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OFFICE OF INDUSTRIAL TECHNOLOGIES

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

BENEFITS

- Saves over $100,000 annually
- Reduces energy use
- Improves product quality
- Increases production
- Reduces production downtime

APPLICATIONS

Compressed air systems are found throughout industry and consume a significant portion of the electricity used by manufacturing plants. Aging and inefficient compressed air systems need to be modernized in order to achieve reliable product quality, reduce energy consumption and improve productivity.

Compressed Air System Renovation Project Improves Production at a Food Processing Facility

Summary

In 1994, Mead-Johnson Nutritionals, a subsidiary of Bristol-Myers Squibb, implemented a compressed air system improvement project at their Evansville, Indiana, plant. Implementation of the project allowed the plant's compressed air system to function so efficiently that they were able to take one-third of their compressed air capacity offline. The project also led to significant savings in compressed air energy and maintenance costs. More importantly, it allowed for more reliable production and better quality control due to the addition of air demand control that stabilized the plant air pressure. The addition of increased storage capacity allowed the system to carry the plant through brief, periodic power outages. The total cost of the project was $412,000. With total annual compressed air energy savings of $102,000 (4% of plant power costs) and a rebate from the utility of $148,000, the project's payback was just over 2.5 years. In addition, the project allowed the plant to avoid spending over $900,000 on a new compressor.

Company / Plant Background

Bristol-Myers Squibb is a diversified, worldwide health and personal care company whose main products are pharmaceuticals, consumer medicines, beauty care, nutritional supplements, and medical devices. Mead-Johnson Nutritionals is the subsidiary that manufactures nutritional products for children and adults and has over $20 billion a year in sales. The Evansville, Indiana, plant is a 1,500-person facility that specializes in making infant formulas and adult nutritional supplements. The site also supports the manufacturing and packaging of several Bristol-Myers Squibb pharmaceutical products.

Compressed air is important at the Evansville plant because it serves the packing machines, actuators, and sterilizer retort purges that require air at a minimum pressure of 80 psig. Because the plant makes food and pharmaceutical products, it requires clean, dry air for its production to pass stringent quality controls. Therefore, to ensure that the air is contaminant-free, the air treatment system at Mead-Johnson's plant includes two sets of coalescing filters and a dryer that brings the air to a dew point of between 35 and 39^0 Fahrenheit.

Prior to the project, the plant was served by three 300-hp lubricant-free rotary screw compressors that produced up to 3,000 scfm during high demand at discharge pressures that were between 95 to 105 psig. As the plant's production requirements evolved over time, the compressed air system was having difficulty meeting the minimum pressure requirements of the end use applications, and the plant was considering purchasing a new 600-hp compressor.

Project Overview

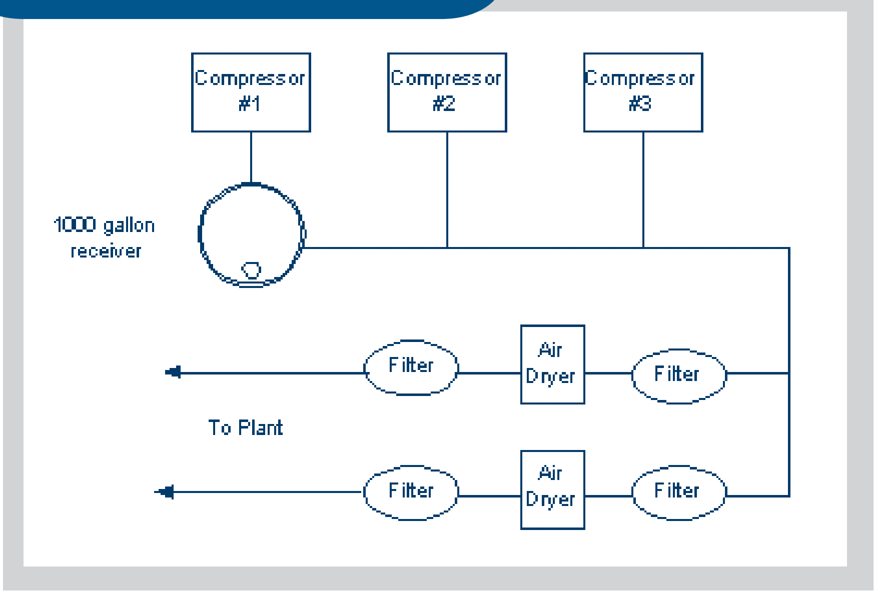
The Evansville plant conducted an evaluation of its plant with some technical assistance from an independent consultant to determine how to best improve the system. The evaluation revealed that the plant's compressed air system could be more optimally configured, which would reduce energy consumption and avoid the need for the additional compressor.

The first observation was that the compressors' control system was not centralized and was ineffectual because it was not receiving accurate signals about airflow and pressure levels. This caused the compressors to work independently of each other and prevented them from reacting efficiently to sudden changes in air demand. It also caused them to run at full capacity longer than necessary.

Next, the project team realized that insufficient air storage led the compressors to have to run more frequently than necessary. The plant's production cycles are intermittent, particularly the retort purge process, which causes the demand for compressed air to fluctuate. In addition, the plant experiences periodic power outages that caused the compressors to shut down. The system had a 1,000-gallon storage receiver, which was inadequate to provide the air required during the plant's demand surges or during the power-outage-induced compressor shut downs. This often caused the plant to operate all three compressors so that the end-use applications could receive adequate volumes of air.

The filters in the system's dryers functioned well. However, they were only designed to handle 2,400 scfm, so that during periods of high demand they were overwhelmed and could not adequately treat the volume of air that was coming through them. This caused pressure drop in the system's air treatment equipment. Pressure drop is a function of a compressed air

Original Compressed Air System



system's dynamics—the interaction of airflow rate with the inherent resistance of the pipeline and air system components. Because of the increased resistance caused at times by the filtration components, the compressed air system experienced a pressure drop of 10 to 15 psig. This was one of the main reasons why the compressor discharge pressures had to be kept at 95 to 105 psig.

Another cause for concern was the plant's air leakage rate. The plant performed a leak survey, which revealed that leaks consumed 1,000 scfm, or one-third of the plant's peak output. Most of the leaks were located in the piping distribution system, which was quite old, and in some of the fittings of the end-use applications.

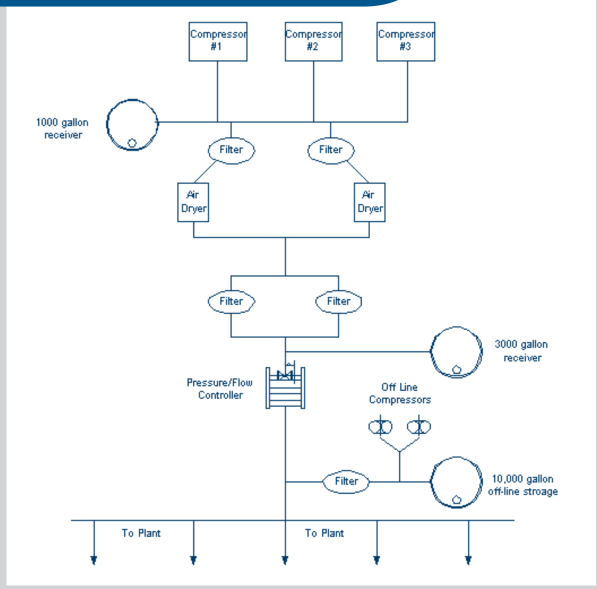
Finally, the compressed air system was frequently blamed for problems related to production equipment. When certain end-use applications would break down, the equipment vendors often claimed that those applications were not receiving adequate pressure to operate properly, causing them to fail. Since the plant's pressure fluctuated, the plant engineers could not rule out the possibility that low or fluctuating pressure could be the cause of these problems and therefore responded by making piping modifications and increasing the plant pressure. During the joint evaluation, they discovered that the compressed air applications could function reliably at a lower pressure level.

Project Implementation

Mead-Johnson used a system-level strategy based on the joint evaluation they conducted with the outside consultant to implement an improvement project on their compressed air system. The components of the project addressed each of the issues that were preventing the efficient operation of the compressed air system.

First, the plant installed a management information system (MIS). The MIS allowed plant engineers to accurately monitor the airflow, pressure, air temperature and dew point, demand events, and pressure drops. Next, the plant installed 3,000 gallons of additional storage

New Compressed Air System



linked to a pressure/flow controller to provide enough air for temporary surges and to stabilize the pressure level in the main header at 85 psig. Since the air demand patterns of the retort purge process were more volatile than that of other applications, the plant purchased two 15-hp, lubricant-free compressors to supply air for this process. These small compressors generate air at 175 psig and store it in a 10,000-gallon receiver that supplies the retort purging process and other intermittent demand events.

Once these items were completed, the plant performed an intense leak detection/repair campaign after which the leakage rate was brought down to between 400 and 500 scfm. The leak detection/repair then became an ongoing process that allowed plant personnel to locate and repair leaks periodically to prevent the leakage rate from going above 500 scfm.

Results

The improvements to the plant's compressed air system resulted in substantial energy savings and more efficient production. Prior to the project, the plant normally operated two of three 300-hp compressors at full load with the third one operating between 50 and 100% of full load. With this compressor configuration, the plant was not always able to meet the needs of its end-use applications. With the new configuration, the plant base loads one of the compressors, operates another at around 60% of full load, and uses two 15-hp compressors at 50% of full load to provide air for the retort purge process. This configuration allows the plant to maintain one 300-hp compressor for back up. Currently, two 300-hp compressors discharge air between 104 and 114 psig into the storage receiver, and the pressure/flow controller maintains the header pressure at 85 psig. Thanks to the leak repair and improved control strategies, the plant now meets its production requirements with an average of 2,300 scfm.

The plant saves $102,000 (2,542,000 kWh) in energy costs annually, which represents just over 4% of annual electricity costs. This is attributable to both the plant's ability to take a compressor offline and to the reduction in consumption from the lower leakage rate. With the rebate from the power company of $148,000, the total cost of the project was $264,000, making the simple payback 2.6 years. Had the plant decided to purchase a new 600-hp compressor, it would have had to construct an additional building to house it and a new transformer. The cost of all of these items would have been in excess of $900,000, which the plant avoided by not choosing this strategy.

In addition, the stability and reliability of the airflow improved the reliability of the production process by eliminating production downtime. Prior to the project, the power-outage-induced compressor shutdowns interrupted the production process. The air storage capacity installed during the project is sufficient to allow production to continue through the brief outages until the power comes back on and the compressors can be restarted.

Lessons Learned

In many cases, reconfiguration of a compressed air system and upgrading of ineffective components can be more successful than adding compressors to meet air demand. Obsolete controls, inadequate storage, air leaks, and deficient air treatment equipment reduce a compressed air system's efficiency, leading to energy waste, unreliable product quality, and excessively high operating costs. In the case of Bristol-Myers Squibb's Evansville plant, a compressed air system improvement project that addressed the demand and supply sides of the system made it more efficient, allowing it to meet the plant's air demand. In addition, the project led to substantial reductions in compressed air energy costs and avoided the need for another compressor.

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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For Additional Information, Please Contact:

OIT Clearinghouse
Phone: (800) 862-2086
Fax: (360) 586-8303
clearinghouse@ee.doe.gov

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webmaster.oit@ee.doe.gov

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy, EE-20
U.S. Department of Energy
Washington, DC 20585-0121

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