

# 10 Ways to Improve Efficiency for Gas-Fired Boilers

**T**he need to operate a boiler efficiently in today's environment and competitive landscape is at the top of many plant owners and operators list. Unfortunately operating a boiler efficiently while meeting local emission regulations do not always go hand in hand. However, advances in boiler system design and low NOx technology solutions have made this a much more achievable task.

The potential for energy improvements and cost savings are substantial, when considering that most boilers operating today are performing at efficiencies that are less than 81%. The general guidelines listed below take a total boiler systems approach in managing boiler efficiency (for natural gas-fired boilers), which can instantly improve overall boiler performance and sustainability, helping to achieve more cost-effective maintenance and operations of your steam system.



*A 50,000 lb/hr boiler supplied with a low NOx 30 ppm burner, CataStak™ SCR system and EconoStak economizer. The unit was certified to operate at better than 95% fuel-to-steam efficiency.*

## 1. Reduce Excess Air

One of the first considerations when you want to improve boiler efficiency is to look at how your excess air levels are being controlled. An often-stated rule of thumb is that boiler efficiency can be increased by 1% for each 15% reduction in excess air. With a properly designed O<sub>2</sub> trim system, your boiler will maximize combustion efficiency and minimize heat loss up the stack. In order to maintain excess air at optimum levels, ensure that boiler control systems are working properly and periodically have a qualified boiler/burner technician re-tune the boiler's burner.

## 2. Install an Economizer

In many boilers, useful amounts of energy still exist in the flue gases even after they have passed through the boiler. Economizers are designed to capture and transfer the exhaust heat of the flue gases to pre-heat incoming boiler feedwater. Extended surface economizers are designed for maximum heat recovery and can decrease flue gas outlet stack temperature to as low as 250° F. In general, for each flue gas temperature decrease of 40° F, boiler efficiency is increased by 1%.

## 3. Install a Condensing Economizer

Condensing economizers are designed to pick up both sensible and latent heat by condensing flue gas water vapor. They have been designed to decrease flue gas outlet stack temperature to as low as 100° F. Before considering the installation of a condensing economizer, be sure to determine how the condensed water from the flue gas will be disposed. Unlike a standard feedwater economizer, the low grade heat produced cannot be used by the boiler system. A plant must have a need for constant low grade heat (as with a hydronic heating or washdown application).

## 4. Upgrade to VFD Fan Controls

Variable frequency drives (VFDs) adjust and control fan speed in response to the boiler load. Standard constant speed fan airflow is matched to the boiler load by the opening and closing of a damper so horsepower stays relatively constant regardless of the load (depending on damper arrangements). With VFDs, the exerted horsepower varies three times the fan speed. For example, if a fan is operating at 75% of maximum operating speed, the required horsepower would only be 40% of full load compared to a constant speed fan. In addition to its energy saving benefits, VFDs can also increase the service life of the fan motor, decrease maintenance costs and can significantly reduce noise levels.

## 5. Install a SCR System with a No FGR Burner

For applications requiring ultra low NOx (ULN) operation, an SCR system with a standard no FGR low excess air burner uses considerably less fan horsepower than a high FGR, high excess air ULN Burner. A ULN burner requires a significantly larger fan and generally has limited turndown and response to load swings to respond to plant load swings. A SCR system with a standard burner not only provides emission reductions to as low as 2.5 ppm NOx (depending on the application), but also results in substantial energy reductions and is able to handle most plant load swings with reliable boiler performance.



*A 30,000 lb/hr mobile feedwater system includes a deaerator, pumps, controls and water softener.*

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## 6. Perform Proper Water Treatment

Another major problem that affects boiler efficiency is poor water quality or water treatment. The main objective of any boiler treatment program is to prevent deposit and corrosion of the water side of the boiler. It is important to ensure that any water treatment equipment is designed for the particular make up water entering the system. It is always worth considering Reverse Osmosis (RO) for makeup water treatment. RO reduces blowdown, which increases boiler efficiency and reduces boiler treatment chemicals. Having high condensate return also increases overall plant efficiency and reduces make up water requirements.

## 7. Reduce Boiler Pressure

Any boiler that is operating at a pressure higher than the process requirements offers a potential to save energy by reducing boiler pressure. The boiler pressure directly corresponds to the water/saturation temperature in the boiler. A lower boiler operating pressure results in several efficiency gains including higher LMTD (Log Mean Temperature Difference) between the flue gas and boiler saturation temperature, higher heat transfer, lower heat loss, lower outlet stack temperature and overall reduced fuel usage.

## 8. Consider Boiler Blowdown Heat Recovery

There are two types of boiler blowdown, continuous blowdown and bottom blowdown. Continuous blowdown removes dissolved solids from the water surface and is continuously operating. The bottom blowdown removes sediments that have settled to the bottom of the boiler and is generally used several times a day. The energy contained in the continuous blowdown can be used to preheat feedwater and supply flash steam to a deaerator (reducing overall steam required by the deaerator). Flash tank systems or a blowdown heat recovery system with a flash tank and a heat exchanger are two methods for recuperating energy in the blowdown.

## 9. Upgrade to a High Turndown Burner

Upgrading a boiler with a high turndown burner reduces boiler cycling and heat loss. O<sub>2</sub> trim controls provide feedback to the burner controls to optimize the



air-to-fuel ratio, which controls the amount of excess air and maximizes potential boiler efficiency gains.

## 10. Implement an Energy Efficiency Program

A boiler efficiency improvement program includes two aspects: (1) the actions needed to bring a boiler to peak efficiency and (2) the actions to maintain the efficiency at the maximum level. The general guidelines above provide several opportunities for energy and performance improvements, however it is up to the plant operator to look past the immediate demands of the equipment, and take a broad view of how the system parameters affect the systems as a whole.

Many resources are available today to help operators develop a comprehensive plant strategy to increase efficiency, reduce emissions and boost productivity. Free plant assessments, training sessions offered by industry manufacturers, associations and industrial services, as well as software tools are readily available to help make decisions about implementing efficient practices in your facility a reality. *By David Spain, P.E.,  
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