PCS Nitrogen: Combustion Fan System Optimization Improves Performance and Saves Energy at a Chemical Plant

Benefits

- Saves $420,000 annually
- Saves 76,400 MMBtu annually
- Improves performance
- Achieves a 2-month simple payback

Application

Combustion fans are part of a boiler's burner system and are necessary to provide enough combustion air to the burners. The amount of air allowed into a boiler is typically controlled by louvers, inlet guide vanes, or variable speed drives. Configuring a combustion fan to allow the proper amount of air into the burner can improve boiler efficiency, yielding energy savings and better system reliability.

Summary

In 2003, PCS Nitrogen, Inc., implemented the first phase of a project designed to improve the efficiency of the combustion fan on a boiler at the company's chemical fertilizer plant in Augusta, Georgia. The project involved the installation of an adjustable-speed drive (ASD) on the combustion fan serving the boiler to eliminate the generation of excess steam. Once the project was complete, the ASD was able to modulate the fan's operation more precisely, according to the load. This has allowed the plant to lower the boiler firing rate by 21% during low loads and reduce the production of unneeded steam that was being vented into the atmosphere. The project yields annual energy savings of 76,400 MMBtu and annual energy cost savings of $420,000. In addition, maintenance needs have declined because there is less stress on the fan motor and bearings, and boiler feed water use is lower. With total project costs of approximately $65,000, the simple payback is less than 2 months. Finally, the project's success allows for the implementation of further improvements that will yield estimated annual energy cost savings of $978,000 and energy savings of 177,800 MMBtu per year.

Company/Plant Background

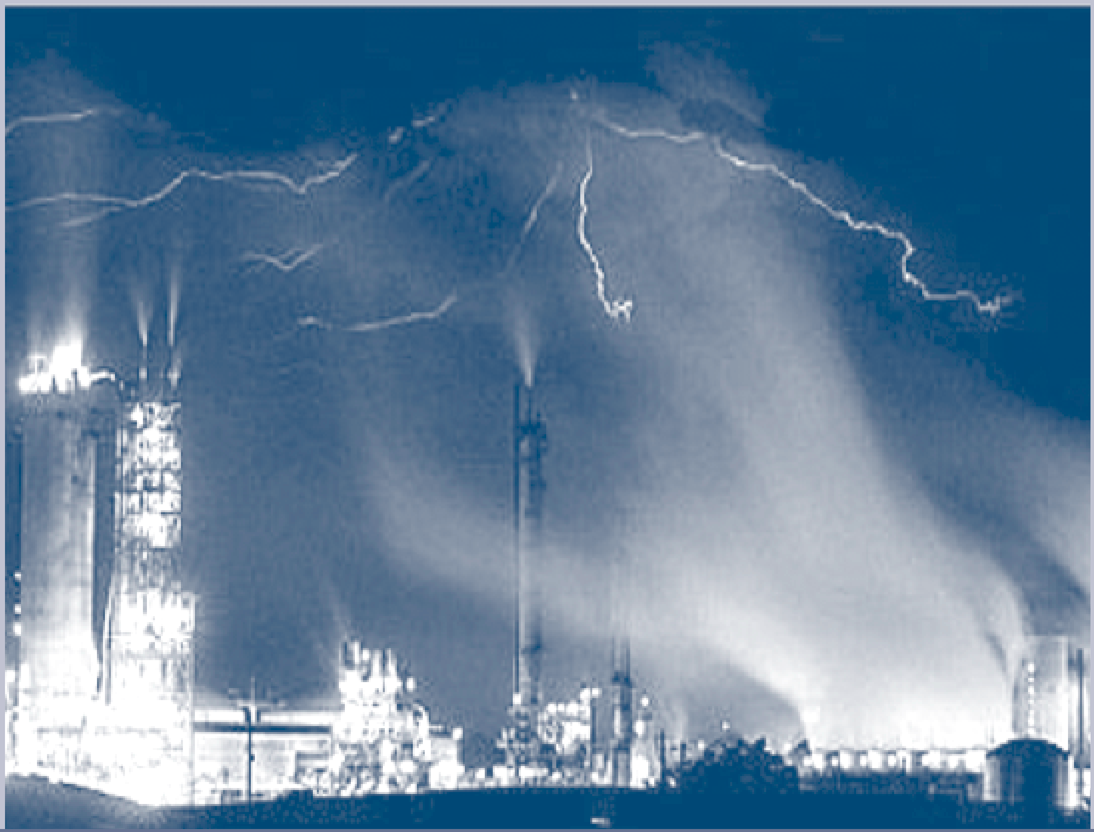
Formerly the Arcadian Corporation, PCS Nitrogen is the U.S. subsidiary of PotashCorp of Saskatchewan, Inc., commonly known as PotashCorp. With approximately 5,000 employees in five countries and thousands of customers around the globe, PotashCorp is the world's largest integrated producer of three agricultural fertilizers: nitrogen, phosphate, and potash. PCS Nitrogen produces all of its parent company's nitrogen fertilizers in four facilities in the United States and one in Trinidad. In addition to fertilizers, PCS Nitrogen markets its product as a raw material for adhesives, dyes, pharmaceuticals, plastics, and resins.

PCS Nitrogen's Augusta, Georgia, plant is the largest producer of nitrogen chemical and fertilizer products in the eastern United States. The Augusta plant is a highly integrated manufacturing site that uses natural gas to produce a range of intermediate and end-user products. The plant's steam system is served by a 150,000-pound-per-hour (lb/hr) boiler that depends on a 300-horsepower (hp) combustion fan system to deliver air to the burner.

Project Overview

Before the project, the boiler's normal operating rate was 45,000 lb/hr. Because of improvements in the plant's heat recovery capacity, the need for steam from the boiler had become significantly lower. However, the combustion fan system's inlet louvers could not seal tightly, and this caused excessive air leakage at low loads. Because of this air leakage, the boiler's low-load limit had to be kept mechanically set at 28,000 lb/hr (19%) to maintain proper flame conditions and keep the boiler from shutting down. Of that amount (28,000 lb/hr), up to 14,000 lb/hr was not needed and was therefore vented. The vented steam cost the plant up to $7,000 per hour in fuel costs.

In addition, because the fan speed was not adjustable, turbulence and vibration were created when the louvers were closed, which placed great stress on the fan system bearings. Also, the boiler feed water pumps needed to operate at a higher output level to provide adequate feed water to the boiler.



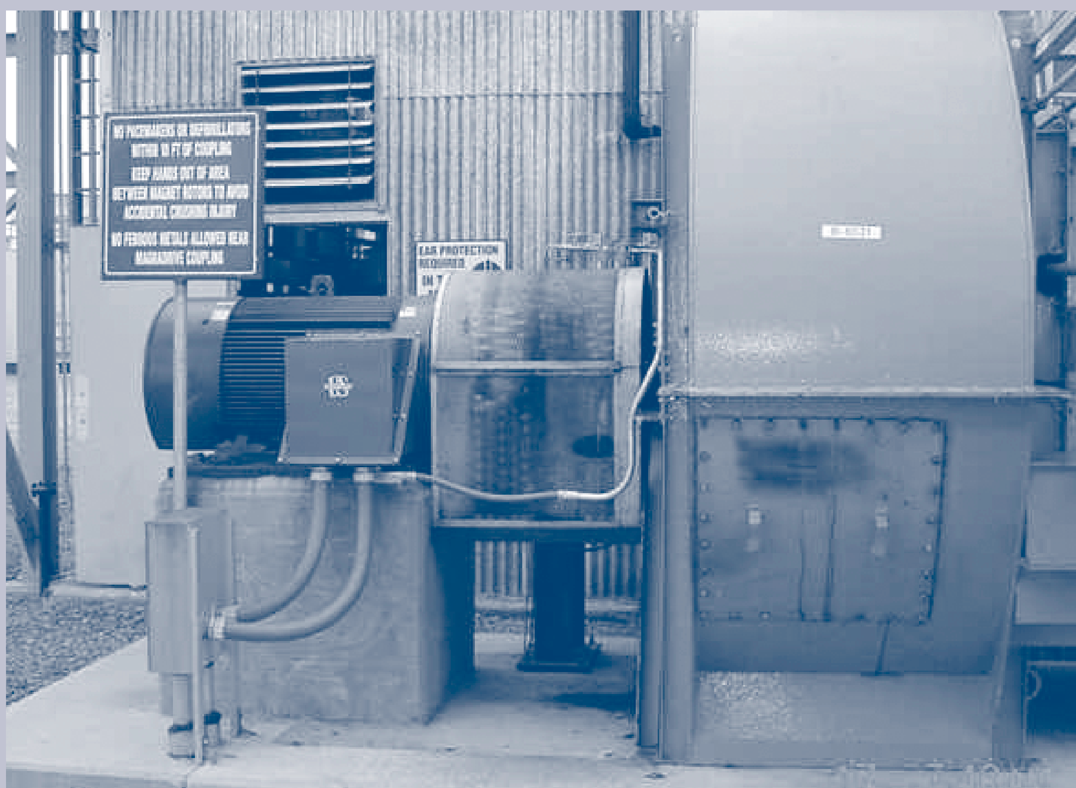
PCS Nitrogen's fertilizer plant, Augusta, Georgia.

Project Implementation

The Augusta plant engineers knew of other steam savings projects that could have been implemented. But because of steam losses that were occurring at that time, those additional projects could not be justified. The engineers began looking for ways to reduce the excess steam while keeping the auxiliary boiler running, thereby lowering energy costs. They were aware of a common type of ASD called a variable-frequency drive (VFD), in which an inverter is used to vary the speed of the motor. However, a

VFD was not deemed cost-effective because of its capital costs, and because the installation would have required considerable electrical work and reconfiguration of the fan system and the boiler room. In addition, the boiler would have had to be shut down for at least 2 weeks, which would have caused an unacceptable amount of production downtime.

After doing some research, the Augusta plant engineers decided to work with MagnaDrive, a Motor Challenge Allied Partner, to install a mechanical ASD that uses magnetic induction to induce eddy currents that transmit motor energy in the form of torque. Because the eddy current drive was mechanical, it had fewer sensitive electronic parts and did not require an inverter, extensive wiring, or boiler room reconfiguration. Also, the mechanical ASD was one-third the cost of a similarly sized VFD and could be installed with less boiler downtime. Following their analysis, the Augusta plant engineers realized that they could retrofit the system with the eddy current drive.



Boiler draft fan in the PCS Nitrogen plant.

While it is not as complex as a VFD, the eddy current drive took 3 days to install. To limit production downtime, the Augusta plant engineers timed the drive's installation to coincide with the boiler's annual maintenance period, when the boiler is offline for about 4 days. The engineers had to enlarge the fan base so that it could accommodate the eddy current drive. Because the fan motor was directly coupled, the ASD could easily be placed in line with the fan shaft. A new actuator was installed for the eddy current drive and was set for a minimum fire rate of 14,000 lb/hr with the louvers in the minimum fire position. The eddy current drive reduced the louvers' leakage rate, allowing the boiler's normal firing rate to be cut in half while maintaining a stable flame in the boiler.

Project Results

The installation of the ASD on the combustion fan system allowed air control to be improved, and this yielded important savings for the Augusta plant. With the ASD in place, the fan system was able to control the combustion air and modulate the fan motor speed to respond to changing load patterns with greater precision. As a result, plant personnel were able to lower the boiler's low-load limit from 28,000 lb/hr to 22,000 lb/hr (19% to 15%), which reduced the amount of vented steam to 6,000 lb/hr.

The first phase of the project is yielding annual energy cost savings of $420,000 and energy savings of 76,400 MMBtu. In addition, there is less stress on the fan motor and bearings because the fan is not fully loaded and less boiler feed water is needed. With total project costs of $65,000, the simple payback is less than 2 months. Moreover, the plant can now implement a project that will upgrade the boiler instrumentation and controls and yield estimated annual energy cost savings of $978,000 and energy savings of 177,800 MMBtu. Another advantage of the mechanical ASD is that it can be easier to maintain than an electronic drive. This has obviated the need to bring in a highly skilled technician, who would have been needed to service and maintain a VFD.

Lessons Learned

Optimal control of combustion air is essential for efficient boiler performance. If the combustion fan does not properly control air at low loads, the burner has to be set at a high firing rate, which causes substantial steam waste and higher energy costs. Improving a combustion fan system's ability to control air at low loads can be quite beneficial. In the case of the Augusta plant, the inlet louvers on the combustion fan allowed considerable air leakage, which necessitated a high boiler-firing rate. Operating the fan and boiler in this manner led to excess steam generation, energy waste, and increased stress on the fan motor and fan system bearings. The installation of a mechanical ASD on the combustion fan accurately controlled the volume of combustion air and enabled the fan's speed to match the system load. This improved the boiler's performance and reduced its energy consumption. Such a drive can easily be applied in fan systems that require variable output to respond to shifting load patterns.

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Project Partners

PCS Nitrogen, Inc.
Augusta, GA

MagnaDrive Corporation
Seattle, WA

For Additional Information, Please Contact:

EERE Information Center
1-877-EERE-INF
(1-877-337-3463)
www.eere.energy.gov

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