BestPractices Case Study

Industrial Technologies Program—Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

Citation Corporation: Compressed Air System Optimization Project Saves Energy and Improves Production at Forging Plant

Benefits

- Saves $45,000 annually
- Saves 820,000 kWh annually
- Improves system performance
- Improves product quality
- Reduces production downtime
- Avoids a $60,000 capital cost
- Achieves a simple payback of 1.5 years

Applications

Compressed air systems are found throughout industry and often use more electricity than any other plant system. An industrial compressed air system's performance depends on maintaining stable and consistent air flow.

Summary

In the 1990s, a subsidiary of the Citation Corporation, Interstate Forging, implemented a compressed air system improvement project at its Milwaukee, Wisconsin, forging plant. The project enabled the plant to maintain an adequate and stable pressure level using fewer compressors, which led to improved product quality and lower production downtime. The project also yielded annual compressed air energy savings of 820,000 kilowatt-hours (kWh) and $45,000, plus better maintenance scheduling. With a total project cost of $67,000, the plant achieved a simple payback of just 1.5 years. In addition, the project's success established that there was no need to purchase a new compressor, resulting in avoided capital costs of approximately $60,000 for a new 200-horsepower (hp) unit.

Company/Plant Background

Citation Corporation manufactures cast, forged, and machined components for the capital and durable goods industries. The company employs 6,000 people, who serve 17 divisions in nine states. The subsidiary, Interstate Forging, forges metal components for the aerospace, automotive, agriculture, construction, defense, mining, petroleum, power generation, and railroad industries. The Milwaukee plant operates four press lines ranging in size from 3,000 to 14,000 tons. The plant also has a machine shop, a shear department, shipping and heat treatment areas, and a paint shop.

Compressed air is vital to the plant's production process because it supports grinding and pressing applications as well as the drop-forge hammers necessary to manufacture various parts. The forging hammers are the most important compressed air application, and require a consistent pressure level of 95 pounds per square inch gauge (psig) to achieve reliable production. Prior to the project, plant operators tried to maintain a system pressure of 100 psig by running five compressors totaling 900 hp that generated up to 3,500 scfm at a discharge pressure of 105 psig.

Project Overview

Despite operating all five compressors and using a 2,500-gallon storage receiver, the system pressure fluctuated between 85 and 100 psig. The pressure fluctuations caused the drop-forge hammers to operate erratically, reducing product quality and increasing cycle time. Convinced that additional compressors were necessary, plant management brought in DOE Allied Partner Pneumatech/ConservAir to review the compressed air system. Pneumatech/ConservAir was to determine how much additional capacity was needed to eliminate the pressure fluctuations and improve the system's performance.

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Citation's Interstate Forging Plant

However, Pneumatech/ConservAir found that the plant could establish and maintain the required system pressure by operating fewer compressors. The hammers' intermittent air demand and insufficient compressed air storage were the main causes of the pressure fluctuations at points of use. The drop-forge hammers' air demand can shift from 300 to 3000 scfm in as little as 30 seconds. Because the plant's storage tank only had a 2,500-gallon capacity, it could not provide enough air at the required pressure through the demand spikes. Also, the hammers were located farther from the compressors than any other application. The system had to work harder to deliver the required volume of compressed air across that distance.

Another problem was an air leakage rate of about 20 percent of system output. Most of the air leaked from the counterbalance cylinders in the hammers, from point-of-use applications, and from some of the system's distribution piping. The air leakage created artificial air demand, which made the compressors work harder to generate the needed air volume. Although it was not a problem for the plant, the review noted that the compressors were controlled manually. This control scheme can be inefficient because it requires careful supervision to determine when to start or stop compressors, and can cause time lapses before units are started up in time to respond to air demand shifts.

Project Implementation

Following the system review, plant personnel implemented a system-level project designed to allow the compressed air system to function effectively without purchasing additional compressors. The first measure was to stabilize the system pressure at the lowest level that met production requirements. To do this, plant personnel installed a Pressure/Flow Controller (P/FL) to separate the demand side of the system from the supply side. In addition, they installed 5,000 gallons of compressed air storage capacity just upstream of the P/FL. Compressed air was set to flow into the storage receivers at 100 psig and to be released into the main header at 95 psig +/- 1 psig.

An Air Forge Hammer at Interstate Forging

Next, plant personnel initiated an innovative leak detection and repair campaign. In addition to finding and repairing the largest leaks in the distribution piping, plant personnel redesigned the shaft seals on the counterbalance cylinders so that repairing leaks on those cylinders could be accomplished without having to disassemble the cylinders. This redesign greatly simplified the task of repairing leaks on those applications. It was also decided to repair leaks daily instead of waiting until semi-annual maintenance shutdowns.

Results

This compressed air system project yielded important energy savings, improved system performance, and enhanced productivity. Currently, the plant operates effectively with three 200-hp compressors, whereas before the project it was unable to meet its air demand while operating five compressors totaling 900-hp at full capacity. The system pressure has been stabilized and lowered to 95 psig, and the remaining compressors, one 200-hp and one 100-hp unit now serve as back up compressors. The stable air supply has reduced production downtime and improved product quality. In addition, the project has allowed the plant to establish a maintenance schedule during regular shifts rather than during non-production time.

The leak repair effort has reduced artificial demand by almost 600 scfm, lowering the average system flow rate. The system's average air demand has declined from between 3,000 and 3,500 scfm to between 2,400 and 2,600 scfm. Because of the project's measures, the plant has achieved annual compressed air energy savings of 820,000 kWh and $45,000. With total project costs of $67,000, the simple payback is just 1.5 years. In addition, because the plant did not purchase a 200-hp compressor, it avoided a cost of $60,000.

Lessons Learned

If a compressed air system does not deliver the desired volumes and pressure levels, it does not mean that additional compressor capacity will solve the problem. Often, compressed air systems can be reconfigured to operate effectively without purchasing additional compressors. In the case of Interstate Forging, a combination of insufficient storage, shifting air demand patterns, and air leaks reduced its compressed air system's efficiency and led to compressed air waste, poor system performance, and unreliable product quality. Optimizing the system by stabilizing the pressure level, repairing leaks, and lowering the system pressure allowed it to perform efficiently. This optimization allowed the plant to operate with fewer compressors, which averted the need for another compressor, resulted in energy savings, and improved productivity.

BestPractices is part of the Industrial Technologies Program, and it supports the Industries of the Future strategy. This strategy helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and energy-management best 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.

Project Partners

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DOE/GO-102003-1654
May 2003