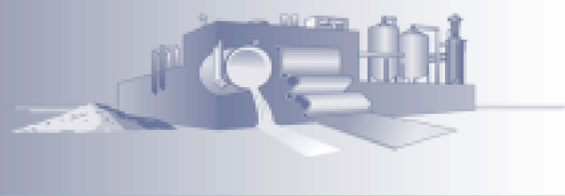
BestPractices Case Study



Industrial Technologies Program—Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

Lehigh Southwest Cement Company: Compressed Air System Improvement Saves Energy at a Lehigh Southwest Cement Plant

Benefits

- Saves $90,000 in annual energy costs
- Reduces annual energy consumption by 900,000 kWh
- Reduces annual maintenance costs by $59,000
- Improves production
- Achieves simple payback of less than 20 months

Applications

Compressed air systems are widespread within the mining industry and consume a significant portion of the electricity that cement plants use. Applying a system-level strategy to optimize a compressed air system's efficiency can improve system performance, save energy, and enhance productivity. The compressed air project described here can be replicated throughout industry.

Summary

In 2001, Lehigh Southwest Cement Company implemented a system-level project that improved the compressed air system at its cement plant in Tehachapi, California. The project stabilized the system pressure, replaced some worn compressors with more efficient units, and reduced compressed air waste. Consequently, the system now operates more efficiently with less compressor capacity and at a lower system pressure. The project yielded significant savings in annual energy costs totaling $90,000 (900,000 kilowatt-hours [kWh]) and lowered annual maintenance costs by $59,000. The project also improved the reliability of the plant's manufacturing processes. Due to another $50,000 in annual savings from eliminating emergency compressor rentals, the total annual savings were $199,000. The total project costs were $417,000; however, a $90,000 incentive payment from Southern California Edison (SCE) reduced this figure to $327,000, yielding a simple payback of less than 20 months.

Company/Plant Background

Lehigh Cement Company, the parent of Lehigh Southwest Cements, was founded in 1897. The company employs more than 6,000 people in plants, terminals, sales offices, and headquarters throughout the United States and Canada, and has annual sales of almost $2 billion. The company's basic product is cement, which is the key ingredient in concrete. However, Lehigh also mines limestone and other raw materials necessary for manufacturing cement, for producing concrete using cement, and for fabricating concrete products.

The Tehachapi plant needs compressed air to serve dust collectors, cylinders, air knives, and pneumatic clutches, all of which are essential for cement production. Before the project, four rotary-screw compressors totaling 1,445 horsepower (hp) served the compressed air system. The three largest compressors, two 550-hp and one 220-hp unit, served the main plant system; the fourth, a 125-hp compressor, was dedicated to air knives. Before the plant was ready to implement the project, the 125-hp compressor failed and the plant depended on the three existing units and a 300-hp rental compressor. The system's pressure fluctuated between 85 and 120 pounds per square inch gauge (psig) and the plant faced periodic production shut downs because of episodes of low pressure.

Project Overview

Lehigh Southwest Cement worked with two U.S. Department of Energy Allied Partners on the project. Air Solutions, of Placitas, New Mexico, reviewed the compressed air system and Accurate Air Engineering, of Bakersfield, California, assisted in implementing the project. Air Solutions performed the review when the four existing compressors were operational and found several conditions that prevented the system from operating efficiently. The pressure level was unstable because of the changing air demand patterns and the compressor control

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Lehigh's Plant in Tehachapi, California

scheme. Over the course of a normal production day, the air demand fluctuated between less than 2,200 to more than 3,300 standard cubic feet per minute (scfm), requiring frequent loading and unloading of compressors. Furthermore, the set points for loading and unloading the compressors were established at a lower point than their design set points, which caused the compressors to operate at 15% to 20% below their maximum efficiency.

The next problem area concerned the cleanliness of the intake air to the compressors. Although plant staff changed the intake air filters regularly, cement dust still clogged these filters. This caused the compressors to work harder and prevented them from generating their rated volume of air. The reviewers also found that, while the air-treatment equipment was adequately sized, the aftercoolers for the larger compressors and some condensate traps were not operational. This forced the dryer to perform their function, which increased the pressure gradient. Additional problems included a convoluted distribution piping system and artificial demand from leaks in worn hoses and sub-headers. Finally, the review identified the fact that the piping in the compressor room was complex and restrictive, which exacerbated the system's pressure drop.

Project Implementation

Staff at the Tehachapi plant decided to implement a system-level strategy based on Air Solutions' recommendations. The plant enlisted Accurate Air Engineering to assist with technical support, measurement, and verification. To stabilize the system pressure, the plant installed a pressure/flow controller (P/FC) along with a 5,000-gallon storage receiver. The compressor discharge pressures were set at 110 psig and the pressure downstream of the P/FC was set at 85 psig. Next, plant personnel disposed of the 220-hp compressor and installed two new 350-hp rotary-screw units.

The new compressors' onboard controls contain microprocessors that can be programmed to communicate with each other. These controls were linked together and programmed to automatically rotate each unit every 24 hours to equalize compressor operating time and to fully load the lead compressor with the second unit trimming and shutting off as necessary. Because both of the larger compressors possessed timed stop/start auto controls, one was baseloaded and the other unit was left in standby mode so it could come online automatically if needed.

Plant personnel decided to improve the intake air conditions and the supply-side distribution piping. To accomplish this, they built a filter wall, which includes several ventilation fans to reduce the amount of dust in the intake air and sealed all doors to the compressor room. They also replaced and reconfigured the compressor room piping so that it led more directly from the compressors to the new storage tank. Then, plant personnel repaired the malfunctioning aftercoolers.

Finally, to reduce compressed-air waste in the demand side of the system, plant personnel replaced the six nonfunctional condensate traps with six high-efficiency drain traps, repaired broken solenoids on the dust collectors, and located and repaired the largest leaks in sub-headers, drop piping, and hoses.

Project Results

The Tehachapi plant's project improved the compressed air system's efficiency, yielding significant energy and maintenance savings. Before the project, the plant needed four compressors to meet its normal air demand. Now, plant personnel can satisfy the plant's air demand by baseloading just two compressors, one 550-hp and one 350-hp unit, and operating a single 350-hp unit in trim mode. The sophistication of the new compressors' onboard controls allows them to modulate the compressors as effectively as a sequencer controls package. Repairing the compressor aftercoolers and replacing the supply side piping greatly reduced the pressure drop in the system. The P/FC, combined with the 5,000-gallon storage receiver, stabilized the pressure level to 85 +/- 2 psig. In addition, the leak repair

Ventilation Filters on Compressor Room Filter Wall and other measures to reduce compressed air waste reduced artificial demand. The system currently consumes a maximum of 2,900 scfm versus more than 3,300 scfm at peak demand before the project.

Because of the reduced compressor capacity needed to satisfy the plant's air demand and the lower system pressure, the Tehachapi plant's annual compressed air energy savings are $90,000 (900,000 kWh). An additional $50,000 per year is saved because the plant no longer needs to rent a 300-hp compressor; another $59,000 per year is saved through lower maintenance costs. Furthermore, the plant has not had any production shut downs that can be linked to the compressed air system. With the incentive payment from SCE, the project's total cost is $327,000. With total annual savings of $199,000, the simple payback is less than 20 months.

Lessons Learned

Configuring a compressed air system in a manner that reliably supports production with maximum efficiency requires a system-level approach. At Lehigh Southwest Cement's Tehachapi plant, fluctuating pressure levels and poor intake air conditions led to energy waste because the plant operated more compressors than necessary to satisfy air demand. Plant personnel installed a P/FC with storage to stabilize and lower system pressure in conjunction with the construction of a filter wall for the compressor room, the repair of nonfunctional aftercoolers, and the replacement of convoluted piping. Additional measures such as leak and condensate trap repair reduced artificial air demand, allowing for a lower system pressure. By applying such a systems approach towards optimizing the compressed air system, the Tehachapi plant's project reduced the amount of compressor capacity required to satisfy the plant's air demand and achieved substantial energy and maintenance savings. This project's approach and results are being shared with other Lehigh plants across the United States.

The Effect of Intake Air

The effect of intake air on compressor performance should not be underestimated. When intake air is excessively hot or contaminated, it can impair compressor performance, resulting in excess energy and maintenance costs. If moisture, dust, or other contaminants are present in the intake air, they can build up on the compressor's internal components, such as impellers, rotors, and vanes, leading to premature wear and reduced compressor capacity. To prevent adverse effects from low-quality intake air, it is important to ensure that the location of the entry to the inlet pipe is free of contaminants, such as rain, dirt, and cooling tower discharge, and that the intake air is adequately filtered. If the air is drawn from a remote location, the inlet pipe size should be increased in accordance with manufacturer recommendations to prevent pressure drop and reduction of mass flow.

BestPractices is part of the Industrial Technologies Program, and it supports the Industries of the Future strategy. This strategy helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and energy-management best practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices emphasizes 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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