MINING

BestPractices
Project Case Study

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Fan System Optimization Improves Production and Saves Energy at Ash Grove Cement Plant

Summary

In 1999, Ash Grove Cement Company implemented an optimization project on a fan system in its cement plant in Durkee, Oregon. Because of a severe vibration problem, the fan system would often fail and require frequent repairs to the duct-work and adjoining machinery. The plant replaced the belt drive with an Adjustable Speed Drive (ASD) to improve the control of the fan system and lower its energy consumption. This change eliminated the vibration problem and improved the system's airflow control and energy efficiency. The project led to annual energy and maintenance savings of $16,000 and 175,000 kilowatt-hours (kWh). In addition, the fan system's improved reliability allowed the plant to achieve its desired production level. Because of partial funding from the Northwest Energy Efficiency Alliance (NEEA), the total project cost was approximately $10,000, which gave the Durkee plant a simple payback of 7.5 months.

Company/Plant Background

The Ash Grove Cement Company, headquartered in Overland Park, Kansas, operates cement and limestone plants in nine U. S. states and is the fourth-largest cement manufacturer in the country. Ash Grove's eight cement plants produce over 6.1 million tons of portland and masonry cements annually. These cements are

Ash Grove Cement Company Plant in Durkee, Oregon

Benefits

- Saves 175,000 kilowatt-hours (kWh) annually
- Increases equipment life
- Improves productivity
- Saves $6,000 in annual energy costs
- Reduces annual maintenance costs by $10,000

Applications

Fan systems are widespread and can consume a significant portion of the electricity used in industrial plants. In some cases, Adjustable Speed Drives (ASDs) can effectively match available ventilation capacity to system requirements and can improve operational reliability.

commonly used for the construction of highways, bridges, commercial and industrial complexes, residential homes, and other structures.

The Durkee plant's fan system is important for the plant's production process because it serves the baghouse in the plant's ball mill where rocks are pulverized into dust in the cement-making process. The fan system aspirates air across the baghouse, where airborne dust is collected from the fan's airstream. Prior to the project, the baghouse's 125-hp centrifugal fan system, rated for 30,000 atmospheric cubic feet per minute (acfm), was belt-driven through sheaves.

Project Overview

The baghouse's fan system had developed a severe vibration problem that was causing it to fail, which had a negative effect on the plant's production. The positioning of the inlet dampers and the operation of the system's belt drive caused the vibration problem. During normal operation, plant personnel ran the fan at full speed and closed the dampers to maintain a constant pressure differential in the baghouse. Turbulence and vibration occurred when the dampers were adjusted to maintain the pressure differential. The vibration from this operation created excessive shaking in the ductwork and in the fan system support structure, resulting in frequent stress cracks.

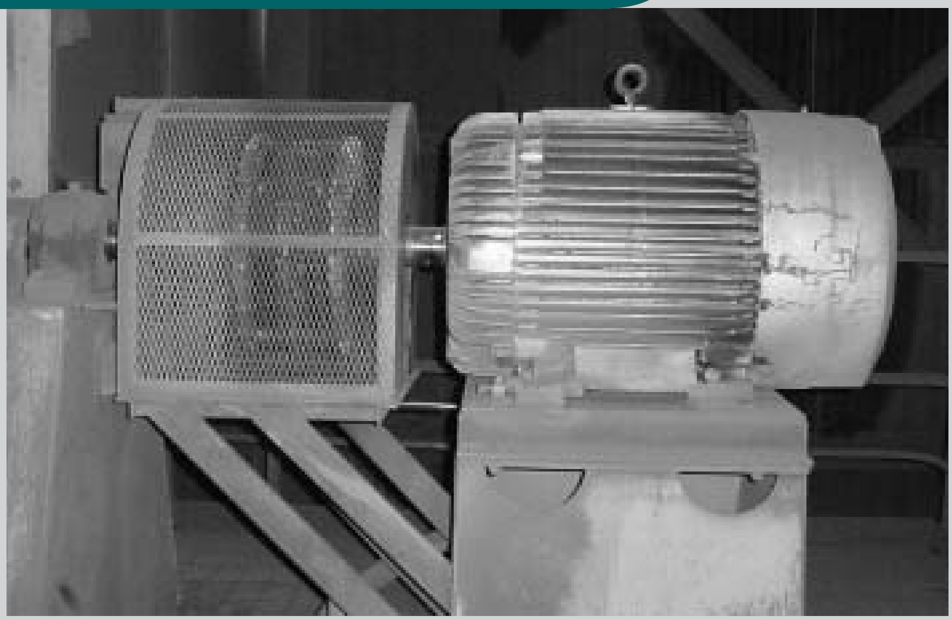
The fan system's belt drive aggravated the vibration problem. During the fan motor start-up, the motor was energized with the dampers closed, which caused the motor to require excessive torque to become energized. The high torque start-up currents would peak at 875 amps on the 125-hp motor for ten seconds, causing voltage sags, motor heat build-up, and additional turbulence. The motor starter, overload protection, and wire had to be oversized to accommodate this energy-intensive start. The combination of high starting inertia, vibration, and heat build-up in the bearings and sheaves was so great that the belts would slip, heat up, and eventually burn off. Plant personnel had to replace the belts before the fan could be restarted, leading to significant production downtime. In addition, noise from the belts and high vibration was so loud that it could be heard throughout the plant. The plant's maintenance personnel had to repair broken welds and stress cracks in the ductwork on a weekly basis because of the vibration problem.

Project Implementation

After researching several possible solutions, plant personnel realized that replacing the existing drive would be more cost-effective than trying to repair the fan system. Plant personnel therefore decided to work with DOE's Allied Partner, MagnaDrive, to remove the belt drive and retrofit the system with MagnaDrive's mechanical ASD. The plant installed a mechanical ASD that uses magnetic induction to induce eddy currents that transmit motor energy in the form of torque. The lack of a direct mechanical connection between the motor and load allows the ASD to substantially reduce vibration. The mechanical ASD was also suitable because it had no sensitive electronic parts that would be prone to maintenance problems in the dusty environment of the baghouse.

The ASD's installation was not difficult nor costly. The fan motor was moved from the offset position, which eliminated the need for sheaves and belts, and mounted in line with the fan shaft. The ASD was placed between the two shafts, with the existing damper actuator adapted as a control input for the ASD. Plant personnel built a new mounting plate for the fan motor, but no inverter-duty motor nor extensive rewiring was required. Ease of installation, along with the ASD's ability to continuously adjust the amount of torque in response to changing load patterns, greatly influenced the decision to replace the existing belt drive and discontinue use of the damper control system.

The Fan with the Mechanical ASD Installed



Project Results

The installation of the ASD on the fan system eliminated the vibration problems that the system was experiencing and led to energy and maintenance savings for the Durkee plant. Once the ASD was in place, the dampers were no longer needed to control the fan system because the ASD could control it by varying the fan motor speed. The vibration level caused by the dampers was reduced from 0.5 inches per second to 0.05 inches per second. In addition, the fan motor could start more efficiently because it was no longer connected to the fan through belts and did not have to overcome the inertia of the fan and the process air. The high torque start-up currents necessary to start the fan motor went from 875 amps for 10 seconds to 742 amps for 1.5 seconds. The inrush current reduction also lessens heat build-up in the motor windings, improving motor performance and prolonging motor life. As a result, the new ASD has reduced production downtime and the maintenance burden.

The plant has increased production by 32,000 tons per year, a 3.5 percent increase, and has achieved annual maintenance savings of $10,000 from not having to perform ducting and support-structure repairs and fan belt replacements. In addition, the project significantly reduced noise levels.

The ASD's ability to vary the fan motor speed to match the baghouse's load allows the fan system to operate with less energy. Reduced energy use saves 175,000 kWh and $6,000 annually, a reduction of approximately 20 percent in the fan system's annual energy costs. Coupled with the maintenance savings, the plant's total annual savings are $16,000. Because of the cost sharing arrangement with NEEA, the total cost of the project was $10,000, which made the simple payback 7.5 months. One final advantage of the mechanical ASD is that it has been easier to maintain than an electronic drive, reducing the need for highly skilled technicians to service and maintain the drive.

Lessons Learned

Proper optimization of a fan system can have substantial benefits that go beyond energy savings. In the case of the Ash Grove plant, the design of the baghouse's fan system led to excessive vibration. This excessive vibration imposed heavy maintenance costs on the plant and seriously hindered the plant's productivity. Replacing the existing belt-driven drive with a mechanical ASD eliminated the source of the system's maintenance burden, which improved the plant's productivity and reduced its energy consumption. The ASD allowed for the energy savings and better performance by accurately matching the appropriate fan speed to the system demand. The new drive also allows the system to operate reliably because instead of being controlled by dampers, which caused the original vibration problem, airflow is now controlled by the ASD. This type of drive can be applied in many ventilation or fan systems that require variable output to meet changing load patterns. In addition, an ASD can improve the performance of other systems such as blowers, pumps, compressors, grinders, mills, and conveyors.

Industry of the Future—Mining

In mid-1998, the National Mining Association reached an agreement with the U.S. Department of Energy's Industries of the Future Program to join in creating research and development partnerships to develop and deploy new technologies that will improve environmental performance and enable the industry to meet increased global competition. The mining industry supplies the minerals and coal essential to the infrastructure of virtually the entire U.S. economy: glass, ceramics, metals, and cement for buildings, bridges, roads, and equipment, and coal or uranium to generate more than 70% of the nation's electricity.

OIT Mining Industry Team Leader: Toni Grobstein Maréchaux (202) 586-8501.

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 emerging technologies and best energy management 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

Ash Grove Cement
Durkee, OR

MagnaDrive Corporation
Seattle, WA

Northwest Energy Efficiency Alliance (NEEA)
Seattle, WA

For Additional Information, Please Contact:

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

Visit our home page at
www.oit.doe.gov

Please send any comments, questions, or suggestions to
webmaster.oit@ee.doe.gov

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

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