Metal Casting

BestPractices
Project Case Study

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Compressed Air System Retrofitting Project Improves Productivity at a Foundry

Summary

In 1996, Cast Masters performed a compressed air improvement project at its foundry in Bowling Green, Ohio, in which the compressed air system was retrofitted with a more appropriately sized compressor to serve the foundry's processes. The foundry replaced two aging 50-horsepower (hp) compressors and one 25-hp compressor with a new 75-hp rotary-screw compressor. The project allowed the foundry to reduce its energy and maintenance costs, and improved productivity because the new system's reliability sharply reduced production downtime. The annual energy and maintenance savings from the project were $15,000 and the reduced production downtime increased annual revenue by $18,000. Because the total cost of the project was approximately $20,000, the simple payback was 1.3 years.

Company/Plant Overview

Cast Masters is a specialty steel foundry based in Bowling Green, Ohio. Since 1958, the Bowling Green site has been producing precision castings for machinery components, dies, molds, tooling, and wear parts from a variety of specialty steels and alloys. The foundry's three main processes include sand molding, investment casting, and ceramic molding. While the foundry has many compressed air applications, compressed air is most critical for its sand molding processes because it is needed for the sand blasting and conveying tasks. Altogether, the foundry's end uses require 400 to 450 scfm of compressed air at 90 psig in order to operate reliably during the foundry's normal operations.

Prior to the compressed air system project the foundry used two aging 50-hp rotary-vane compressors and one 25-hp rotary-screw compressor, producing 430 to 480 scfm. The three compressors operated simultaneously at a discharge pressure of 100 psig in order for the end-use applications to receive air at 90 psig. Despite running all three compressors at once, the foundry experienced frequent production delays because the rotary-vane compressors would often fail and required considerable repair and maintenance to get them operating again. Because the compressor failures were impacting the foundry's productivity, Cast Masters decided to review the system to determine how to best resolve the situation.

Benefits

- Saves $12,000 in annual energy costs
- Improves productivity and reliability
- Lowers annual maintenance costs by $3,000
- Reduces production downtime, increasing annual revenue by $18,000

Applications

Compressed air systems are widely used in industrial production processes and are often the largest electricity end use in a plant. As industrial facilities evolve, their compressed air systems need to be evaluated to ensure that they are of the proper size and configuration to allow a site to efficiently accomplish its production processes.

Project Overview

The foundry reviewed its compressed air system in collaboration with an independent consultant to determine how to best improve the system. The evaluation began in the compressor room and revealed that the two rotary-vane compressors were near the end of their useful lives and would be very costly to repair. They could continue to be operated, but would not be reliable. This finding validated the foundry's inclination to replace the rotary-vane compressors.

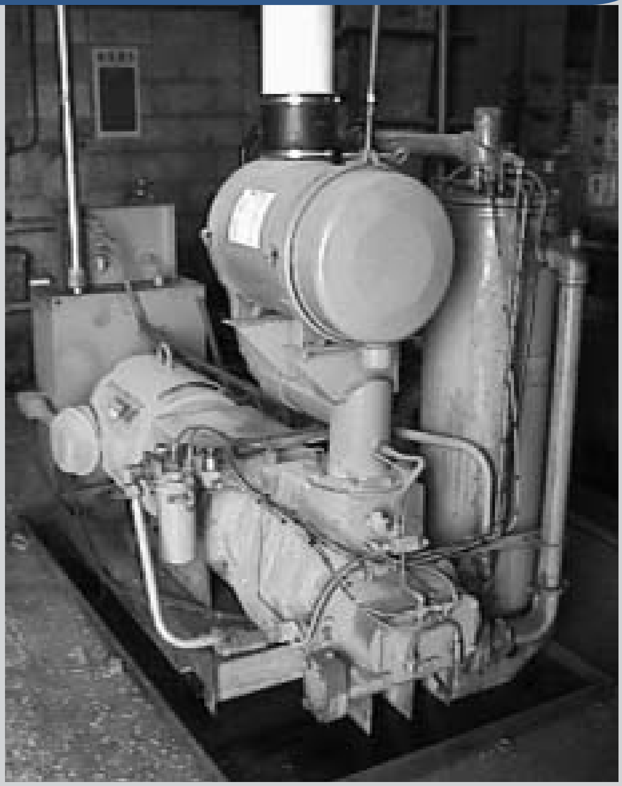
Next, an inspection of the air treatment equipment showed that the desiccant in the air dryer had become overloaded with moisture because, in the summer, the inlet air temperature, or the temperature of the air entering the dryer, was 10 to 15 °F above the maximum recommended inlet air temperature. This had two impacts: it prevented the dryer from removing moisture from the system consistent with the dryer rating, and it increased the resistance to the airflow, increasing pressure drop. Pressure drop is a function of a compressed air system's dynamics, or the interaction of airflow rate with the inherent resistance of the pipeline and air system components.

Finally, the system review found that the foundry could reduce air waste by replacing worn hoses at end-use applications and reconfiguring blow off lines.

Project Implementation

In order to optimize the system, the foundry decided to replace the poorly functioning rotary-vane compressors and to make modifications to other components that would improve the system's efficiency. After doing some research to determine the proper type and size of compressor its system needed, the foundry disposed of one 50-hp rotary-vane compressor and installed a 75-hp rotary-screw compressor. Because the new compressor could generate over 400 scfm, it was deemed capable of serving as the base-load compressor during normal operations. The remaining rotary-vane compressor was serviced and kept for backup use, while the 25-hp rotary screw compressor was kept for nighttime and week-end shifts. In addition, the foundry opened the bandwidth on the latter two compressors' valve settings in order to guard against potentially excessive loading and unloading.

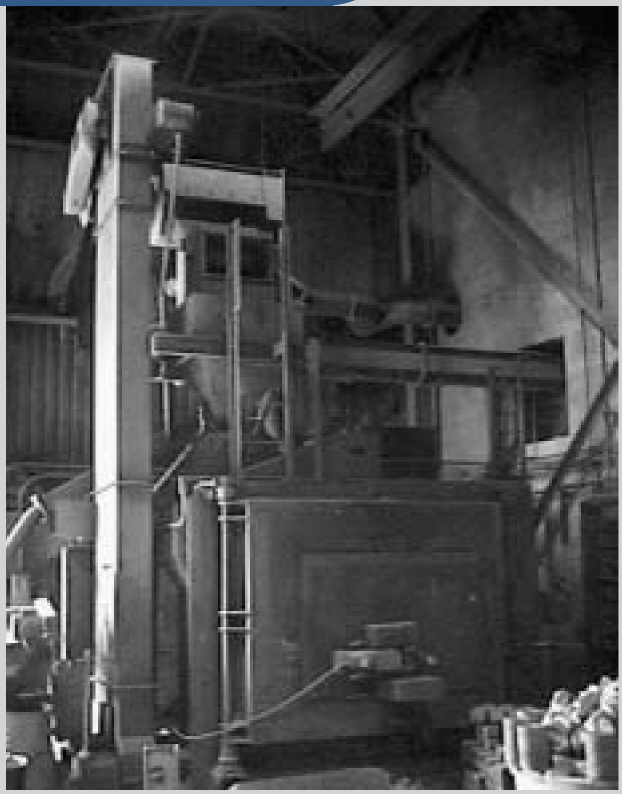
THE NEW 75-HP ROTARY-SCREW COMPRESSOR



The foundry then restored the air dryer to its original performance capacity by replacing the desiccant. Because the inlet air temperature was at the manufacturer's recommended level most of the year, this was deemed an effective solution until a way could be devised to deliver inlet air at those temperatures in the summer months.

Finally, the foundry examined the hoses leading to its end use applications, replacing the ones that were worn and leaking. In addition, plant engineers and managers reminded staff to turn off compressed air applications when not in use and to look for and report leaking hoses and pipes, as well as other malfunctioning equipment.

SAND RECOVERY SYSTEM



Results

Retrofitting the compressors, coupled with the additional measures performed during the project, improved the system's performance and the foundry's production. The 40 percent reduction in aggregate horsepower, from 125 to 75 hp, led to annual compressed air energy savings of $12,000, or 272,000 kWh. Because the new compressor does not require as much maintenance and repair, the foundry's maintenance costs have declined by $3,000 per year. More importantly, the system's improved reliability has eliminated production downtime. This has improved the foundry's productivity and led to $18,000 in increased revenue. The project's implementation cost $20,000, and the annual energy and maintenance savings total $15,000; the project's simple payback was 1.3 years.

In addition to lower energy use and improved reliability of production processes, the foundry's compressed air system now operates more efficiently because of the project's implementation. The restoration of the air dryer's desiccant has reduced the system's pressure drop, allowing the foundry to lower its compressor discharge pressure to between 93 and 95 psig. Due to the replacement of worn, leaking hoses and the shutdown of unneeded compressed air applications, the system's total air demand has declined by approximately 50 scfm, to between 390 and 420 scfm. This reduced air demand is well within the capacity of the system's new 75-hp compressor and has allowed the foundry to operate reliably without the need for additional compressors, even at peak needs.

Lessons Learned

In many industrial plants, compressed air systems are frequently found to possess greater compressor capacity than what is truly necessary for those plants' production needs. An evaluation of an industrial facility's compressed air system can determine the most efficient size and type of compressed air system that satisfies a plant's production requirements. In the case of Cast Masters, once improvements were made to the air treatment equipment and certain distribution components, the foundry's needs were easily met despite a 40 percent reduction in its compressed air system's aggregate horsepower. By implementing a systems approach towards equipment replacement, and configuring the system to have the lowest compressor capacity that meets production requirements, the Bowling Green Foundry was able to increase the efficiency of its compressed air system. This has led to increased productivity and energy savings.

Proper Compressed Air Dryer Inlet Conditions

In order for air dryers to perform as rated, three dryer inlet conditions must be met: a pressure level of 100 psig, an inlet air temperature of 100 °F, and an ambient (room) temperature of no more than 100 °F. If the inlet or ambient air temperature exceeds 100 °F, or if the pressure level is less than 100 psig, the dryer will not be able to remove moisture adequately. In addition, the saturated desiccant increases pressure drop, and if the improper conditions persist over time, the desiccant may become damaged.

INDUSTRY OF THE FUTURE—METAL CASTING

The metal casting industry—represented by the American Foundrymen's Society (AFS), North American Die Casting Association (NADCA), and the Steel Founder's Society of America (SFSA), has prepared a document, ***"Beyond 2000,"*** *to define the industry's vision for the year 2020. OIT's Metal Casting Vision Team partners with metal casters, national laboratories, universities, and trade/environmental/technical organizations to develop and implement energy efficiency technologies that benefit both the industry and the United States. Recently, the Metal Casting Team facilitated the development of the Metal Casting Technology Roadmap, which outlines industry's near-, mid-, and long-term R&D goals.*

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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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