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Technical Case Study

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

Benefits

- Saves $180,000 annually
- Improves system efficiency and reliability
- Lowers maintenance costs

Applications

Compressed air systems are found extensively in industrial production processes and are often the greatest source of electricity consumption for a plant. Proper configuration of a compressed air system is essential for efficient operation.

Compressed Air System Modifications Improve Efficiency at a Plastics Blow Molding Plant

Summary

In 1997, Southeastern Container performed modifications to the compressed air system at their blow molding plant in Enka, North Carolina. The project was based on a survey of the plant's compressed air system performed by North Carolina State University's (NCSU) Industrial Extension Service. The project allowed the plant's compressed air system to operate more efficiently, which resulted in significant compressed air energy savings and better production. The total energy savings from the implementation of the modifications were $180,000 (7,400,000 kWh) per year, which represent over 16% of their compressed air electricity costs. In addition, maintenance costs were reduced by approximately 75%. Because the project's cost was $80,000, the simple payback was less than 6 months.

Plant/System Overview

Southeastern Container is the largest manufacturer of polyethylene terephthalate (PET) soft drink bottles in the world. The Enka, North Carolina,

Southeastern Container Plant

plant is a 300,000 square foot facility with 250 employees that makes bottles for Coca-Cola. The main operations at the plant are blow molding and injection molding in separate, but integrated, sections of the facility. The blow molders require clean, dry compressed air at an operating pressure of 600 psig in order to produce a high quality bottle. Therefore, the plant operates its compressed air system with a high- and a low-pressure level. Prior to the project, the plant's compressed air system consisted of two 800-hp centrifugal compressors that generated 5,300 cfm of low-pressure air at 115 psig and three 300-hp booster compressors that increased 4,800 cfm to the high-pressure level of 650 psig. At the time of the project, the plant's production was increasing, which led it to upgrade some of its compressors that were aging and nearing the end of their useful lives.

Project Overview

The Enka plant decided to consult with NCSU's Industrial Extension Service to ensure optimal system configuration while it was undergoing its compressor upgrade project. The survey by NCSU's Industrial Extension Service made some observations, providing the plant with a system-level strategy that would improve the efficiency of the plant's compressed air system.

The first observation from the survey was that the plant's compressors were venting compressed air unnecessarily because their blow off rate was set at 87% of their load. This caused them to vent air that had already been compressed. 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 to prevent the system pressure from rising above its set point. If the system pressure exceeds the compressor set point, the airflow can reverse direction and come back into the impeller. This is known as "surge," and it causes serious damage to the compressor. In the case of the Enka plant, the survey revealed that the blow off point could be set below 75% without any risk of surge.

The next observation was that the three booster compressors had severe internal and external leakage rates around the valve cover plates and unloader valves. This condition prevented the booster compressors from operating efficiently because it caused them to recompress air that had decreased in pressure after it had leaked. In addition, the survey found 367 scfm of low-pressure leaks and 505 scfm of high-pressure leaks in the distribution system that hampered the compressors' ability to stabilize the system pressure.

The survey examined the air treatment equipment and found that the two 800-hp compressors were linked to the dryers that served them by one common supply and recommended that a bypass valve be installed around those dryers in case of a dryer failure. In addition, the survey recommended the purchase of an additional dryer because the plant planned to add a third 800-hp compressor to support the air demand from the plant expansion project.

In addition, the survey identified some applications that used compressed air that could be supported with less energy-intensive methods. The plant was cooling and hardening the bottlenecks by blowing cool, compressed air on them with vortex coolers. The survey suggested using a less energy-intensive method, such as a cabinet cooler, to accomplish this instead. Also, some of the blow mold machines were continuously blowing compressed air through air jets onto the pre-form feed lines to prevent them from jamming. NSCU's team proposed installing an electromechanical vibrator to perform this function. Finally, the survey showed that the plant's stackers were using compressed air in venturi vacuum producers to pick up and position dividers between layers of bottles. They suggested that this function be performed with a central vacuum system whose energy cost would be about 10 to 30% of the venturi devices' energy costs.

Project Implementation

As soon as the survey was completed, the Enka plant began implementing many of its recommendations. The first order of business was to lower the blow-off set points on the 800-hp centrifugal compressors to 75% of the compressors' load. Next the plant replaced the unloader valves and cover plates around the booster compressors with newer, more advanced models. As recommended, the plant purchased and installed a new dryer with the installation of the third 800-hp centrifugal compressor. Then the plant performed a leak detection and repair project on the largest leaks in its system and switched from cooling the bottlenecks with compressed air to using cabinet coolers. In addition to the recommendations of the NCSU experts, the plant managers decided to replace the solenoid condensation traps with new pneumatic ones because they suspected that the traps were not working properly which may have led to episodes of moisture carry-over into the compressed air system.

Project Results

The modifications performed by the Enka plant enhanced the efficiency of its compressed air system and resulted in appreciable energy savings. The lowering of the blow-off set points was a simple adjustment to the controls that did not require any capital expenditure and led to annual energy savings of $100,000. Due to the new unloader valves, the leak repair, and the elimination of the blow mold machine vortex coolers, the plant was able to both reduce and stabilize its pressure level. These modifications resulted in additional energy savings of $80,000 per year. Altogether, the plant's energy savings were just over 16% of its annual compressed air electricity costs.

Inappropriate Uses of Compressed Air

Compressed air is probably the most expensive form of energy available in a plant. Because compressed air is also clean, readily available, and simple to use, it is often chosen for applications in which other energy sources are more economical. Users should always consider more cost-effective forms of power before considering compressed air. Inappropriate uses of compressed air include any application that can be done more effectively or more efficiently by a method other than compressed air. Some potentially inappropriate uses of the compressed air and alternatives include:

Inappropriate Use	Replacement
Open blowing	Fans, blowers, mixers (or use nozzles)
Personnel cooling	Fans
Parts cleaning	Brushes, blowers, vacuum pumps

In addition, the pneumatic condensation traps eliminated the moisture carry-over problems, which led to more consistent product quality. Due to the lowered pressure and moisture-free air, there was much less wear and tear on the cover plates and rings on the unloader valves. Prior to the project, the cover plates and rings had to be replaced every 2 months. Once the project was complete, these components lasted six times longer, which decreased compressed air maintenance costs by 75%.

Lessons Learned

Often, industrial compressed air systems can be made more efficient without large capital expenditures. Periodic evaluations of all the components in a compressed air system can determine whether it is operating efficiently. In this plant's case, the control scheme was causing the compressors to work harder than necessary by preventing them from unloading when they reached the lower end of their throttling band. Had the blow-off set points not been lowered, the compressors would have continued to blow off unnecessarily high volumes of compressed air. Furthermore, alternative methods of accomplishing certain tasks were employed that were less costly than the compressed air applications that had been used to perform them. Modifying the compressors' control scheme and eliminating inappropriate applications resulted in substantial energy savings and improved efficiency.

BOOSTER COMPRESSORS

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.

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