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OFFICE OF INDUSTRIAL TECHNOLOGIES

ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY

Benefits

- Saves $63,000 annually
- Reduces energy use
- Increases efficiency

Applications

Compressed air systems are common in industrial plants and consume large amounts of electricity. The pressure level requirements of the end-use applications in a plant should determine the system pressure level. Ensuring an appropriate, stable pressure level at the end-use applications is critical to the performance of any industrial compressed air system.

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Compressed Air System Enhancement Increases Efficiency and Provides Energy Savings at a Circuit Board Manufacturer

Summary

In 1993, Sanmina Corporation (formerly Hadco Corporation) successfully improved the compressed air system at their Owego, New York, plant. Personnel at the plant implemented a system-level improvement project on its compressed air system following a comprehensive audit that provided a sound strategy to optimize the system's potential. Once the project was completed, plant personnel were able to reduce the plant's compressor use and lower its system pressure. In addition, the project resulted in significant savings in energy and maintenance because the system's efficiency was greatly improved. With a total project cost of $55,000 and annual compressed air energy savings of $63,000 and 742,000 kWh per year, which reduced annual energy costs by 5%, the plant achieved a simple payback of 10.5 months.

Sanmina Plant, Owego, New York

Company/Plant Overview

Sanmina Corporation develops and supplies printed circuit boards that are used in many commercial and consumer applications around the world. The Owego plant employs 1,300 people and specializes in the production and assembly of the printed circuit boards. The plant's production process requires compressed air for drills, routers, air knives, and waste treatment presses to perform functions such as cutting the circuit boards out of panels, hot air solder leveling, and expelling waste chemicals through filtration equipment.

For these applications to operate properly, they require a minimum pressure level of 90 psig. Prior to the project's implementation, the plant's end-use pressure level was kept higher than 95 psig to satisfy production staff. As a result, the plant operated a 350-hp rotary screw compressor at full capacity and a 300-hp compressor at about 30% capacity in order to meet the air demand. The compressors' discharge pressure varied between 105 and 115 psig and produced 1,800 to 2,200 scfm.

Project Overview

In response to requests by plant personnel for additional compressed air generating capacity, Sanmina decided to have a system-level evaluation conducted of its compressed air system by an independent consultant to determine whether additional compressors were necessary. The evaluation identified several areas in which efficiency gains were possible and produced a strategy to improve the compressed air system that averted the purchase of more compressors.

The first problem the evaluation identified was excessive pressure drop. 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. Pressure drop in the plant was coming from several areas. Point-of-use equipment in both the drill area and the routers were causing pressure drop because they contained oil-coalescing filters. Since the plant's compressors were lubricant-free, these filters created an unnecessary impediment to the airflow. Another source of the system's pressure drop was from several refrigerated dryers that were installed on the supply to the drills. Since the dryers at the compressors were providing air at a lower dew point than the ones closer to the drills, these latter ones were redundant. In one area an incomplete piping loop and inadequately sized hoses leading to point-of-use equipment caused a large pressure drop under maximum flow. The pressure drop was so severe that the end use pressure would sometimes fall to 76 psig, which degraded the performance of the applications.

Another issue that exacerbated the pressure drop was that certain areas of the piping distribution system were undersized, causing a higher than necessary pressure gradient. This situation particularly affected the chemical filter press area, where the piping restriction limited the amount of air that the presses received. This imbalance between the amount of air demanded and the amount being delivered caused a draw down of the main header, which sent all available air flowing towards the filter press at the highest velocity possible. This situation caused the storage pressure to lower very rapidly when the partially loaded compressor unloaded and contributed to unstable system pressure. The result was a shorter unload cycle for the compressor and increased energy consumption.

The factors that led to the plant's pressure drop also caused 150 scfm 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 Sanmina's case, artificial demand existed because the system pressure had to be kept higher than required by the end-use applications. In addition, the drills and routers released significant amounts of compressed air during their idle time. Since a stable pressure of 90 psig was sufficient to satisfy productive air demands, the higher pressure levels that the plant maintained led to excess air consumption.

Project Implementation

The Sanmina plant executed a system-wide improvement project on its compressed air system that included many recommendations made in the evaluation. This project included the following modifications:

- Header segments that had strong pressure gradients were evaluated throughout the facility and piping mains were upsized or added as needed.
- Unnecessary point-of-use filters and dryers that created pressure drop were removed.
- Automatic air control valves were added to drills and routers to eliminate the use of air during idle machine time. In addition, air pressure switches on drills and routers were checked and malfunctioning ones were replaced.
- A pressure/flow controller was installed in the compressor room to stabilize the main header pressure.
- A back-pressure/flow controller was installed on the waste treatment filter press to control the volume of compressed air used at this application (see text box).
- 3,000 gallons of additional air storage capacity was installed in the compressor room to optimize the operation of the pressure/flow controller.

Once these modifications were made and the components installed, the system operated more efficiently and the plant began to lower the system pressure. Currently, the compressor discharge pressure is between 105 and 110 psig going into the storage receivers, and the pressure/flow controller keeps the main header pressure at 90 psig.

Back Pressure/Flow Controller

The application of Sanmina's pressure/flow controller is a special one. Most pressure/flow controllers are piloted to control the downstream pressure in response to pressure signals and allow necessary volumes of air to be released into the header. In this case, the flow controller is piloted to control the airflow rather than the downstream pressure. This was needed for the chemical filter press area, whose consumption patterns were leading to an imbalance between the amount of air supplied and the amount needed. The back pressure/flow controller therefore controlled the volume of air going into the filter press. The effect was to stabilize the system pressure by controlling the downstream airflow.

Since the plant expected to operate the 300-hp compressor periodically, a reduced voltage motor starter was installed at a cost of $11,000. This allows repeated starts without causing heat build up in the motor. Also, solenoid-operated condensate valves to control the cooling water were added to save water use when this compressor is not in operation.

Results

The compressed air system improvement project resulted in energy savings and improved reliability. Prior to the project, the 300-hp compressor was operating at about 30% load. Now it only needs to run 30 minutes a day at partial load. In addition, the reduction in artificial demand and system pressure reduced the plant's air consumption from between 1,800 and 2,200 scfm to approximately 1,500 scfm. Furthermore, the improvements to the piping distribution system, the removal of redundant filters and the pressure/flow controllers stabilized the system's pressure level and greatly reduced pressure drop. With a total project cost of $55,000 and annual electricity savings of $63,000 (742,000 kWh) representing 5% of the plant's electricity costs, the simple payback was 10.5 months. The energy savings were higher than estimated because the plant was able to lower the system pressure more than it had anticipated.

Lessons Learned

Although Sanmina's compressed air system project focused on many of the system's demand side components, it reflected an integrated approach towards the system's overall performance. The project's emphasis was on controlling the airflow characteristics in many sections of the compressed air system. By controlling these airflow characteristics and then re-evaluating the system pressure level, Sanmina's plant achieved a good balance between the supply and demand sides of its compressed air system, leading to a high degree of operational efficiency and energy savings.

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