J. R. Simplot: Burner Upgrade Project Improves Performance and Saves Energy at a Large Food Processing Plant

Benefits

- Saves $299,000 in annual energy costs
- Saves 52,000 MMBtu of natural gas annually
- Improves boiler performance
- Saves 526,000 kWh per year
- Achieves a simple payback of less than 14 months

Applications

Worn or inefficient burners and burner control systems can lead to boiler malfunctions, production downtime, and excessive energy costs. Upgrading the efficiency of burners and burner control systems can improve a boiler's efficiency and reliability in order to reduce energy consumption and avert costly boiler shutdowns.

Summary

To reduce energy consumption and costs, the J.R. Simplot Company completed a project in 2003 that increased the efficiency of the steam system at its potato processing plant in Caldwell, Idaho. The project was based on an evaluation, performed using the Steam System Assessment Tool (SSAT), by Bill Moir, a Qualified Specialist with Steam Engineering, Inc. The SSAT was developed for the U.S. Department of Energy's (DOE) Industrial Technologies Program BestPractices. The Caldwell plant improvements are saving 52,000 MMBtu and 526,000 kWh annually. Energy and maintenance cost savings total $329,000 per year. Since total project costs were $373,000, the simple payback is less than 14 months. Similar efficiency measures were replicated at other Simplot facilities in 2003 and 2004, following analyses conducted using the SSAT. Those energy efficiency improvements are yielding natural gas savings of 176,000 MMBtu per year.

Company/Plant Background

The J.R. Simplot Company is a major food and agribusiness corporation based in Boise, Idaho, with annual sales of around $3 billion. The company has more than 12,000 employees in the United States, Canada, China, Mexico, and Australia. Simplot's business activity includes the production of food, fertilizer, turf, and horticultural products; cattle feeding; and other agribusiness enterprises. The company has an ongoing energy efficiency program that focuses on employee training. David Hawk, Director, Energy & Natural Resources, and Alan Christie, Food Group Engineering Manager at Simplot, have worked closely with DOE, the Washington State University Energy Program, and the Idaho Department of Water Resources Energy Division to raise awareness about the productivity and financial benefits of increased energy efficiency in industrial systems.

The Caldwell facility is one of the company's largest; it produces approximately 270 million pounds of frozen french fries per year. The site is equipped with three natural-gas-fired, water-tube boilers. Two are rated for 70,000 pounds per hour (lb/hr), and the third is rated for 60,000 lb/hr. Steam is generated at 275 pounds per square inch gauge (psig) saturated. Steam is important to the plant's production processes because it directly supports potato peeling, blanching, and frying tasks.

Project Overview

In 2000, Simplot commissioned Steam Engineering, Inc., to analyze steam systems at its production facilities as part of its corporate energy efficiency program. In the initial assessment at the Caldwell site, analysts found that the plant's average steam load was 90,000 lb/hr, and excess combustion air levels were averaging 50%. In

addition, the flue gas oxygen content was as high as 7.5%. All three boilers were operated at part-load to satisfy the plant's peak steam demand of 140,000 lb/hr. Peak and average demand levels fluctuated constantly because the potato peeling vessel had to be filled rapidly to evaporate moisture in the potatoes. Condensate reuse was minimal; only the high-pressure condensate from the hot oil heat exchangers was returned to the boilers.

The initial conclusion was that the steam system's efficiency could be dramatically improved by installing new burners equipped with parallel positioning controls, and adding a flue gas oxygen trim system to reduce the amount of excess air needed for quality combustion.

Intake Air Assembly

Combustion Efficiency

Combustion efficiency is a measure of how effectively the heat content of a fuel is transferred into usable heat. The stack temperature and flue gas oxygen levels are primary indicators of combustion efficiency. Operating a boiler with an optimum amount of excess air minimizes heat loss up the stack and improves combustion efficiency. In practice, combustion conditions are rarely ideal; additional or "excess" air must be supplied to burn the fuel completely.

The correct amount of excess air is determined by analyzing flue gas oxygen levels. Inadequate excess air results in unburned fuel, while too much excess air results in lost heat—indicating lower boiler fuel-to-steam efficiency. Natural-gas-fired boilers that operate efficiently should have an excess air level of 10%.

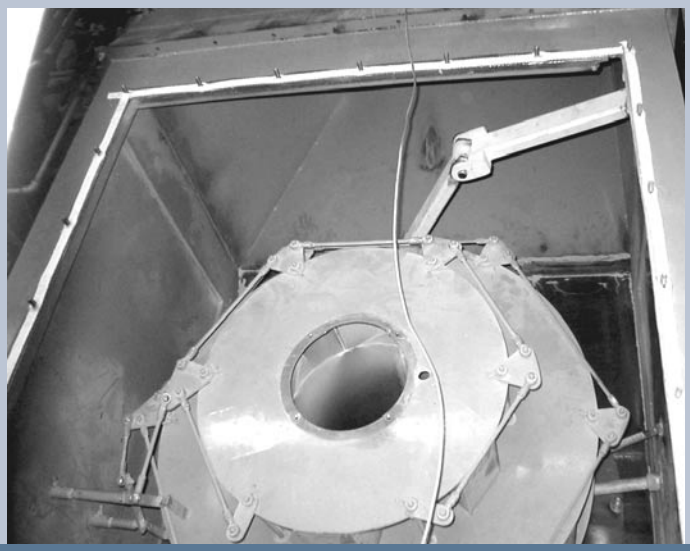
When fuel composition or steam flows are highly variable, an on-line oxygen trim system should be considered. An oxygen trim system provides feedback to the burner controls to automatically minimize excess combustion air and optimize the air-to-fuel ratio.

In 2002, when the SSAT software was launched, Bill Moir used it to assess the Caldwell plant's steam system. The SSAT model indicated potential natural gas savings of more than 25,000 MMBtu annually if the boilers at the Caldwell facility could be operated consistently at a flue gas oxygen level of 3%. This could be accomplished by upgrading the aging burners and controls and installing flue gas oxygen trim systems on the boilers, as indicated in the earlier analysis. In addition, the SSAT model showed that upgrades to the condensate system would allow more condensate to be recovered, that the boilers could operate at excess combustion air levels of 10%, and that only two boilers could meet the plant's steam load.

Project Implementation

Simplot's management decided to implement Steam Engineering's recommendations, based on the SSAT analysis, at the Caldwell facility first. If the Caldwell project was successful, then similar measures would be taken at other Simplot sites following SSAT-based evaluations.

To minimize production downtime, the new burners and controls were installed on two boilers during scheduled plant outages. After the existing burners were removed, new faceplates were mounted on each boiler front before the new burners could be installed. Then, new combustion air fans, flue gas recirculation ducts, flue gas oxygen analyzers, and boiler control systems with oxygen trim systems were installed on each boiler. Once all of the improvements were completed, plant personnel were able to meet the plant steam load using less steam and natural gas without diminishing production.



Burner and Burner Housing

Project Results

The Caldwell plant project has significantly increased the efficiency of the plant's steam system. Because the new burners are more efficient and recirculate flue gas better, the boilers now operate at an average flue gas oxygen level of 3% or less. The plant's peak steam load is now 110,000 lb/hr, and two boilers are able to meet that load, at excess combustion air levels of just 10%. The project simplified the condensate return process by bringing the condensate directly to the deaerator and allowing the deaerator pressure to float. This has allowed the plant to achieve a condensate recovery rate of 50% and to take the plant's five condensate pumps off-line.

The Caldwell plant project has reduced annual natural gas consumption by 52,000 MMBtu (7.5% of previous annual consumption), for a cost savings of $279,000 per year. Annual electricity savings amount to 526,000 kWh, saving another $20,000 per year, because the condensate pumps and the boiler draft fan on the third boiler are off-line. These changes are also saving $30,000 in annual maintenance costs. Total annual project savings are $329,000. Because the project's total costs were $373,000, the simple payback is less than 14 months. In addition, production is now more reliable; no boiler outages have been reported since the project was completed.

Since the completion of the project, Simplot management has mandated the use of the SSAT to evaluate steam systems at all of its production facilities. To date, efficiency measures based on SSAT modeling have been replicated at eight other Simplot facilities, resulting in annual natural gas savings of 176,000 MMBtu. In addition, Simplot's involvement with the Western U.S. Food Processing Efficiency Initiative (part of the State Technologies Advancement Collaborative) has allowed the expertise developed in these efforts to be leveraged with other successful energy efficiency efforts for the benefit of other food processing companies in the western United States.

Lessons Learned

Using a uniform methodology and tool for evaluating and optimizing industrial steam systems can generate valuable strategies for improving these systems' performance and saving energy. At J.R. Simplot's Caldwell plant, an SSAT-based analysis validated the potential energy savings resulting from a conventional strategy for optimizing the efficiency of the steam system. The SSAT analysis also identified additional benefits from that strategy.

DOE Industrial Technologies Program BestPractices Steam System Assessment Tool

BestPractices has a suite of tools for evaluating and identifying opportunities for energy savings in steam systems. The primary steam-related tool is the Steam System Assessment Tool (SSAT). The SSAT is a software package that allows users to model various improvement scenarios and accurately estimate potential energy and cost savings from individualized steam system improvements. This and other steam-related software tools can be obtained through the EERE Web site (www.oit.doe.gov/bestpractices/software_tools.shtml), or they can be ordered from the EERE Information Center by calling 877-337-3463.

In the wake of the project's success, Simplot saw the SSAT as an effective, "common denominator" type of tool for evaluating opportunities to improve all the company's steam systems. Management therefore established a corporate policy to institutionalize the use of the SSAT at all Simplot facilities using steam. To date, the SSAT has been used at eight other Simplot facilities, and the resulting analyses are updated annually. Uniform tools and methodologies such as this one can easily be adopted in any industrial facility that uses steam.

Partner Profile

Bill Moir, Engineering Manager at Steam Engineering Inc., is a mechanical engineer and both an SSAT Qualified Specialist and Instructor. Bill has more than 30 years of experience in evaluating steam systems in a variety of industrial facilities, ranging from water treatment plants to manufacturing facilities to specialized power plants. He has been working with J.R. Simplot since 1999, and he routinely uses SSAT to help analyze the steam systems and boilers at each of the company's production facilities.

Qualified Specialists

Qualified Specialists are industry professionals who identify cost-cutting and efficiency opportunities in industrial plants. Experienced professionals who complete a qualification training workshop and exam for specific DOE-developed software tools receive special designations, and they can use these tools to help plants reduce costs, decrease maintenance and downtime, and improve productivity. The training recognizes and enhances a professional's expertise in the use of DOE's AIRMaster+ software tool, Pumping System Assessment Tool, Process Heating Assessment and Survey Tool, or Steam System Tools.

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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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Washington State University
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