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

Benefits
- Saves $106,000 annually
- Increases production
- Improves product quality
- Reduces maintenance costs

Applications

Compressed air systems are found throughout industry and often represent the largest end use of electricity in a plant. Maintaining a stable and consistent flow of air is critical to the performance of any industrial compressed air system.

Compressed Air System Overhaul Improves Production at a Powdered Metal Manufacturing Plant

Summary

In 1998, GKN Sinter Metals completed a successful compressed air system improvement project at its Salem, Indiana manufacturing facility. The project was performed after GKN undertook a survey of its system in order to solve air quality problems and to evaluate whether the capacity of their compressed air system would meet their anticipated plant expansion. Once the project was implemented, the plant was able to increase production by 31% without having to add any additional compressor capacity. The project also resulted in significant savings in energy (19% of annual electricity costs) and maintenance. The total cost of the project's implementation was $116,000 and the annual compressed air savings were $106,000, resulting in a payback of just over 13 months. In addition, the project resulted in a 56% reduction in compressed air energy costs per unit of production.

Company/Plant Background

GKN Sinter Metals is the world's largest full-service manufacturer of precision powdered metal parts. The company has 36 plants around the world in which it uses powdered metal to produce over 6,000 different parts having complex geometric shapes such as filters, bearings, gears and connecting rods.

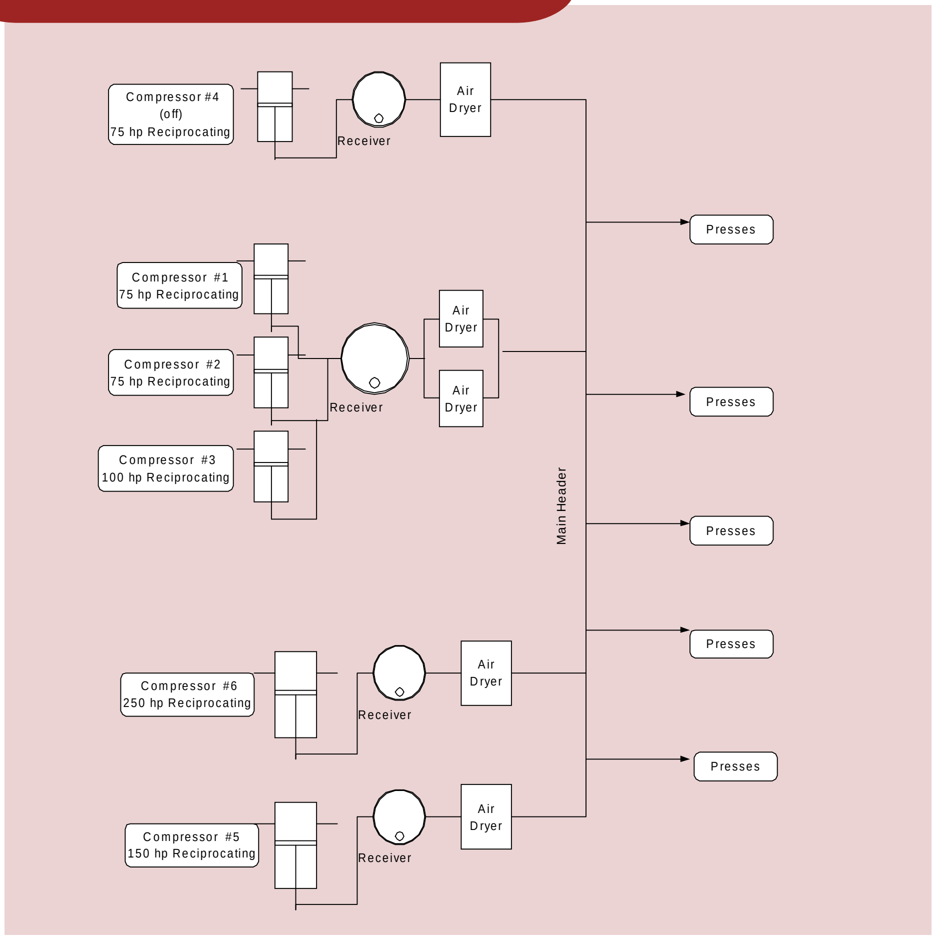
The GKN Salem, Indiana Plant

These products are needed for engines, transmissions and other industrial applications. The Salem, Indiana, plant employs 430 people and focuses on components for power steering and transmissions for the automotive industry. Compressed air is essential for the plant's production process since it is needed for many of the sizing and compacting presses. In order for the plant's production to be reliable, the end use applications require compressed air that is moisture free, stable, and at a minimum end use pressure level of 90 psig. Prior to the project, the plant normally operated four reciprocating compressors totaling 575-hp at a compressor discharge pressure of 110 psig and had an additional 75-hp compressor for peak use.

Project Overview

In 1997, the Salem plant decided to have an independent assessment performed on its compressed air system because it was experiencing difficulty in maintaining the minimum pressure level needed for the plant's end use applications. A system-level evaluation was performed that led to a comprehensive strategy to optimize the plant's compressed air system. The assessment showed that the plant's compressed air system was unable to maintain a stable pressure level primarily because of a high

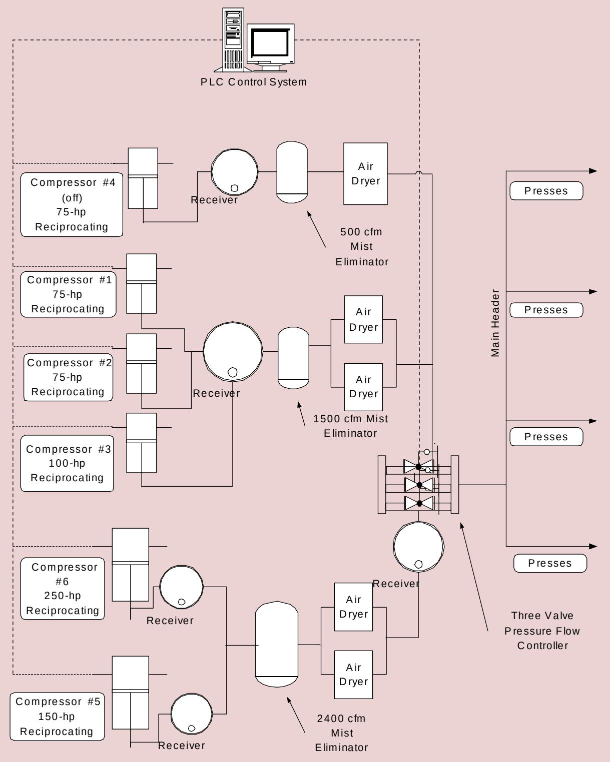
Diagram 1: System Before the Project



and fully opened regulators that were causing excessive pressure drop and cycling of multiple compressors. Pressure 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 leaks, opened regulators, and compressor cycling created a dynamic system profile in which the system pressure level fluctuated severely. Therefore, the plant had to maintain the compressors' discharge pressure at 110 psig or higher in order for all of the presses to receive compressed air at 90 psig. The leaks were primarily at point of use components such as regulators, filters and hoses. Fixing the leaks and installing higher flow components would allow the main header pressure to be lowered while maintaining adequate system pressure and airflow.

Since the plant was maintaining such a high system pressure level, it was generating 1300 excess standard cubic feet per minute (scfm) serving 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 was created by the leaks and unregulated end use operations.

Diagram 2: System After Project and Plant Expansion



The assessment also found a problem with oil and moisture carryover into the system due to the type of air treatment and drainage equipment that was present in the plant. The lubricant carryover lowered the plant's productivity by causing erratic press operation, which compromised product quality. The moisture buildup affected the compressors' ability to stabilize the system pressure because the presence of water in the system steadily increased the system's pressure drop.

Project Implementation

After the evaluation, GKN Sinter Metals implemented a system level improvement project on its compressed air system. The project was implemented in two phases in order to address the most critical issues and to minimize production downtime.

The main objective of the first phase was to correct the system's excessive pressure drop. The plant followed the evaluation's recommendations by first installing a pressure/flow controller along with a 5,000 gallon storage receiver. An important part of this phase involved the proper sizing of the new components with the piping system and the end use applications to optimize the rate of airflow. The header was modified and both the pressure/flow controller and the connecting pipe were sized to allow the maximum airflow needed by the compacting presses in addition to anticipated plant growth. Once in place, the pressure/flow controller and the additional storage stabilized the system's pressure level and eliminated much of the pressure drop. The main compressor discharge pressure was then controlled between 96 and 103 psig while the pressure/flow controller maintained a plant header pressure between 93.5-94.5 psig for end uses in the plant.

The plant also performed an intense three-day leak detection and repair operation to eliminate the largest leaks in the system, including those at the point of use components (regulators, filters and hoses). Phase I also included the installation of three mist eliminators (one in each area of the plant where compressors were located) to eliminate moisture carryover into the system. In addition, the dryer and filter drains were upgraded and the heat exchangers on the air dryers were cleaned and flushed. Lastly, a common signal header was installed downstream of the air treatment components along with a programmable logic control (PLC) automated compressor sequencer. The plant estimated that it would need about 450–500-hp after the expansion and expected to base load compressors 5 and 6 and one of the three smaller compressors (1, 2 & 3).

After the first phase modifications were made, a second assessment was performed that showed that the installed components were operating properly. The main action items in phase II included completing the automated compressor sequencer programming, installing interfaces with local controls on the five compressors being automated, and implementing an annual comprehensive leak detection and repair operation. In addition, the plant retrofitted their open blowing applications with nozzles that were engineered to reduce air consumption. They also installed a new low air pressure alarm and adjusted the pressure/flow controller valve to allow greater amounts of stored air to be available to handle larger and longer demand events.

Results

The compressed air system project at the plant led to substantial savings due to reduced power consumption and improved product quality. The project also allowed for significant increases in production levels. Prior to the project, the plant operated four compressors totaling 575-hp at full capacity (2,143 scfm) with one 75-hp compressor for peak use and one 75-hp for emergency back up. This is shown in Diagram 1. Once the first phase of the project was complete, compressors 5 and 6 totaling 400-hp were adequate to support the plant's normal demand prior to the plant's expansion.

Due to the presence of the mist eliminators, the quality of the compacted metal parts was improved due to reduced moisture levels in the compacting presses. This has led to a 6% reduction in production rejects.

The leak detection and repair work allowed the system's leakage rate to be reduced by over 700 scfm. In addition, the compressors operated more efficiently, cycled much less frequently and required less maintenance because they broke down less often. This was largely due to the new sophisticated control system, which was more responsive to changes in air demand patterns, and modulated the compressors more effectively.

After the project's completion, the plant increased its manufacturing space by over 60% and began to add more end use equipment leading to an increase in production capacity of 31%. However, the system was operating so efficiently that the increase in air demand from the expansion was easily met by one more 75-hp compressor. Currently, the plant base loads three compressors totaling 475-500-hp that yield 2024 scfm (compressors 5 and 6 and one

Pressure/Flow Controllers

One key to improving a compressed air system is to understand the needs of the end use applications. If a stable air supply is critical for the operation of the applications, one way of ensuring the stability of the airflow is by installing a pressure/flow controller with storage. If a system's demand for compressed air changes, it causes the pressure level to change causing more compressors to come online in order to meet the demand and stabilize the pressure. A pressure/flow controller effectively separates the demand side of a compressed air system from its supply side and controls the pressure level of the air going to the end use applications independently of the demand events. Typically, compressed air will move into the storage receiver at a higher pressure than the system pressure. When a temporary demand event occurs, a pressure/flow controller, which can respond more rapidly than the compressors, pulls air out of the storage receiver and distributes it to the header system at the controlled lower pressure level. The system efficiency is improved by allowing it to respond to varying demand on the production floor while avoiding unnecessary compressor starts.

of the three smaller compressors) and only needs a fourth 75-hp compressor for peak needs. This is seen in Diagram 2.

The annual electricity consumption is more than 2 million kWh, which is 25% less than before the project's implementation. Moreover, the plant's annual electricity cost due to compressed air has gone from $155,000 per year prior to the project's implementation to $88,000 per year. This savings represents 19% of the plant's electricity costs.

The plant realized annual energy savings of $67,000, as well as $39,000 in maintenance costs from not having to operate as many compressors for total annual savings of $106,000. The simple payback for the project was 13 months in spite of a production capacity increase of 31%. Compressed air cost per unit of production decreased by 56%.

Lessons Learned

Leaking and sub-optimally configured industrial compressed air systems can waste energy, lower productivity, increase operating costs, and affect product quality. By addressing leaks, using a pressure/flow controller to match supply with demand and implementing a comprehensive control strategy, GKN Sinter Metals was able to substantially reduce energy spent on compressed air, increase production, improve product quality, and reduce maintenance costs.

PRESSURE/FLOW CONTROLLER

INDUSTRY OF THE FUTURE—STEEL

Through OIT's Industries of the Future initiative, the Steel Association, on behalf of the steel industry, has partnered with the U.S. Department of Energy (DOE) to spur technological innovations that will reduce energy consumption, pollution, and production costs. In March 1996, the industry outlined its vision for maintaining and building its competitive position in the world market in the document, The Re-emergent Steel Industry: Industry/Government Partnerships for the Future.

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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 focuses on 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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