tank, which is vented to atmosphere and has a constant plume of flash steam and blow-thru steam that can be seen discharging above the roof.

Steam is distributed throughout the facility in overhead piping. When originally designed, the facility utilized a below-slab condensate return system buried within the concrete floor. This system has since failed and been replaced with an overhead condensate return piping system. Nearly 100% of condensate is piped to return; however, only two condensate return pumping stations are in use. Condensate return pumps were not installed as typically required when the system was converted from below-slab to overhead condensate return. The result is that additional steam pressure is required to force the condensate up to the ceiling and back to the boilers. Facility personnel performed a system test to determine the steam pressure required to force the condensate back to the boilers, and found this to be about 28 psig. Without the pressure requirement to push condensate, it is anticipated that steam pressure could be set to about 100 psig for process operation.

Saint-Gobain uses about 200 steam traps at the Albion facility; most are small inverted bucket style traps, with some float and thermostatic style models.

CHARTING A PATH FORWARD

Ahead of corporate goals, in 2012 Saint-Gobain's Albion facility initiated efforts towards developing a comprehensive energy management and sustainability program to improve the site's overall energy efficiency, while also reducing greenhouse gas emissions and water consumption. To meet their goals, the Albion facility sought outside assistance from industrial energy experts to help with identifying areas where the plant could improve. Therefore, CHA Consulting was contracted to conduct two investment grade energy efficiency studies covering several specific areas of focus. The studies identified an array of potential Energy Conservation Measures (ECMs) including equipment upgrades, controls improvements, energy recovery opportunities, and operations & maintenance enhancements. Additionally, funding offered through the New York State Energy Research & Development Authority (NYSERDA) was obtained to finance a 50% cost-share for both studies.

2012 Energy Study
One of the primary areas of focus in the initial energy study was compressed air. Baseline development included comprehensive monitoring of the compressed air system for approximately one month. Points trended included compressor power, air flow and system pressure. A facility wide compressed air leak survey was also performed using an ultrasonic leak detector. Other areas evaluated for energy efficiency opportunity included office HVAC equipment and controls; process makeup air systems; and process exhaust heat recovery. System baselines were developed using a combination of airflow/temperature measurements, bin analysis and utility analysis.

2013 Energy Study
The second detailed energy study focused on the boiler plant, steam distribution and condensate return systems.

Baseline development was completed through a combination of feed water pump data logging, temperature/pressure measurements, review of feed water chemical logs, boiler stack combustion testing, bin analysis and utility analysis. A facility wide steam trap survey was also performed using an ultrasonic detector.

RECOGNIZING THE OPPORTUNITIES

During the detailed energy studies system baseline energy consumptions, operating characteristics and the real cost of operating the various process utility systems was established. As a result, a multitude of operational, equipment and system deficiencies were identified.

Compressed Air System

The compressed air system was found to be responsible for approximately 20% of total site electric consumption; with an annually operating cost of about $120,000. The logged data established average system airflow to be 522 CFM, with a maximum of 719 CFM. Average system pressure is 99.1 psig; however, pressure fluctuated between 78.1 psig and 106.9 psig. Overall average system efficiency is 0.252 kW/CFM. Other notes on the compressed air system include the following:

- Currently relying on aging equipment, where both primary compressors have > 100,000 run hours.
- Dryers and piping headers are undersized for necessary flow, leading to bottlenecks and system pressure loss.
- Large pressure fluctuations (28.8 psig swing) lead to process equipment failures and product loss.
- Low pressure points in the system force machine downtime with inadequate air supply to operate.
- Air leak survey identified 106 leaks totaling 126 CFM, which is equal to 24% of system air demand.

Process Exhaust & Makeup Air Systems

Total exhaust volume from the manufacturing floor is estimated to be about 160,000 CFM, where only 75,000 CFM of makeup air is being mechanically brought into the building. Therefore, the air balance is lacking 85,000 CFM in building makeup air. The RTO is responsible for an estimated 41,300 CFM of process exhaust air; with a typical discharge stack temperature 230°F. Other notes on the process exhaust and makeup air systems include the following:

- Large negative building pressure leads to excessive infiltration of unconditioned outside air.
- Open doors to allow air into the plant present site safety and security concerns.
- Lack of adequate ventilation leads to hazy, poor indoor air quality and employee health concerns.
- Negative pressure restricts process exhaust systems, leading to increased maintenance on fans and belts.
- Existing AHUs responsible for makeup air are very old and several have already failed.

Boiler Plant & Steam/Condensate Systems

The boiler plant was found to be responsible for about 80% of site natural gas consumption and 30% of the plant's water use; with an annual operating cost of $621,000. Baseline analysis established an average steam production rate of 9,690 lbs/hr. Approximately 96% of all steam is

used by manufacturing processes, and the remainder for building heat. Boiler stack combustion testing revealed a firing efficiency of 81%; where overall system efficiency was found to be only 67%. Boiler plant makeup water totals an estimated 1.5 million gallons per year, averaging 2.9 gpm. Other notes on the boiler plant & steam/condensate systems include the following:

- Basic/antiquated controls include jack-shaft linkage, constant speed draft fans with inlet vane dampers, and on/off feed water pumps.
- Continuous surface blowdown through open ball valve is manually adjusted once/day.
- Steam trap survey identified 29 failed stream traps, which is equal to 15% of the total.
- 12 steam or condensate leaks were found.
- Over 1,600 ft of uninsulated steam or condensate piping identified.
- Elevated steam supply pressure to overcome condensate return backpressure.

ENGINEERING THE IMPROVEMENTS

After thorough review of the system baselines and deficiencies, CHA developed detailed system improvement strategies and concepts to address the plant's operational needs while emphasizing energy efficiency. Through this analysis, recommendations for comprehensive system improvements were identified and consist of the following details:

Compressed Air System

- Construction of a new compressor room in an area of high air demand and away from the boiler room.
- Installation of a new 125 HP variable speed, two-stage, rotary-screw air compressor.
- Installation of a new digital scroll refrigerated dryer.
- Compressor exhaust heat reclaim for building heating.
- Utilize cool outdoor air for compression.
- Air storage and piping improvements for improved air distribution and pressure stabilization.
- Demand expander air flow station for precise system pressure control.
- Repair compressed air leaks and implement planned maintenance program.

Process Exhaust & Makeup Air Systems

- Remove 10 old steam coil AHUs
- Install 4 direct-fired, variable speed rooftop makeup air units totaling 120,000 CFM to be controlled by building pressure sensors.
- Install heat recovery loop in RTO exhaust stack for preheating makeup air to the building.

Boiler Plant & Steam/Condensate Systems

- Boiler controls upgrades to include parallel positioning, oxygen trim, variable speed draft fans, and variable speed feed water system
- Reduced surface blowdown with conductivity controllers to automate boiler water blowdown.
- Boiler stack economizer to preheat feed water.
- New condensate return & dearator systems.
- Flash steam energy recovery with vent condenser.
- Repair failed steam traps and implement planned maintenance program.
- Install steam and condensate piping insulation.
- Install point-of-use condensate receivers.
- Improved overall system efficiency to 81%.

RESULTING ANNUAL SAVINGS

In addition to manufacturing operational improvements, Saint-Gobain is expected to experience substantial energy consumption savings by implementing the recommended projects for the various process utility systems. The resulting annual utility savings are as follows:

Compressed Air System

- Electric Consumption: 615,600 kWh
- Electric Demand: 96 kW
- Natural Gas: 16,000 therms
- Utility Cost Savings: $ 51,000

Process Exhaust & Makeup Air Systems

- Electric Consumption: 96,600 kWh
- Electric Demand: 10 kW
- Natural Gas: 106,000 therms
- Utility Cost Savings: $ 58,300

Boiler Plant & Steam/Condensate Systems

- Electric Consumption: 145,000 kWh
- Electric Demand: 25 kW
- Natural Gas: 240,000 therms
- Water & Sewer: 1,039,000 gallons
- Utility Cost Savings: $ 142,100

Overall Project Economics

- Electric Consumption: 857,200 kWh (12%)
- Electric Demand: 131 kW (12%)
- Natural Gas: 362,000 therms (21%)
- Water & Sewer: 1,039,000 gals (21%)
- Utility Cost Savings: $ 251,400 (20%)
- Estimated Project Cost: $ 1.5 Million
- Simple Payback: 6.0 Years
- Est. NYSERDA Incentive: $ 558,000
- Resulting Simple Payback: 3.7 Years

IMPLEMENTING THE IMPROVEMENTS

Going forward Saint-Gobain and CHA have charted a path to implement the recommended projects at the Albion, NY facility.

2016

Projects currently underway include all upgrades to the compressed air system and installation of the 4 new rooftop makeup air units. Demolition of the 10 old, steam coil AHUs is also being performed.

2017

Design of the boiler plant upgrades is currently underway with construction planned for next spring.

2017 – 2018

Succeeding projects will include implementation of the recommended improvements to the steam distribution and condensate return systems outside of the boiler room. A heat recovery system to transfer heat from the RTO to preheat building makeup air is also being planned.

AUTHORS' BIOGRAPHY

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Mr. Avalone is a Project Manager and Mechanical Engineer at CHA where he is responsible for the engineering design of mechanical and industrial systems, conducting energy audits in commercial and industrial facilities, managing energy efficiency improvement projects, managing design and construction projects and performing Industrial Outreach and project management duties on behalf of NYSERDA's Industrial & Process Efficiency and FlexTech programs.

Mr. Avalone has extensive experience providing industrial energy management solutions, including conducting and managing energy studies, developing energy management plans and implementing energy conservation solutions. He has worked with over 100 different manufacturing companies at facilities throughout the U.S. including the automotive, electronics, pharmaceuticals, textiles, mining, food & beverage, glass & optics, petroleum, defense, paper, and plastics industries.

Mr. Avalone received his B.S. in Mechanical Engineering from Union College. He is a registered Professional Engineer in NYS, a Certified Energy Manager and LEED Accredited Professional. He is a member of the American Society of Heating Refrigeration & Air Conditioning Engineers and the Association of Energy Engineers, and serves on the board of directors for the Rochester Chapter of the Association for Facilities Engineering.

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Mr. Paeth has been employed at Saint-Gobain since 1984. He has held several positions throughout his career with Saint-Gobain including Process Engineer, Plant Engineer, Maintenance Manager, ADFORS Energy Manager, Environmental Manager and Engineering Manager. He is currently responsible for the Albion plant maintenance and engineering departments. Mr. Paeth has managed the Albion Plant's capital budget and projects including design and build of proprietary production machinery. He has managed several plant relocations, both domestic and international. He also has responsibility for several international technology development projects. Mr. Paeth holds a SUNY mechanical engineering tech degree.