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Project Case Study

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Compressed Air System Upgrade Results in Substantial Energy Savings

Summary

In 1996, BWX Technologies, formerly Babcock and Wilcox, completed a retrofit project on the compressed air system at their Lynchburg, Virginia, manufacturing plant. The replacement of antiquated compressors and dryers, along with the implementation of a more sophisticated control strategy, significantly improved the efficiency of the compressed air system and led to important savings in energy and maintenance costs. The total cost of the project's implementation was $487,000. The total annual savings were $264,000, or 4.2 million kWh, leading to a simple payback of less than 2 years. In addition to compressed air energy and maintenance savings, the project reduced the plant's need for wastewater treatment.

Plant Overview

The BWX Technologies plant in Lynchburg, Virginia, is the main production site for its Naval Nuclear Fuel Division (NNFD). The plant manufactures components that contain nuclear fuel and reactor parts used for military ship propulsion. Due to major reductions in defense budgets, defense contractors such as the NNFD have had to reduce overhead costs. Among their cost reduction targets are energy expenditures. Because compressed air is one of the most energy-intensive motor systems at the Lynchburg facility, the company was interested in finding ways to improve its efficiency.

BWX Technologies Plant in Lynchburg, Virginia

Benefits

- Saves $264,000 and 4.2 million kWh annually
- Reduces energy use
- Reduces maintenance expenditures
- Increases plant efficiency
- Reduces water consumption and treatment

Applications

Compressed air systems are found throughout industry and consume a significant portion of the electricity used by manufacturing plants. Aging and inefficient compressed air components that are upgraded within a system-level strategy lead to energy savings and increased productivity.

The plant's compressed air system is important in its production process because it is necessary for uranium recovery operations, vapor blast, waste treatment, and machine shop operations. The principal applications of compressed air are vapor blast, sparging operations, and various pneumatic tools such as lathes, grinders, and drills. Of all these applications, the vapor blast causes the greatest number of intermittent air demand spikes. Prior to the project implementation, the plant's compressed air system was served by two aging 600-hp water-cooled, centrifugal compressors that had to be operated at full load because the control scheme was designed to run this way. These compressors generated approximately 5,000 scfm and it was estimated that, depending on production schedules, they vented between one- and two-thirds of their output into the atmosphere.

Project Overview

The Lynchburg plant engineers were aware that their compressors were venting large volumes of compressed air into the atmosphere. They examined the compressors, which had been installed in the mid 1970s, and determined that they had reached the end of their useful lives. In addition to venting air due to unneeded full load operation, the compressors required more frequent servicing than they did in the 1980s.

The plant engineers also knew that excessive moisture was present in the system because they had to bleed condensate from the end user points once each week. They examined the air treatment equipment and the condensate traps and found that the air dryer had been overloaded for several years and was unable to remove moisture adequately. Based on the age and performance of the compressors and the air dryer, the plant engineers realized that a system-level strategy was necessary to increase the system's efficiency.

Project Implementation

The plant engineers reviewed proposals to repair the existing compressors as well as to replace them. They found that the cost of overhauling the existing compressors was less than the cost of replacing them. However, they also knew that the older 600-hp centrifugal compressors would need

Reconfigured Compressor Room

to be replaced in several years and that air-cooled compressors would significantly reduce the plant's cooling water costs. Therefore, they decided to replace the compressors and the dryer, while installing a new control strategy that would match the system's air demand more closely to its supply. The plant engineers decided to install three 350-hp, air-cooled, rotary-screw compressors and two dryers, one large and one small. The large dryer was rated for 3,700 scfm and would be used during normal plant load. The smaller dryer was a 900-scfm dryer that would be used during periods of peak air demand. The package from the vendor included a sequencing controller for all three compressors, two 3,800-gallon storage receivers, and a pressure/flow controller.

Before all of the equipment was put in place, the plant built a special heat exchange room on the roof that uses a series of louvers that allow heat to be released in summer and recaptured in winter. Construction of this room was essential for adequate ventilation because the air-cooled rotary-screw compressors would generate significantly more heat than the existing water-cooled centrifugal compressors. After installation, the plant began operating the new compressors at a discharge pressure of 105 psig and the pressure/flow controller was set to release air into the main header at 95 psig. Previously, the centrifugal compressors' discharge pressure had been as high as 110 psig and the end-use applications received air at pressures that fluctuated between 90 and 100 psig.

Results

The retrofit of the plant's compressed air system has made the system more efficient because it is able to more accurately supply the amount of air demanded. Prior to the project's implementation, the two 600-hp compressors operated at full capacity. Since they produced more air than the end-use applications needed, the excess was vented into the atmosphere. Currently, normal plant operations only require 2,000 scfm; when the vapor blasts are in use, plant operations require up to 3,800 scfm. As a result, the control system baseloads only two 350-hp compressors and brings the third one online as the air demand increases. The plant is now able to adequately supply its end-use applications by using less total horsepower.

3,800-Gallon Storage Receivers

Due to the reduced horsepower and compressor run-time, the plant saves $146,000, or 4.2 million kWh, in annual electricity costs. Since the need for cooling water has been eliminated, the plant saves $111,000 per year in cooling water costs. In addition, the new air treatment configuration has virtually eliminated condensate buildup in the system, which has reduced the need to bleed condensate from the system's end-use points. This has reduced maintenance expenditures by $7,000 per year. Because the new compressors are air-cooled, the need for cooling water and its associated treatment costs has been eliminated; this has translated into substantial energy savings. The plant has reduced its purchases of wastewater treatment chemicals because wastewater from all areas has been reduced by 400,000 gallons per day. The total annual savings amounts to $264,000; with a total implementation cost of $487,000, the simple payback is 22 months.

Lessons Learned

The replacement of a compressed air system's components is most appropriate when completed within the context of a system-level strategy to improve the performance of the system. Because the compressors at the BWX plant were worn out, plant personnel decided to replace them with compressors that cost less to operate and that better served the plant's needs. Applying the proper size of compressed air components to meet the plant's needs also guided the decision to purchase new dryers. If plant personnel had purchased a similarly sized air dryer, they would have had a dryer that was oversized for 70 percent of the plant's daily operational needs. By using a systems approach towards equipment replacement and selecting the size and type of equipment that best suited the plant's requirements, BWX was able to optimally match its air supply to its air demand, thereby increasing the efficiency of its compressed air system. This has led to energy savings and greater plant efficiency.

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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