# 10 Tips:
# Efficient Burner Operation and Selection

*By Jeff Rafter, Maxon Corp.*

**Inefficient combustion heating systems could be costing you money and manpower. Here are 10 ways to improve burner operation.**

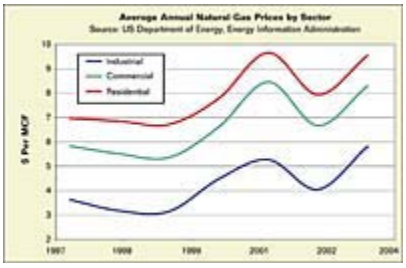


**Figure 1. No one can say with certainty what fuel prices will be, but historical data show one trend: higher prices.**

Since 1997, the average industrial natural gas price in the United States has increased 61 percent. A large portion of this higher price comes from a substantial increase in gas demand by power companies, accompanied by relatively fixed gas distribution infrastructure. In other words, higher natural gas prices will be with us for some time (figure 1).

To help mitigate increases in fuel costs, inspect burners and combustion heating systems to identify opportunities to improve efficiency. These helpful tips will guide your efforts to reduce your natural gas bills.

## TIP 1: Check Adjustment

Today's modern generation of nozzle-mix burners provides outstanding stability and reliability even when misadjusted. It is not uncommon for combustion equipment to be operating well out of adjustment, contributing to inefficiency and poor emissions. Depending upon the specific application of the burner, tuning to a designed air/gas ratio often can reduce fuel consumption by eliminating uncombusted fuel or heat-robbing excess air. Contact your burner manufacturer for operating instructions or adjustment assistance.

**Today, burner manufacturers are integrating intelligent controls on burners to monitor air/fuel ratio and provide automatic adjustment.**

## TIP 2: Perform Maintenance

In addition to the wear experienced in mechanical devices, burners also bear the task of managing combustion temperatures of up to 3,400°F (1,871°C) with natural gas. This can quickly take a toll on the device. Periodically inspect burner internals for wear, excessive oxidation or warping. Pay particular attention to gas nozzles, mixing plates and bluff bodies. In addition, don't forget to clean or replace air filters.

Any device associated with controlling burner ratios should be given extra attention. This includes valves, linkages, regulators and regulator impulse lines. Inspect all of these devices for proper settings and function. When control devices fail, use the opportunity to upgrade to components with better control performance.

## TIP 3: Consider Your Firing Method

One very simple efficiency gain is to convert indirect-fired processes to direct-fired processes. Noncondensing heat exchangers limit heat transfer efficiency of combustion products to around 80 percent. Gain 5 to 20 percent more useful heat by replacing indirect-fired systems with direct-fired burners, where processes allow. A good example would be to replace steam heating coils in an air heater with a direct-fired burner. This change would eliminate the stack losses and piping thermal losses of the boiler and steam piping. If processes are indirect fired to prevent product reactions with combustion products, investigate the newest generation of ultra low emissions burners.

**In addition to the wear experienced in mechanical devices, burners also bear the task of managing combustion temperatures of up to 3,400°F (1,871°C) with natural gas.**

## TIP 4: Get Control

Precision in temperature control has been proven to provide better efficiency by eliminating heat wasted in temperature overshoots in most systems. Replacing on/off or high/low-controlled burners with modulating burners can reduce gas usage.

Some modulating burners also employ “simulated” turndown. That means that by using bypass lines or bypass drillings, the burner only modulates over a part of its operating range. To achieve higher turndowns, the burner may jump to a lower idle input, which is fixed. When this occurs, temperature control precision is lost and “hunting” may ensue as the burner jumps between control and idle. Analyze new or replacement burners carefully and select those with real continuous turndown, not bypass control.

## TIP 5: Understand Control Dynamics

Similar to the control method, if your system already has temperature modulation, be certain your control loop is tuned correctly to limit hunting or overshoot. These actions waste energy and add unnecessary wear on modulating actuators and valves. Contact a reputable service company or your burner supplier for assistance in tuning PID loops.

## TIP 6: Recuperate and Regenerate

As process temperatures climb, the opportunities to reclaim heat from exhaust gases become substantial. Many burners will accept combustion air preheated to 800°F (427°C) or higher. With this option, recuperators can reduce fuel usage substantially by transferring stack energy to combustion air.

Unfortunately, a trade-off exists with preheated air. The energy contained in preheated combustion air helps overcome the activation energy necessary to begin the thermal formation of NOX. Therefore, most recuperated burners produce high levels of NO and NO2.

In regenerative systems, a cyclic firing method is used to alternately store and recuperate energy. Heating a media bed with exhaust gases does this. In the second half of the cycle, the energy stripped from exhaust gases is added back into combustion air before it enters the burner. Regeneration may be done by burner pairs or by a single regenerative assembly. Similar to recuperation, regeneration is only economically practical when process temperatures are 1,000°F (538°C) or higher. The same risk exists with poorer emissions performance.

In both recuperation and regeneration, carefully consider the capital cost of the additional equipment. While the efficiency increase always makes sense, a five- or seven-year payoff may not fit your company’s business plan. Treat all efficiency-improving projects like a capital purchase and figure the return on investment.

## TIP 7: Get With the Airflow

Beyond combustion efficiency and heat transfer efficiency, consider that most burners are powered designs, also called forced draft. That is, these burners use a fan or blower to provide a pressurized combustion air supply. These blowers consume electricity to create pressurized airflows.

Different blower designs exhibit different fan efficiencies depending upon their size and the style of impeller used. Blower efficiency peaks for most designs near the rated nominal maximum flows and is reduced as flow is throttled down. For this reason, burners that control combustion air with valves or dampers reduce electrical efficiency as they modulate down.

To combat this trend, variable-frequency drives (VFDs) may be used to modulate combustion air for electrical savings. Use caution with VFDs as significant control error can be induced if fuel control is not synchronized with airflow.

## TIP 8: Select Smartly

Many of the industrial burner manufacturers have product catalogs over a foot thick. Why? Decades of gas process heating have proven that specific burner designs can have dramatic effects on the heating efficiency of various types of equipment. By varying characteristics such as discharge velocity, flame shape, flame radiance, control methods and flame stoichiometry, burner manufacturers can tune the heat transfer characteristics of their products to various types of process heating equipment.

Select burners that are intended for the process or device you are heating. Consider how each product burns fuel and transfers heat to your end product. Selecting right burner can have a dramatic effect on your fuel bill.

## TIP 9: Size Safely

Very often, burners get a generous comfort margin in sizing. It is not uncommon to find burners installed that are too large for the actual demand of the process. When this oversizing occurs, the combustion air blower is less efficient. In addition, most all-metal process heating burners use higher levels of excess air for cooling at low firing rates. Therefore, in addition to blower inefficiency, combustion inefficiency may be added when burners are oversized if the added combustion air is not deducted from the process's total mass flow.

## TIP 10: Automate

The technology of the air/fuel ratio control in most modern burners is analogous to a carburetor. Ratio is controlled by mechanical or pressure devices that suffer from hysteresis and constantly changing parameters such as air temperature, barometric pressure, clogging air filters and application pressures. In short, wear, human error and Mother Nature all conspire to reduce efficiency in most burners.

Much like the automotive industry did in the 1980s, today burner manufacturers are integrating intelligent controls on burners to monitor air/fuel ratio and provide automatic adjustment. These controls may work by position control or by mass flow control, but either way, they seek to eliminate the error associated with mechanical devices, people and Mother Nature by applying intelligence.

Since the mid-1990s, several systems have been developed and installed that have proven to provide optimal efficiency and reduced emissions by automating air/fuel ratio control. In addition, a decade of service has shown these systems to provide the added benefit of reliability and uptime much like the modern day car engine with 100,000-mile tuneups.

Installing intelligent fuel/air ratio control can easily be justified in fuel savings with a return-on-investment (ROI) calculation. If exact data is unavailable about where your combustion system

is operating, practical experience shows most systems are out of optimal adjustment by a minimum of 2 to 4 percent due to human error or control drift. Calculate the annual saving of 2 to 4 percent for a subject device, and divide it into the cost of the ratio control system to determine an approximate payoff.

No one can say with certainty what fuel prices will be. However, actual prices, spot prices and futures all show the same trend…up. Examine your combustion systems as soon as possible to locate adjustments or improvements to help combat rising fuel prices. PH