Energy Tips – Steam

Steam Tip Sheet #24 • April 2004

Industrial Technologies Program

Upgrade Boilers with Energy-Efficient Burners

Background

The purpose of the burner is to mix molecules of fuel with molecules of air. A boiler will run only as well as the burner performs. A poorly designed boiler with an efficient burner may perform better than a well designed boiler with a poor burner. Burners are designed to maximize combustion efficiency while minimizing the release of emissions.

A power burner mechanically mixes fuel and combustion air and injects the mixture into the combustion chamber. All power burners essentially provide complete combustion while maintaining flame stabilization over a range of firing rates. Different burners, however, require different amounts of excess air and have different turndown ratios. The turndown ratio is the maximum inlet fuel or firing rate divided by the minimum firing rate.

An efficient natural gas burner requires only 2% to 3% excess oxygen, or 10% to 15% excess air in the flue gas, to burn fuel without forming excessive carbon monoxide. Most gas burners exhibit turndown ratios of 10:1 or 12:1 with little or no loss in combustion efficiency. Some burners offer turndowns of 20:1 on oil and up to 35:1 on gas. A higher turndown ratio reduces burner starts, provides better load control, saves wear-and-tear on the burner, reduces refractory wear, reduces purge-air requirements, and provides fuel savings.

Efficient Burner Technologies

An efficient burner provides the proper air-to-fuel mixture throughout the full range of firing rates, without constant adjustment. Many burners with complex linkage designs do not hold their air-to-fuel settings over time. Often, they are adjusted to provide high excess air levels to compensate for inconsistencies in the burner performance.

An alternative to complex linkage designs, modern burners are increasingly using servomotors with parallel positioning to independently control the quantities of fuel and air delivered to the burner head. Controls without linkage allow for easy tune-ups and minor adjustments, while eliminating hysteresis, or lack of retraceability, and provide accurate point-to-point control. These controls provide consistent performance and repeatability as the burner adjusts to different firing rates.

Alternatives to electronic controls are burners with a single drive or jackshaft. Avoid purchasing standard burners that make use of linkages to provide single-point or proportional control. Linkage joints wear and rod-set screws can loosen, allowing slippage, the provision of sub-optimal air-to-fuel ratios, and efficiency declines.

Applications

Consider purchasing a new energy-efficient burner if your existing burner is cycling on and off rapidly. Rotary-cup oil burners that have been converted to natural gas use are often inefficient. Determining the potential energy saved by replacing your existing burner with an energy efficient burner requires several steps. First, complete recommended burner-maintenance requirements and tune your boiler. Conduct combustion efficiency tests at full- and part-load firing rates. Then, compare the measured efficiency values with the performance of the new burner. Most manufacturers will provide guaranteed excess O_2, CO, and NOx levels.

Example

Even a small improvement in burner efficiency can provide significant savings. Consider a 50,000 pound per hour process boiler with a combustion efficiency of 79% (E1). The

Maintenance Requirements

Conduct burner maintenance at regular intervals. Wear on the firing head, diffuser, or igniter can result in air leakage or failure of the boiler to start. One burner distributor recommends maintenance four times per year, with the change of seasons. A change in weather results in a change in combustion.

Fan Selection

Fan selection is also important. Backward-curved fans provide more reliable air control than forward-curved fans. Radial-damper designs tend to provide more repeatable air control at lower firing rates than blade-type damper assemblies.

Steam Tip Information is adapted from material supplied by PBBS Equipment Corp and Blesi-Evans Company and reviewed by the DOE BestPractices Steam Technical Subcommittee. For additional information refer to Steam Tip Sheet #4 Improve Your Boiler's Combustion Efficiency *and* Improving Steam System Performance—A Sourcebook for Industry *("Steam System Basics: Generation" section). These materials are available from the EERE Information Center at 877-337-3463.*

boiler annually consumes 500,000 million British thermal units (MMBtu) of natural gas. At a price of $4.50/MMBtu, the annual fuel cost is $2.25 million. What are the savings from installing an energy efficient burner that improves combustion efficiency by 1%, 2%, or 3%?

Energy Savings Due to Installation of an Energy-Efficient Burner

Burner Combustion Efficiency Improvement (%)	Annual Energy Savings, (MMBtu/year)	Annual Savings ($)
1	6,250	28,125
2	12,345	55,550
3	18,290	82,305

Cost Savings = Fuel Consumption x Fuel Price x (1 – E1/E2)

If the installed cost is $50,000 for a new burner that provides an efficiency improvement of 2%, the simple payback on investment is:

Simple Payback = $50,000 ÷ $55,550/year = 0.9 years

Suggested Actions

- Perform burner maintenance and tune your boiler.
- Conduct combustion-efficiency tests at full- and part-load conditions.
- If the excess O_2 exceeds 3%, or combustion efficiency values are low, consider modernizing the fuel/air control system to include solid-state sensors and controls without linkage. Also consider installing improved process controls, an oxygen trim system, or a new energy-efficient burner.
- A new energy-efficient burner should also be considered if repair costs become excessive, reliability becomes an issue, energy savings are guaranteed, and/or utility energy-conservation rebates are available.
- Install a smaller burner on a boiler that is oversized relative to its steam load.

About DOE's Industrial Technologies Program

The Industrial Technologies Program, through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. The Industrial Technologies Program is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

The Industrial Technologies Program encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following eight energy and resource intensive industries:

- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- Steel

The Industrial Technologies Program and its BestPractices activities offer a wide variety of resources to industrial partners that cover motor, steam, compressed air, and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), compressed air systems (AirMaster+), steam systems (Steam Scoping Tool), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The Energy Matters newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at **www.eere.energy.gov/industry/bestpractices** or by contacting the EERE Information Center at **877-337-3463** or via email at **eereic@ee.doe.gov**.

BestPractices is part of the Industrial Technologies Program 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.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

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Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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