

Best Practices

Best Practices Technical Case Study

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OFFICE OF INDUSTRIAL TECHNOLOGIES

ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY

BENEFITS

- Saves \$185,000 annually
- Increases production
- Improves product quality
- Lowers maintenance costs
- Avoids capital purchase

APPLICATIONS

Compressed air systems are found extensively in industrial production processes and are often the greatest source of electricity consumption in a plant. Proper configuration of a compressed air system is important in ensuring that it operates efficiently.

COMPRESSED AIR SYSTEM OPTIMIZATION SAVES ENERGY AND IMPROVES PRODUCTION AT A TEXTILE MANUFACTURING MILL

Summary

In 1997, a compressed air system improvement project was implemented at the Peerless Division of Thomaston Mills in Thomaston, Georgia. The compressed air system project was undertaken in conjunction with an effort aimed at modernizing some of the mill's production equipment. Once they were both completed, the mill was able to increase production by 2% per year while reducing annual compressed air energy costs by 4% (\$109,000) and maintenance costs by 35% (\$76,000). The project also improved the compressed air system's performance, resulting in a 90% reduction in compressor downtime and better product quality. Since the project's total cost was \$528,000 and the annual savings are \$185,000 per year, the simple payback is 2.9 years. The mill also achieved a cost avoidance of \$55,000 by installing a more optimal arrangement of compressors.

PEERLESS DIVISION, THOMASTON MILLS, INC.



Company/Plant Overview

Thomaston Mills, Inc. is a diversified manufacturer of textile products for the apparel, home furnishings, and industrial markets. Thomaston's manufacturing facility in Thomaston, Georgia is a vertically integrated facility whose 1500 employees produce a full range of textile products. Of the three separate mills at Thomaston's facility, the grey mill is where all of the mill's compressed air applications are located. These applications include air jet looms (which use the greatest amount of compressed air), spinning frames and blowguns.

Prior to the project, the grey mill was served by seven centrifugal compressors, six of which were 800-1000-hp, with one 350-hp compressor as back up. The mill also had an auxiliary 200-hp rotary screw compressor. The six larger compressors were manually controlled and operated at full load. The compressors were generating 21,600 scfm at discharge pressures of 96 psig or higher in order for the applications to receive air at the minimum level of 86 psig, specified by the manufacturer.

Project Overview

The compressed air system in the grey mill was surveyed in 1995 because the mill wanted to expand its manufacturing capacity and lower its production costs in order to remain competitive in the face of stiff competition from less expensive imports. Prior to the survey, the mill had planned to purchase a 900-hp centrifugal compressor to meet the impending increase in demand for compressed air from 60 new air jet looms that it planned to install. The survey showed that by making some modifications to the original compressed air system and purchasing smaller compressors, its compressed air needs could be adequately met without the new 900-hp compressor. The survey then became the basis for a system-level compressed air system optimization strategy.

One of the survey's main findings was that the mill was unable to maintain a stable pressure level, causing the air jet looms to shut down whenever the end use pressure fell to 60 psig. In response to the inadequate pressure level, the mill would bring more compressors online in order to provide the system with the minimum pressure it needed. The mill's inability to maintain a stable pressure level stemmed from the fact that the mill's compressed air storage was inadequate and that the system was experiencing excessive pressure drop due to leaking, worn hoses, drains and valves at points of use, and from poorly functioning filters in some of the air treatment equipment.

Another situation revealed by the survey was excessive compressor blow off due to shifting air demand patterns. Centrifugal compressors blow off or vent compressed air into the atmosphere when the system demand falls below the compressors' minimum stable flow. This is because centrifugal compressors have a limited throttling capacity. If the system demand falls below a centrifugal compressor's minimum stable flow, it will vent excess air in order to prevent the system pressure from rising above its set point. Otherwise, it runs the risk of shutting down. In this case, the mill always had one compressor blowing-off about 50% of its output.

Next, it was discovered that the bypass valves on two of the centrifugal compressors were not working reliably. Bypass and blow-off valves on centrifugal compressors need to function properly in order to prevent the possibility of a situation known as surge. Sometimes a reversal of airflow can occur in centrifugal compressors at low flow rates. The air then surges back into the compressor and can cause serious damage to it. If a reversal of airflow occurs, bypass valves prevent the air from flowing back into the compressor.

30,000 GALLON STORAGE RECEIVER



The mill was experiencing a high degree of overheating and moisture carryover in the compressors, leading to compressor shutdowns and excessive production downtime. The overheating occurred in the summer months and was due to inadequate cooling capacity. Moisture carry over was caused by solenoid-operated condensate drains whose valves were partially open and would leak water into the next stage of the compressor, leading to vibration-induced shutdowns and possible mechanical damage.

The system's leakage (510 scfm) came mainly from the worn end-use components that were also responsible for pressure drop. One other source of leakage was in the humidifying nozzles, where the air pressure needed to be controlled at 30 psig. The mill was achieving the pressure level with a manually adjustable valve that would allow 270 scfm to escape under certain conditions. In addition, leaky hoses in the blow gun area were old and had been patched or spliced together. If a hose were to break, the pipe nipple inside of it could result in injury since the airflow and pressure would cause the hose to whip back and forth until the air was shut off.

Finally, the mill discovered that the minimum pressure level needed for the Murata frames, their highest pressure application, was actually 80 psig instead of 86 psig.

Project Implementation

Thomaston Mills' compressed air system project incorporated many of the survey's recommendations and facilitated the planned mill expansion. The mill expanded its manufacturing capacity by removing 129 shuttle looms and replacing them with 60 new air jet looms. In order to meet the increased demand and provide better trim capacity to the system, the mill installed two 350-hp rotary screw compressors. At the same time, the mill disposed of its aging 200-hp rotary screw compressor. The mill then installed the following items as recommended in the survey:

- A pressure/flow controller along with 40,000 gallons of storage in three receivers – one 30,000 gallon tank and two 5000 gallon receivers to stabilize the system pressure
- A heavy duty mist eliminating filter downstream of the new 350-hp compressors
- A cycling refrigerated dryer downstream of the filter
- A programmable logic control system that linked the compressors with the pressure/flow controller
- A pilot operated regulator to replace the manually adjustable valve serving the humidifying nozzles
- Pneumatic drains in the compressor room in place of the solenoid-operated condensate drains

Once all of these components were in place, the mill implemented other recommendations. The mill addressed the compressor overheating issue by extending the cooling water pipe from the main compressor room to the area where peak-use compressors were placed and reconfigured the piping from two other cooling water towers so that they served the main compressor room. Rather than build an additional cell on the cooling water tower, they installed a fan exhaust system to take heat out of the main compressor room. The mill then replaced the unreliable bypass valves on the two centrifugal compressors, retrofitted the controls on one compressor and installed a 6" header to connect another compressor to the peak-use compressors upstream of the pressure/flow controller. Finally, the mill identified and repaired the leaks in the end use components bringing their leakage rate down from 510 scfm to only 200 scfm or 1% of total airflow.

Results

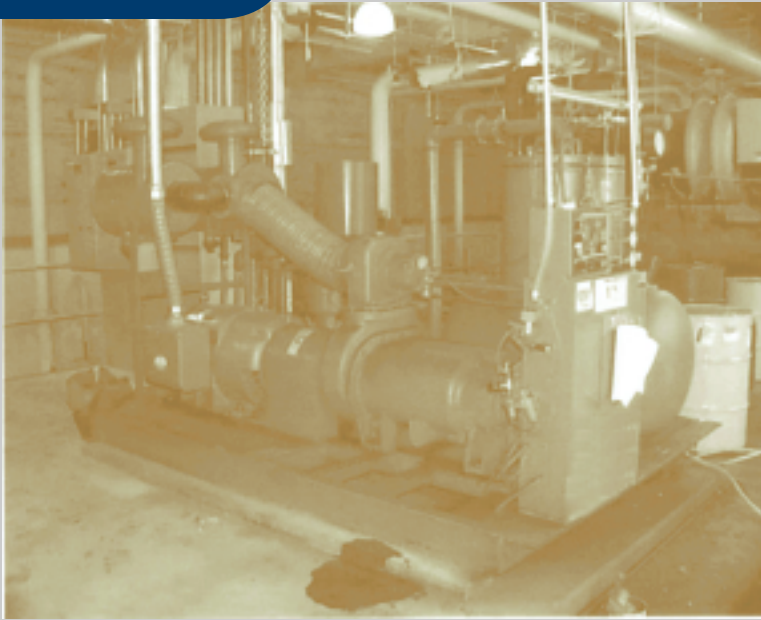
The compressed air system improvement project at the Thomaston mill generated energy savings while improving product quality and increasing system reliability. Although the mill ended up with a system that had greater total horsepower than before the project, it was able to operate with less of that horsepower online, despite an increase in demand due to the modernization effort. In the system's current configuration, five centrifugal compressors are base loaded, with a 1000-hp compressor for back up. One of the new 350-hp compressors is also base loaded and the other one starts and stops as needed. Using this rotary screw compressor as a trim compressor has greatly reduced blow-off from the centrifugal compressors. This has resulted in annual energy savings of \$109,000 (3,430,556 kWh) per year, which represent 4% of annual electricity costs. In addition, by purchasing two 350-hp compressors instead of a 900-hp centrifugal compressor, the mill achieved a cost avoidance of \$55,000.

In addition, the mill's production benefited from the increased reliability of the compressed air system. The greater quantity of stored air combined with the pressure/flow controller allowed the mill to stabilize the system pressure at 82 psig. This improved the productivity of the air jet looms and spinning frames leading to more consistent product quality. The elimination of moisture carryover and the improved cooling capacity reduced the mill's compressor shutdown rate by 90%, which greatly decreased production downtime and allowed for an increase in productivity. The elimination of the compressor overheating and moisture carryover, coupled with the replacement of the bypass valves has reduced the mill's maintenance requirements and lowered maintenance costs by \$76,000 annually. Finally, the mill improved safety by replacing the hoses in the blow gun area.

Lessons Learned

Often a compressed air system can be made more efficient if it is properly configured and maintained within the context of a system-level strategy. Manufacturing plants having intermittent demand for compressed air can waste energy and lower productivity by not maintaining the compressors properly, by not having adequate storage, by not controlling compressors effectively, and by not treating the air adequately. In the case of Thomaston Mills, reconfiguring the compressor cooling system, matching air supply with air demand, implementing an effective control strategy, and eliminating moisture carry over greatly increased the efficiency of the compressed air system. A combination of proper attention to equipment maintenance, effective use of equipment through a system control strategy, adequate storage and air quality that meets production needs improves production and saves energy.

TRIM COMPRESSOR



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 focuses on 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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