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OFFICE OF INDUSTRIAL TECHNOLOGIES
ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY

BENEFITS

- Saves 1.87 million kilowatt-hours (kWh) annually
- Saves $108,000 annually
- Reduces energy use
- Increases production by 15 percent
- Improves product quality
- Reduces maintenance costs

APPLICATIONS

Compressed air systems are found throughout industry and consume large amounts of electricity. Maintaining a stable and consistent flow of air is critical to the performance of any industrial compressed air system. The true pressure requirements of end-use applications in a plant should determine the system pressure level.

Compressed Air System Project Improves Production at a Candy-Making Facility

Summary

In 1996, the H.B. Reese company successfully implemented an upgrade of its compressed air system at its production facility in Hershey, Pennsylvania. Once the project was completed, the plant was able to take two compressors totaling 150 horsepower (hp) offline while increasing output and product quality. The project resulted in a 4 percent reduction in annual energy costs and lowered maintenance costs due to the increased operational efficiency of the newly configured system. With the project's total cost of $310,000, and annual savings of $108,000 per year, the plant achieved a simple payback of just under 3 years. In addition, due to better quality control, the plant was able to increase production by 15 percent without having to bring additional compressors online.

Company/Plant Background

H.B. Reese is a subsidiary of the Hershey Foods Corporation, producing confectionery products, such as chocolate-covered peanut butter candies. The Reese plant in Hershey, Pennsylvania, is a 500,000 square-foot facility with 900 employees. The facility doubled in size between 1957 and 1970 to accommodate the increase in demand for its candy products. Compressed air is important for the production process, because it is needed to operate the cylinders on the wrapping machines and robotic applications. These end-use applications require very clean, moisture-free compressed air at a consistent pressure level in order to operate reliably. Prior to the project, the Reese plant had to operate their compressors at a discharge pressure of 110 pounds per square inch gauged (psig) so that the robots and cylinders would receive air at the minimum acceptable pressure level.

Project Overview

In 1995, the Reese plant commissioned a professional survey of its compressed air system because it wasn't able to generate compressed air at the consistent pressure level needed for reliable production. The survey led to a comprehensive strategy to improve the plant's compressed air system's efficiency and performance.

The survey found a number of issues that prevented the plant's compressed air system from operating optimally. As the plant's manufacturing capacity had increased over time, additional compressors were added. By the time of the survey, the plant had a total of thirteen 75-hp rotary-screw compressors housed in various areas of two buildings. Because the buildings were not connected to each other, the plant effectively had two compressed air systems that were operating independently of each other. The survey showed that if the two systems were to be connected into one system, it would generate and deliver compressed air more effectively.

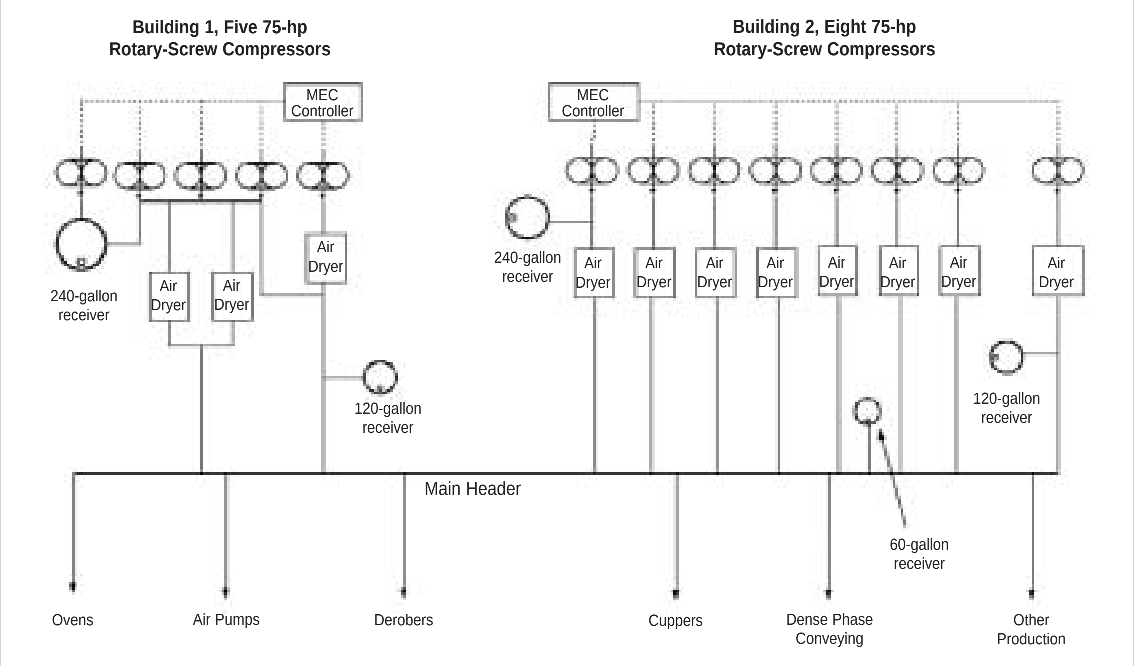
Next, the survey found that the plant's compressed air system experienced considerable pressure loss between the compressors and the end-use applications. This caused the system's pressure level to fluctuate widely and led to inconsistent pressure at the points of use. Pressure loss/drop is a function of a compressed air system's dynamics—the interaction of airflow rate with the inherent resistance of the pipeline and air system components. The main factors that led to the Reese plant's pressure drop were leaks in both the plant's distribution piping network and components in the system such as filters, regulators, lubricators, hoses, and fittings. In addition, some of the components were improperly sized for the airflow and pressure that they were supposed to provide.

The leakage load at the time of the assessment was 20 percent of the compressed air system's output. Another 15 percent of the system's output was being consumed unnecessarily in open blowing applications. In addition, solenoid-operated condensate drains allowed air to escape, causing the system pressure to fall. The combination of leaks, inefficient components, leaking condensate drains, and open blowing applications caused the pressure level to fluctuate by 12 to 21 psig between the compressors and the production equipment. When temporary demand events occurred, the pressure level declined further and additional compressors were brought online to bring it back up.

The factors that caused the plant's pressure drop were also causing over 200 standard cubic feet per minute of artificial demand. Artificial demand is the excess air required by a system's unregulated uses because the system is being operated at a pressure level in excess of actual production requirements. In this case, the artificial demand that was created by the leaks, undersized components, and unregulated point of use operations required the system pressure level to be set at a much higher level to maintain minimum acceptable pressure for end-use applications.

Finally, the survey found that the system's dryers were overloaded when the compressors operated at high or low temperatures. This caused some moisture to carry over into the system. The survey recommended installing coalescing filters to mitigate this situation.

Compressed Air Systems Before Project Implementation



Project Implementation

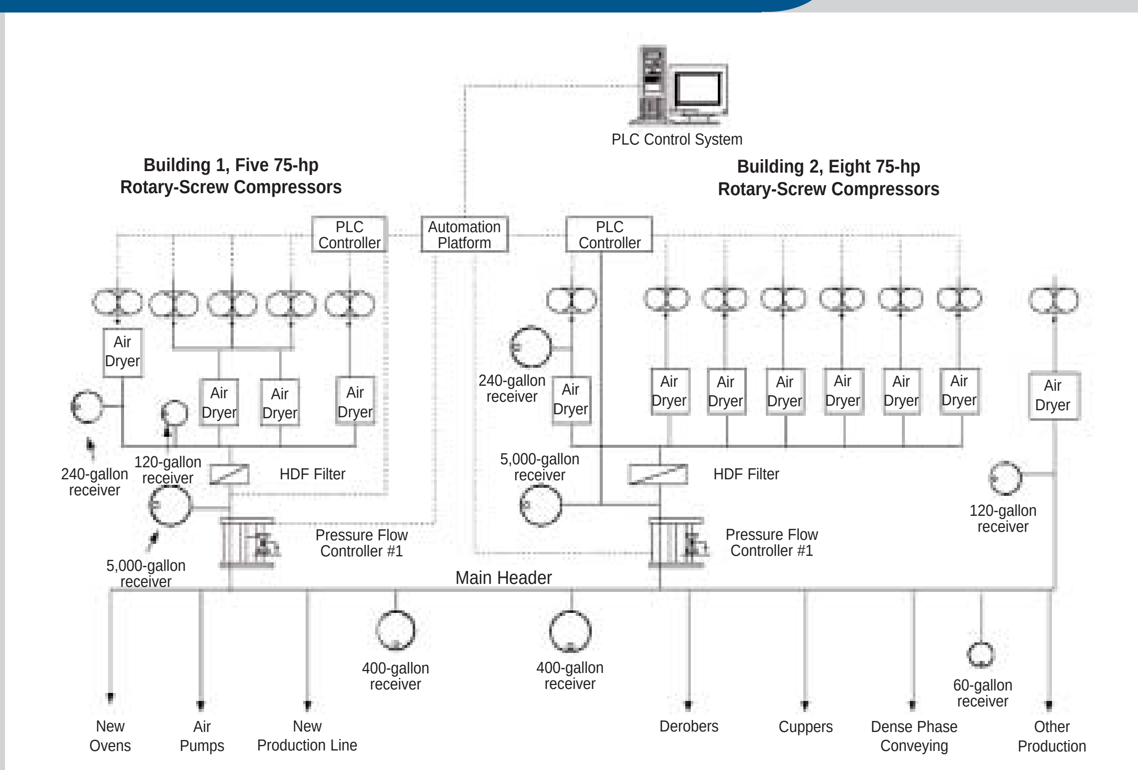
To address the problems in its compressed air system, the plant implemented a system level improvement project that incorporated many of the survey's recommendations.

The first and main action item was to connect the two systems and overhaul the piping network that fed the production equipment. Following the survey's recommendations, the plant centralized the location of its compressors within each of the two buildings and then connected both systems with a 3-inch pipe. The plant also modified and replaced undersized components such as filters, lubricators, fittings, and hoses, all located near the end uses, for maximum rate of airflow. This lowered the minimum pressure level needed by the production equipment from 85 to 75 psig.

Next, the plant installed two pressure/flow controllers, one for each building, along with 10,000 gallons of storage capacity in two tanks. In order to manage the compressors more effectively, the plant upgraded its controls by installing a more sophisticated, programmable logic control system and linking it to the pressure/flow controllers.

As the plant began to lower the system pressure, the leakage rate became less severe. Nevertheless, the plant performed a leak detection and repair project in which they fixed the most significant leaks in the piping network. This allowed the plant to further lower its system pressure. In order to address the overloading of the dryers, two large coalescing filters were installed just after each pressure/flow controller. In addition, the plant retrofitted its open blowing applications with vortex nozzle tips to reduce air consumption.

Compressed Air System After Project Implementation



Results

The compressed air system improvement project at Reese's plant in Hershey, Pennsylvania, resulted in energy savings, better product quality, and increased production. Prior to the project, the plant operated 13 compressors at full capacity, with aggregate horsepower totalling 975 hp. Once the project was completed, the newly configured system operated so efficiently that it only needed 11 compressors totaling 825 hp. The energy savings were 1.87 million kilowatt-hours (kWh), or over $87,000 per year. This represents 4 percent of the plant's annual electricity costs. There were also savings of over $21,000 from reduced maintenance, making the total savings $108,000 and leading to a simple payback of just under 3 years. More importantly, because the product quality improved, the plant produced less waste, which helped the plant increase production by 15 percent without adding more compressors to the system.

The facility was able to take some compressors offline because of the new lower system pressure. The plant was able to lower the system pressure because the reconfigured piping and the re-engineered distribution components lowered the system pressure drop. The installation of the pressure/flow controllers with storage stabilized the system pressure. The plant is now able to operate the compressors at 85 psig instead of 110 psig and delivers compressed air consistently to the production equipment at 75 psig.

Lessons Learned

An improperly configured industrial compressed air system prevents optimal system performance and leads to increased waste byproduct, energy waste, and higher operating costs. In the case of the Reese plant, the incremental addition of compressor capacity over a number of years led to an arrangement of compressors, piping, and undersized distribution components that prevented the system from delivering its full potential airflow at the desired pressure level. The operational solution had been to add compressors in order to boost the plant's ability to maintain the needed pressure. Once the plant modified its system by linking the two systems together and reengineering the distribution components more optimally, the compressed air system was able to perform more effectively, which led to considerable energy savings and improved production.

Proper Configuration of Distribution System Components

Often the importance of the components that make up a compressed air system's distribution network is underestimated. To deliver compressed air to end use applications at the required volumes and pressure levels, it is essential for the entire distribution system to be properly configured. Incomplete and improperly sized or configured piping networks increase resistance to the airflow, making the compressors work harder than necessary to provide air to the end uses at required pressure levels. In addition, distribution system equipment that connects end-use equipment to the system header—equipment such as filters, regulators, lubricators, hoses and fittings—must be properly engineered and sized for maximum rate of flow, not flow per cycle. If the equipment is not engineered this way, these components can become a compressed air system's greatest source of pressure drop. A properly configured and adjusted distribution system will allow for optimal airflow through a compressed air system.

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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