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Technical Case Study

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Compressed Air System Improvements at an Automotive Plant

Summary

In 1998, the Ford Motor Company implemented a compressed air system improvement project at its Woodhaven Stamping plant in Woodhaven, Michigan. As a result of the system approach that it took towards improving the plant's compressed air system, the plant was able to take an 800-hp air compressor offline, shut down several high pressure satellite compressors, and operate the remaining compressors more efficiently. The plant reduced its annual energy consumption by 7,900,000 kWh and energy costs by $400,000, representing over 3.5% of its annual electricity costs.

Plant Overview

The Woodhaven stamping plant is a 2.7 million-square-foot facility with 2,400 employees that is part of Ford's Vehicle Operations Division. The plant processes approximately 1,600 tons of steel per day into vehicle components such as body parts. The plant has many large stamping presses that use significant amounts of the plant's compressed air.

Compressed air used by the stamping presses and the plant's other compressed air applications was generated by four large centrifugal compressors, and was supplied to these end-uses off the main header at 75 psig. Prior to the modifications, robots used high-pressure compressed air for vacuum venturi cups used to handle parts on various press lines. These robots were served by seven small rotary screw satellite air compressors operating at 110 psig.

Project Overview

A project team composed of plant management, production engineers, and technical support staff from the Detroit Edison Utility Company evaluated

Woodhaven Plant

Benefits

- Saves $400,000 annually
- Reduces energy consumption
- Reduces maintenance costs
- Required minimal capital expenditure

Applications

Specifying correct pressure levels for end-use equipment and making the appropriate changes to the supply system can improve the performance of almost any compressed air system. Compressed air systems are found throughout industry and consume a significant portion of the electricity used at manufacturing plants.

the plant's compressed air system and generated a system level strategy to improve the system's efficiency and performance. The team discovered that compressed air was being lost due to a high leakage rate in both the distribution system and the stamping press counterbalance cylinders. In addition, the team determined that the vacuum venturi cups in some robot press lines would operate satisfactorily when supplied with air at 70 psig vs 110 psig.

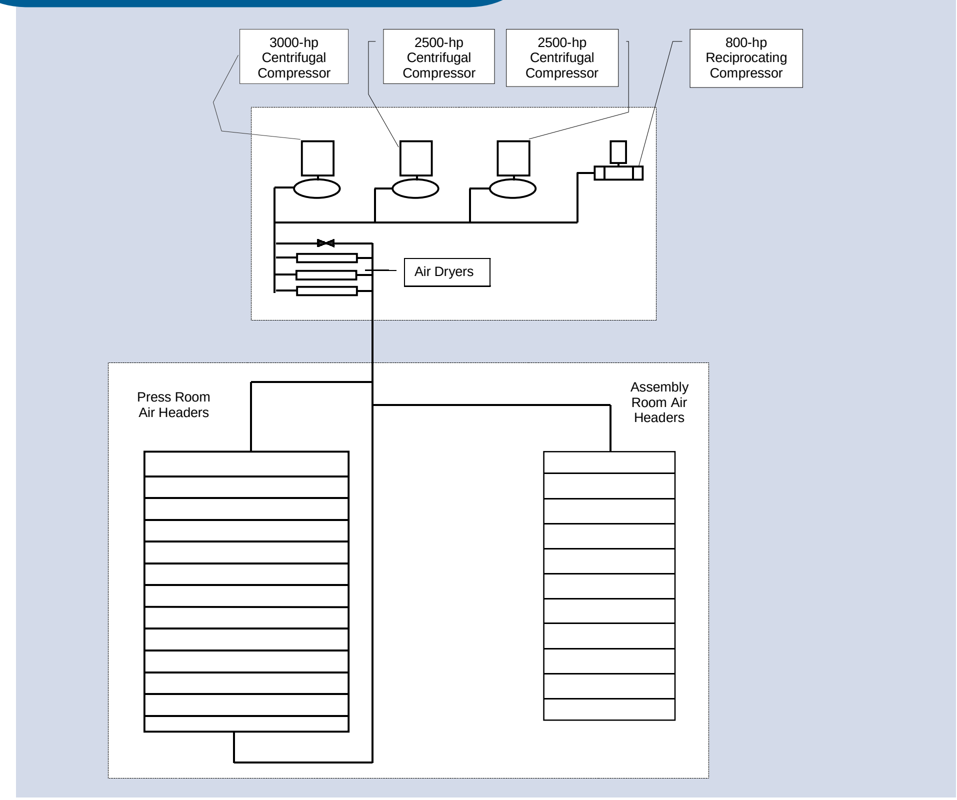
In order to reduce the air being lost from the leaks in the system, the team decided to implement a comprehensive leak management program. In addition, the team decided to find a way to supply the robots with air from the main header, eliminating the need for the high-pressure satellite compressors.

Project Implementation

Establishing and implementing the leak management component of the project took about six months to perform. First, a leak detection/correction team was formed. The team identified and corrected the compressed air leaks throughout the system. The seals on the stamping press die automation valves were a major source of leaks and were replaced.

The team noticed that the system was using inefficient flow measuring orifice plates and replaced them with low-loss venturis and averaging pitot tubes. These devices are more efficient because the pressure drop across them is

Compressed Air System Diagram



lower. It was possible to lower the compressor discharge pressure settings significantly, and the average main header pressure went from 75 psig to 70 psig. This change not only reduced the amount of energy that was required to produce the compressed air (see text box), but also reduced artificial demand (see text box), which contributed to lower compressed air and energy consumption.

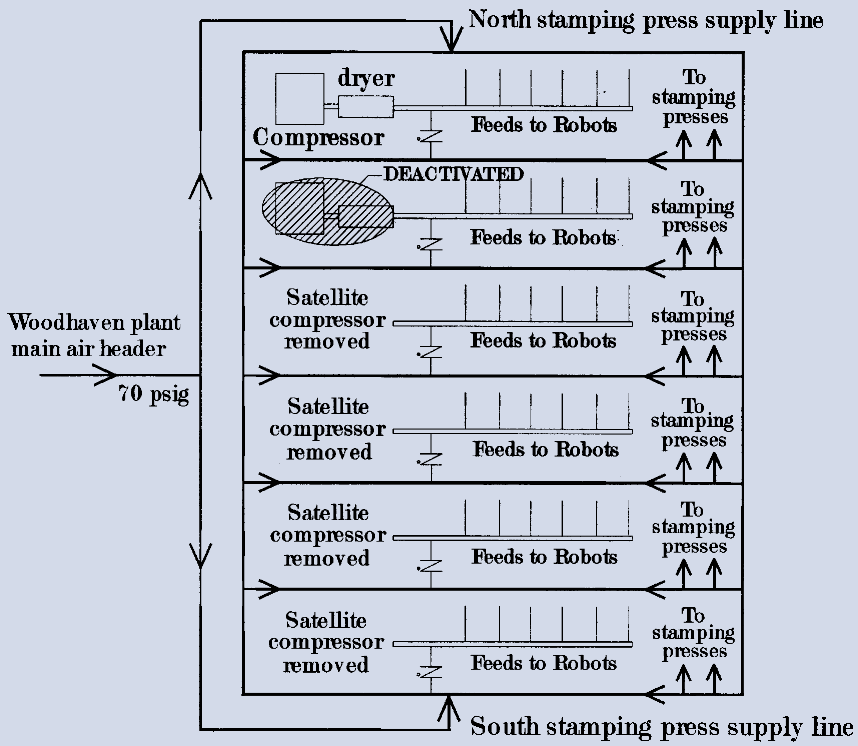
Lowering System Pressure

Lowering compressed air system pressure by adjusting compressor setpoints can save substantial amounts of energy. For systems in the 100 psig range, a good rule of thumb is that for every 2 psi drop in average system pressure, energy consumption will be reduced by 1%.

Artificial Demand

Artificial demand is defined as the excess air required by a system's unregulated uses because the system is being operated at a pressure in excess of production's true requirements. When average system pressure is reduced, artificial demand is lowered, resulting in less demand for air.

Revised Compressed Air Feeds to Robots



Review of the design characteristics of the robot's vacuum cup flow venturi determined that they would operate satisfactorily with the pressure available from the main header (about 70 psig). Five of the robots already had a supply line from the main header in parallel with the discharge piping from the high pressure satellite compressor. These five were reconfigured to receive air from the main header.

Project Results

The leak management program and actions to reduce pressure drop allowed the Ford plant to both reduce compressed air needs and reduce the pressure of the air being supplied. As a result, the average standard cubic feet per minute (scfm) of compressed air supply declined by 18%, from 25,000 scfm to 20,500 scfm. The plant was able to take an 800-hp compressor (10% of their capacity) off-line, and was able to operate the remaining compressors more efficiently at a lower pressure. The aggregate annual energy savings were 7,900,000 kWh and the project reduced the plant's annual energy costs by $360,000, or more than 3.5%. About $40,000 was saved in avoided costs since the planned purchase of new satellite compressors was cancelled. Also, since one less compressor was operating, the plant was able to spend less on maintenance and gained backup compressor capacity, reducing the chance of downtime.

Lessons Learned

High-pressure air should only be used when absolutely necessary. In this case, assumptions regarding the pressure level required by some robot vacuum cups resulted in unnecessary equipment being purchased and installed. Had the robots been valid high-pressure applications, the satellite compressors would have been an efficient solution. Instead, it was found the robots could operate satisfactorily at the plant's normal pressure level.

Another important lesson is that leak detection and correction programs need to be ongoing efforts. Air leaks continue to occur, so leak management programs need to be continuous efforts and are very important in maintaining the efficiency, reliability, stability, and cost effectiveness of any 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.

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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