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

Ohio Aluminum Industries: Compressed Air System Improvement Project Saves Energy and Improves Product Quality

Benefits

- Saves $73,200 in annual energy costs
- Saves 716,000 kWh annually
- Improves system performance
- Yields a simple payback of slightly more than 1 year

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 for proper size and configuration. This ensures efficient production.

Summary

In 2001, Ohio Aluminum Industries implemented the first phase of a compressed air system improvement project at its Cleveland, Ohio, plant. The plant implemented the project after a system-level evaluation, which identified the causes of the system's air pressure problems and determined how to best solve them. Once the project was implemented, the system's pressure was stabilized and its performance improved. Because of its improved performance and efficiency, the plant was able to reduce the system's compressor use without any decline in production. The project yielded annual energy savings of 716,000 kWh and $73,200. With a total cost for the first phase of the project of $83,500, the simple payback is slightly more than 1 year.

Plant/Company Overview

Ohio Aluminum Industries is an aluminum component producer based in Cleveland, Ohio, and is part of Foundry Systems International (FSI) Group. Ohio Aluminum Industries produces a wide range of precision aluminum components for the defense, aerospace/aircraft, and automotive industries. The plant's main processes include green sand molding, dry sand molding, and permanent and semi-permanent molding. In addition, Ohio Aluminum Industries specializes in prototyping of complex parts, aluminum heat treatment, and testing.

The plant needs compressed air for a variety of applications, but it is most critical for its core machines that require clean, dry air for the molding processes they perform. In order for the molding processes to be reliable, the table lift cylinders in those machines require air at 120 pounds per square inch gauge (psig). Two 300-horsepower (hp) rotary screw compressors and one 50-hp back-up unit serve the plant. Prior to the project, these compressors generated up to 2,500 standard cubic feet per minute (scfm) at a discharge pressure of 125 psig, but the average system pressure that the plant could maintain was 105 to 110 psig. This situation led to production delays and product quality problems.

Project Overview

Working with Department of Energy Allied Partner, Air Power USA, engineers at the Cleveland plant performed a system-level evaluation to determine how to best improve the system. While the evaluation found the compressors to be in good operating condition, they were being operated more heavily than originally intended because the plant's production parameters had grown over time. The plant needed to operate the two 300-hp compressors at full load 18 hours per day.

The main problem the evaluation identified was the size and configuration of the compressor discharge piping. This discharge piping was too small for the volume of air that was being

Ohio Aluminum's plant in Cleveland, Ohio.

sent through it. The discharge piping was also connected to a crossing header near a 90° turn. This piping configuration caused pressure fluctuations and strong backpressure as the compressors had to fight against the resistance of the discharge piping. The backpressure gave false signals to the compressor controls leading to premature compressor unloading.

The pressure fluctuation associated with the discharge-piping configuration was exacerbated by the air demand patterns of the core machines. When the core machines came online, they caused sudden increases in air demand, which led the system pressure to decay before the compressors could react. In addition, the survey discovered a leakage rate of 600 scfm, poorly functioning pre- and after-filters on the dryers that increased pressure loss, compressed air waste from blow off applications, and some moisture carryover from an ineffective condensate drain.

Project Implementation

After the evaluation, Ohio Aluminum implemented a system-level improvement project on its compressed air system in two phases in order to address the most critical issues and to minimize production downtime. The first phase's intent was to stabilize and lower the system's pressure level. The main action item during this phase was to correct the discharge header piping by replacing the existing 3-inch header with a 5-inch pipe and replacing the 90° crossing header with a 30° directional entry pipe.

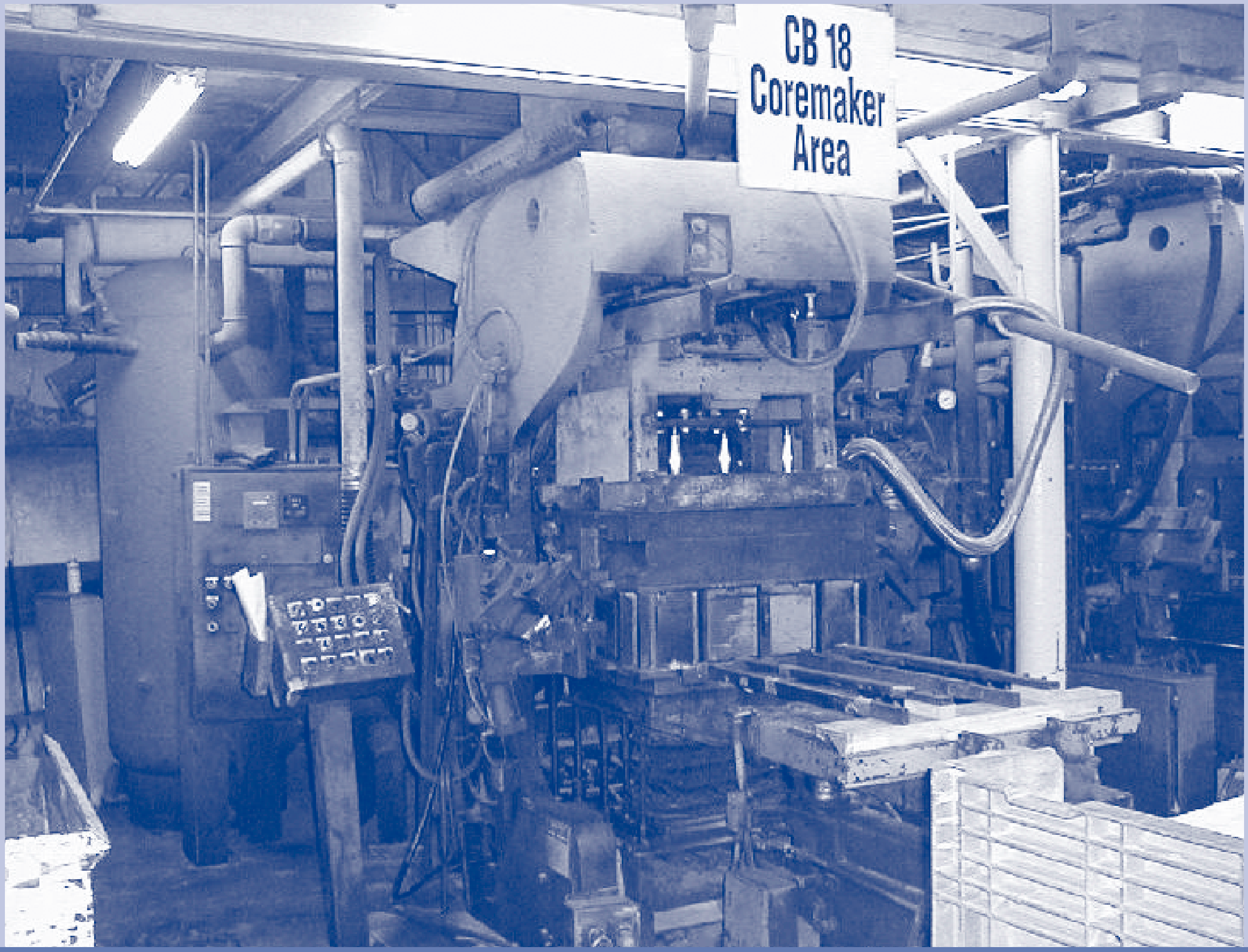
Because the core machines' air demand was more intermittent than that of the plant's other applications, plant personnel followed the recommendation of separating the supply of air to those machines from the rest of the system. Of the three operations performed by the core machines, two could be performed at 90 psig. The airflow for the 90-psig tasks was diverted from the plant's air supply into a 1,550-gallon receiver, which then fed the core machines through another pipe in parallel to the feed off the main header. The plant dedicated the 50-hp compressor to supply the core machines' cylinders at 120 psig through another separate header.

In addition, the project's first phase included a leak repair effort that reduced the leakage rate by approximately 15%. Plant personnel also replaced old pre- and after-filters on the dryers with new ones and replaced the manual condensate drain with a level-actuated electronic one. Reconfiguring the system in this manner and reducing compressed air waste allowed the plant to lower the system pressure to 95 psig.

Results

The reconfiguration of the compressors' discharge piping, coupled with the additional measures taken during the first phase of the project, have improved the compressed air system's performance, leading to energy savings and better system reliability. By replacing the compressor discharge piping and separating the high pressure air to the core machine from the rest of the system, the plant has been able to stabilize and lower the system pressure, reducing compressor use. Currently, the plant only needs to baseload one 300-hp compressor and bring the second one online at part load for 60% of each day.

Repairing the leaks and replacing the condensate drain have reduced artificial demand and compressed air waste. These measures have yielded annual energy savings of 716,000 kWh and $73,200.



A core machine in Ohio Aluminum's plant.

In addition, the core machines' performance improved due to the stable, high pressure air being delivered to the cylinders. This has reduced the amount of cycle time in the core machines, leading to improved product quality. With a total project cost of $83,500, the simple payback is just over 1 year.

Lessons Learned

A properly configured industrial compressed air system allows for optimal system performance, energy efficiency, and reliable production. In the case of Ohio Aluminum's Cleveland plant, an undersized and poorly configured piping arrangement caused severe pressure fluctuations and led the compressors to have to work harder in order to deliver the needed airflow at the desired pressure level. In addition, intermittent and high-pressure air demand from one of the main compressed air applications exacerbated the pressure fluctuations. Once the plant modified its system by replacing the piping near the compressor discharge and separating the core machines' air supply from that of the other applications, the compressed air system performed more effectively, which saved energy and improved production.

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