STEEL

BestPractices
Project Case Study

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OFFICE OF INDUSTRIAL TECHNOLOGIES

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

Compressed Air System Upgrade Generates Significant Energy Savings At A Steel Mill

Benefits

- Saves $456,000 annually
- Reduces energy use
- Reduces maintenance needs

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.

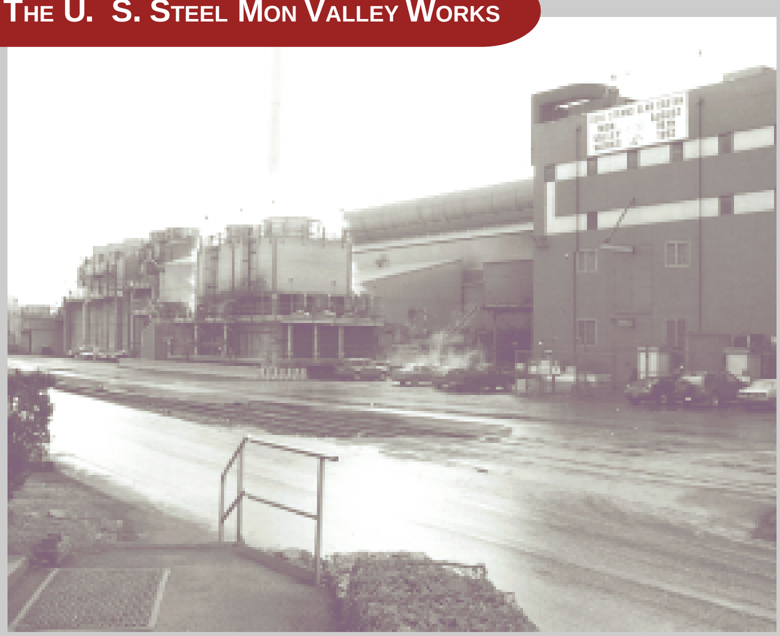
Summary

In 1996, U. S. Steel completed a project in which the main compressed air system at their Edgar Thomson plant in Braddock, Pennsylvania was overhauled. The installation of new compressors and dryers, along with the elimination of inappropriate compressed air uses significantly improved the efficiency of the compressed air system, leading significant savings in energy and maintenance costs. The total cost of the project's implementation was $521,000. The total annual savings were $457,000, leading to a simple payback of just under 14 months. Of the total savings the project yielded, $140,000 are energy savings that represent about 18% of the plant's annual compressed air energy costs.

Plant Background

U. S. Steel Group, a unit of USX Corporation, is headquartered in Pittsburgh, Pennsylvania. USX is a major worldwide producer of oil and natural gas, as well as the largest producer of steel products in the U.S. U. S. Steel Group manufactures a wide variety of steel plant products, coke and taconite pellets. The Edgar Thomson Plant in Braddock, Pennsylvania is an integrated steel

The U. S. Steel Mon Valley Works



making facility with 800 employees that converts iron ore into steel and makes steel slabs.

The main compressed air system is vital for the plant's production process since it serves the Basic Oxygen Plant (BOP), two blast furnaces and the powerhouse. The principal applications of compressed air are pneumatic actuators and pistons that actuate large cylinders. Prior to the system overhaul, the plant's compressed air system was served by six aging 400-hp air and oil-cooled, rotary screw compressors that were spread out over the plant. These compressors leaked oil, broke down frequently and could no longer provide air at the pressure level for which they were rated.

Project Overview

The Edgar Thomson plant engineers reviewed their compressed air system and realized that simply replacing the old compressors would not solve the system's problems. Based on their experience, they knew that a system-level strategy was necessary to address the problem effectively. As a starting point the engineers examined the six compressors and determined that they were in poor condition and very costly to repair. The compressors had been installed in the early 1980s. By 1996, they operated so poorly that they could not produce the airflow and pressures they were rated for, causing the plant to borrow compressed air from other systems in the plant.

In addition to being in poor operating condition, the oil that the compressors were leaking had several impacts on the system. First, it imposed excessive maintenance and lubricant costs on the plant because the oil had to be frequently replaced. Second, the oil was carrying over into the end use equipment, leading to unreliable product quality. Third, the oil had contaminated the air dryers and filters to the point that they were no longer performing effectively. Lastly, the oil's presence in the dryers and filters severely obstructed the airflow, which led to a severe pressure drop across the system. Although they operated the compressors at discharge pressures of 90 psig or more, the end use applications were barely receiving air at their minimum required pressure of 60 psig because the oil had so congested the filtration equipment.

Finally, the plant identified some large leaks and inappropriate uses of compressed air that were contributing to excess air demand and were wasting energy.

Project Implementation

The plant took the rotary screw compressors offline and installed two 600-hp centrifugal compressors in a central location that required minimal engineering and equipment to connect the compressors. A few of the rotary screw compressors were kept for back-up use and during extreme hot or cold weather. Because of their poor condition, these rotary screw compressors are seldom used due to the risk of introducing oil and dirt into the system.

Next, the plant installed two new dryers, one for each of the new compressors and new filters in the air/lubricant separators. At the same time, the plant performed a leak detection/repair campaign and eliminated some inappropriate uses such as blow off and spot cooling applications.

Once all of the equipment was in place and the leak repair was complete, the plant began operating the new compressors at a discharge pressure of 90 psig. The plant engineers found that the end use applications were receiving air at 80 psig. Since they knew that the end use applications could operate at 60 psig, they began to gradually lower the compressor discharge pressure to 70 psig.

Results

The overhaul of the plant's compressed air system resulted in substantial energy savings. Prior to the project, the plant operated six compressors totaling 2400-hp at full capacity without being able to meet the end use applications' air demand. In addition, the compressors leaked a lot of oil and had to be taken offline for frequent oil changes, leading to unreliable production. With the new system in place, the plant is able to operate more effectively with less total horsepower. Furthermore, the reduction in lubricant

Reducing Pressure Drop

Pressure drop is a term used to characterize the reduction in air pressure from the compressor discharge to the actual point of use. Pressure drop occurs as compressed air travels through the treatment and distribution system. Any type of obstruction, restriction, or roughness will cause resistance to airflow and increase pressure drop.

The biggest sources of pressure drop include components such as air/lubricant separators, dryers, filters, undersized hoses, disconnects, filters, regulators, and lubricators. To minimize pressure drop, components that have the lowest possible pressure drop at specified maximum operating conditions should be selected. When installed, recommended maintenance procedures should be followed and documented. As an example, for most filters it is more cost-effective to change them before they have reached the pressure drop at which the manufacturer recommends replacement.

For systems that are experiencing problems with low operating pressure at points of use, reducing pressure drop is a more effective and efficient solution than adding additional compressor capacity.

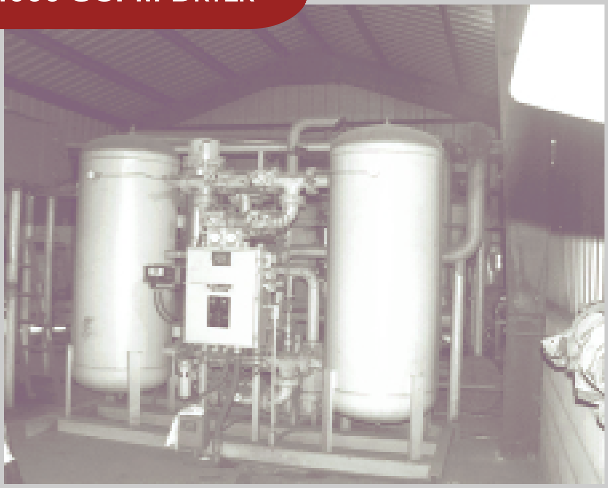
carryover and the compressor downtime it caused has improved the reliability of plant's production and eliminated its dependence on other systems.

The plant is saving $140,000 (4,501,516 kWh) in energy costs annually. This is largely attributable to the lower, more stable pressure level at which the compressors are now required to operate and represents about 18% of the plant's annual energy costs for compressed air. The plant is also saving $126,000 per year in compressor lubricating oil and $191,000 per year in repair and maintenance costs for a total annual project savings of $457,000. Since the cost of the project was $521,000, the simple payback for the project was 13.5 months.

Lessons Learned

The upgrading of a compressed air system's components is most beneficial when performed within the context of a system level strategy to improve a compressed air system. As the compressors at the Edgar Thomson Plant reached the end of their useful lives, the plant decided to overhaul and reconfigure their entire system in order to fully benefit from the measures they were taking to improve it. Had the air treatment equipment not been replaced, the lubricant in the dryers and filters would have continued to obstruct the airflow and to maintain the pressure drop. Had the pressure not been lowered, the compressors would have continued to supply air at discharge pressures of 90 psig. This would have allowed artificial demand to prevent energy savings from being realized. By using a systems approach towards equipment replacement and adjusting the pressure to the lowest level that served the plant's requirements, the Edgar Thomson Plant was able to increase the efficiency of its compressed air system. This has led to significant energy and maintenance savings.

4000 SCFM Dryer



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.

Project Partners

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