Don’t Burn *Excess* Money with Your Boiler/Burner Package

How to Save on Energy Costs with Burner Retrofits

How old is your boiler?
If your boiler/burner (package) is like more than 200,000 commercial and industrial boiler packages in operation today, then it’s more than 20 years old. Which means it’s probably only 60 to 70 percent efficient and large amounts of fuel and associated cash are simply being wasted every minute the equipment is being operated.

Burning unnecessary money in today’s economy is simply unacceptable. And while a whole new boiler package would fix your problem, such a significant investment (usually $100,000 or more) may be difficult to justify during these challenging economic times.

Fortunately, there are a variety of options available to you through less costly retrofit and upgrade improvements to greatly increase the boiler package’s efficiency and reduce fuel usage. Assuming the boiler vessel itself is in good shape, the best, most immediate opportunities to cut boiler room fuel use and electric bills are in the burner, burner components and controls.

Let’s take a look at your burner retrofit options and how to incorporate them.

Replacing the Burner

The burner is the true driver of fuel use and costs in your boiler.

After about 20 years of service, a typical burner simply gets tired. Linkage joints, cams and other moving parts wear out, and the burner’s ability to keep tight control on the fuel-air ratio becomes degraded.

The result is commonly referred to as “hysteresis”, or the inability of the burner to repeat desired excess air levels across the firing range for optimum combustion. Higher excess air means lower combustion efficiency. And, your legacy burner can suffer from a whole host of other issues including plugged or deteriorated nozzles and gas orifices, and deterioration of other combustion head components responsible for proper fuel and air mixing. All of this results in unburned fuel (CO, hydrocarbon, etc,) and higher than required excess air levels, leading to poor performance and overall efficiency reduction; excess cash being burned….

If your current burner has too many worn-out parts or outmoded technology, adding new controls is probably not going to fix these underlying issues. So the solution is simple: replace the old burner with a new one that features advanced controls, higher turndown capability, and lower excess air requirements. Depending on a variety of factors unique to your system, replacing the burner alone can deliver a 5-10 percent reduction in fuel usage.

Older burners are also out of step with today's more stringent emissions regulations established by the federal Environmental Protection Agency and related Air Quality Management Districts. If your system still includes a legacy burner, the looming threat of financial penalties for violations of EPA standards more than likely outweighs the upfront costs of replacing your old burner with a newer model that releases significantly lower harmful emissions.

High Turndown (HTD)

One of the best upgrades you can make is to replace your legacy burner with a new burner incorporating high turndown capability.

While older burners typically operate in a narrow turndown range, HTD burners continue operating at even lower firing rates to meet lower loads. This ongoing operation might sound *less* efficient, but that's not the case.

The reason is with greater turndown capability, the fewer cycles the burner must go through. Before and after every firing cycle, the burner must perform automatically controlled purges where fresh air is blown through the boiler flue gas passages for a specified amount and time; ridding the furnace of any unburned fuel which may have pocketed, and thereby igniting in other than a controlled condition. Anytime cooler air is blowing through a hot boiler or heat exchanger, you have heat loss. Therefore, on subsequent firing cycles the burner must raise the temperature of the water or fluid to be heated to make up for the heat losses associated with pre- and post-purging. Plus, the fan motor (and possibly fuel pumps) must be activated for each purge, adding to your energy costs. It's all needless energy lost.

A HTD burner dramatically cuts back on these cycling occurrences and related expenses. When a cycle begins anew, you're starting with a hotter boiler, reducing the amount of energy required to ramp back up to your setpoint. In addition, the burner is less likely to overshoot the desired setpoint and waste more fuel as the burner oscillates (over and under-shooting) trying to meet the desired pressure or temperature.

Finally, a reduction in cycles means a decrease in failures brought on by cyclic fatigue, reducing your ongoing maintenance costs.

Upgrading Your Existing Burner

However, if your burner is up to emissions standards and retains a satisfactory ability to track at good excess air levels throughout its firing range, then it may be a candidate for various retrofit technology upgrades …

Advanced Controls and More

New burner controls incorporating a programmable logic controller (PLC) or microprocessor based technology, offer several additional opportunities to improve the performance and efficiency of your boiler package through more precise and customized control.

First and foremost is parallel positioning. While traditional controls incorporate "single-point" positioning incorporating shafts and linkages for air-to-fuel ratio control over the firing range, the parallel positioning arrangement allows for independent control of air and fuel flows. A much more precise way of assuring proper oxidation because the desired and exact air-to-fuel ratios can be set at each point in the range. Typically with the legacy single-point positioning systems, compromises in excess air levels must be made at firing rates between low and high fire due to the inherent difficulty of setting up linkages tied to a single positioning motor, normally termed the modulation motor. Parallel positioning systems drive the air, fuel, and possibly low emissions flue gas recirculation (FGR) metering valves independently, but pre-programmed to specified air-fuel-FGR ratio curves set up by the burner commissioner.

Featuring accuracy to within one-tenth of one angular degree, parallel positioning motors or "servos" are set to pre-determined positions throughout the firing range to provide optimal air-fuel-FGR conditions – matched to the burner capability and to the load conditions. Because keeping excess air to a bare minimum throughout the unit is crucial for optimum combustion efficiency, parallel positioning capability improves repeatability and reduces fuel consumption by as much as 5 percentage points.

In addition, oxygen or O_2 trim systems can work in concert with parallel positioning to manage excess air levels even more precisely. Changes in barometric pressure and temperatures, fuel heating value, and other environmental conditions can drive excess air levels up and down throughout the heating season. With O_2 trim, an oxygen sensor measures the flue gas oxygen content and compares that value to setpoint at each position in the firing range. If not on setpoint, fuel or air motors or servos driving valves and dampers are "trimmed" to bring the air-fuel-FGR ratios back to setpoint. This feature can also improve system fuel utilization by up to 5 percentage points.

Adding a variable speed or variable frequency drive (VSD or VFD) can also improve the efficiency of your combustion system. Combustion air or blower motors on older burners are set at one constant speed, regardless of the load on the system. Combustion air flow rates are metered by dampers. Therefore, while the heating load may only be at 30% of full load, electrical loads on the blower motor may be much greater, 70% or more. Boilers are also typically oversized for their application; nobody wants to have a boiler that fails to deliver enough heat or pressure when needed and engineers cannot afford to undersize a boiler due to the inherent cost of a capital purchase and installation if equipment has been undersized. Therefore, in many boiler installations the burner operates for significant periods at low-fire, yet pulling electrical loads on the blower motor much closer to high-fire. That results in wasteful electricity usage and higher than necessary electrical bills.

Variable speed drives don't pull all that excess electrical current when they don't need to since they slow the fan down to lower firing rates. According to the "fan laws", this results in reduced motor horsepower requirements and lower electricity usage. And because many boilers are oversized from the outset, they operate at lower loads nearly all the time. The savings on electricity quickly adds up, often paying for this upgrade in less than two years.

Bonuses: An additional benefit to VSD's or VFD's is reduced noise levels at lower fan speeds. Generally speaking, the faster a fan rotates the higher the noise levels emitted by the fan. Since boilers operate typically at lower than maximum firing rates, you can expect a much quieter operating boiler and burner incorporating a VSD or VFD for the fan motor. This produces a quieter operation and a better work environment for all involved—as well as lower maintenance costs - thanks to the reduced stress on moving parts.

In more complex HVAC systems that include two or more boilers, there are PLC (programmable logic controllers) and microprocessor-based control systems that are particularly good at boiler and burner sequencing. Rather than sizing each boiler to handle the full load requirement—a peak load that is rarely reached—multiple boilers can be sized to meet part of the load and be fired up and "modulated" as needed. Over the life of each boiler this sequencing helps reduce energy use and wear associated with cycling of boilers and associated boiler-burner components. In addition, sequencing provides the insurance of redundant equipment as well as flexibility for scheduled maintenance.

Proper Burner Integration

Proper integration of the burner to the boiler and ancillary boiler room systems provide optimal control to meeting plant demand as well as integration with advanced building management and communications systems. That gives building managers the operational control they're looking for in their facility.

Together, many of these upgrades and additions can yield a 15-20 percent energy savings over time. However, if these technologies aren't properly integrated into your system, they won't get you nearly that far.

A boiler system often incorporates equipment from a variety of suppliers following different protocols. Which is why, in a general sense, burner integration is about accommodating this diverse equipment and varying communication protocols - and getting it all to work together to produce optimal results leading to minimum energy use. Only knowledgeable and experienced boiler-burner and combustion/controls engineers are qualified to address these issues, and to do their job right, they must have a full grasp of what's required by a particular installation and all the technology that's available to meet those needs.

The importance of matching burner to boiler can't be underestimated. Perhaps the most important factor is the characteristics of the flame. The burner's flame shape and length, or flame envelope, must be matched to the furnace or combustion chamber to transfer the most heat yet not impinge on the furnace walls in a manner that could be detrimental to the furnace or convection pass materials.

Another key aspect to matching the burner to the boiler or heat exchanger deals with a phenomenon known as combustion noise, combustion vibration, or often referred to as "combustion rumble". Every boiler assembly has its own resonant frequency, so you have to ensure that the burner's combustion characteristics integrate well acoustically with the boiler and its acoustical nature. Since most burners are not custom designed to each application, the burner must be flexible in design so that during the commissioning process, any undesirable combustion noise can be "tuned out" for smooth operation throughout the firing range. In addition, the burner should be constructed of castings or heavy gage materials and "spinnings" which afford strength to the burner surfaces, thereby reducing unwanted high frequency vibrations. Otherwise, at certain loads, the whole package may vibrate causing unacceptable noise and vibrations—not to mention undue wear and tear on the system. Burners constructed of light gage sheet metals and large flimsy surfaces may be less expensive up front, but are noisier for the environment and those exposed to that (vibration) noise, have a much shorter life expectancy, and generally end up being more expensive to the owner over time.

Finally, one detail that should not be overlooked from a design perspective with a new burner and/or related upgrade is that your new burner should be designed to make it easy to inspect and maintain on a regular basis. Easy access for inspection and component replacement is a key element of good burner design. You shouldn't have to pull the burner off the vessel or—worse yet—crawl through the furnace to get to the burner, particularly for the larger sizes.

Because in the final analysis, even with all the latest technology incorporated into a state-of-the-art burner, regular maintenance is still necessary to ensure optimal fuel-air ratio throughout your boiler's firing range and equipment life. If you keep a close eye on things, you'll surely see great improvements in efficiency and lower fuel costs for years to come. It's all about burning less cash…

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