TRIAD
BOILER SYSTEMS

CONDENSING BOILERS
WHAT ARE THEY? WHEN ARE THEY APPROPRIATE?

Increasing energy prices, environmental issues, and a push towards a "Green" corporate image has created strong demand for higher efficiency Condensing Boilers. Condensing Boilers have become the product of choice for energy conscious engineers and end users. When operated within their designed parameters they can offer significant savings in fuel and reduction in pollutants. The inconvenient secret, however, is that when operated outside of their optimal parameters, high efficiency Condensing Boilers are no better than the conventional efficiency boilers they are intended to replace. ***This misapplication of Condensing Boilers has become a serious, yet very common, problem in the industry.***

What is a Condensing Boiler:

A Condensing Boiler is designed to recover heat that is normally discharged to the atmosphere through the chimney (flue or stack) by using a larger than normal heat exchanger in relation to the heat input. Water is a byproduct of the combustion process. These boilers are "condensing" because their flue gases are at a lower than normal temperature, so the water vapor starts to condense out, releasing latent heat. The formation of water represents the single biggest potential loss of efficiency as each pound of water created requires 970 btu's to vaporize. Thus one cubic foot of natural gas is lost to each pound of water created in the combustion process and subsequent phase change of liquid water to a vapor. So, a Condensing Boiler uses less energy, and has a lower flue temperature, resulting in the creation of more condensation. Keep in mind that this condensation is acidic, which causes typical carbon steel, copper, and cast iron to rust.

What is a Conventional Efficiency Boiler:

Conventional Efficiency Boilers operate at temperatures above the condensing point (or dew point) of the flue gas, typically in the 135 deg F range for a conventional natural gas fired burner at 3% oxygen. Most conventional hot water systems operate with supply temperatures between 160 deg F and 180 deg F with return temperatures between 140 deg F and 160 deg F. These temperatures assure that no part of the boiler is exposed to temperatures under the dew point to avoid the risk of corrosion from condensing vapor. As the dew point is typically under 135 deg F, the typical combustion efficiency of any conventional, non-Condensing Boiler is about 83% to 85%.

When Are Condensing Boilers Appropriate:

Condensing Boilers become a viable option when they operate below the dew point (approx 135 deg F). Return water temperatures below the dew point will allow some portion of the water vapor to condense, thus recovering the latent heat of vaporization instead of it going up the chimney. This vapor, now a condensate, is collected in the boiler and directed to a drain or condensate neutralization system (remember the condensate is acidic). This corrosive environment demands that Condensing Boilers be manufactured of suitable materials. Where Condensing Boilers can be supplied out of carbon steel, cast iron, or copper; Condensing Boilers require corrosion-resistant materials such as stainless steel, cast aluminum, and other exotic materials. These material upgrades are a significant reason Condensing Boilers are more expensive than Condensing Boilers. There is no magic to Condensing Boilers, they are simply made to withstand the corrosive effects of condensation.

Similarities between Condensing and non-Condensing Boilers:

All boilers have the same basic components. A burner is used to combust a fuel within a furnace. The temperature of combustion varies depending on the design and performance requirements, but the majority of heat transfer that takes place in any boiler is the radiant energy exchanged in the furnace / combustion chamber. The flue gases leaving the furnace travel into a convective bank (heat exchanger) inside of the boiler. The products of combustion start to cool down from somewhere in the high 1,000 deg F range to 400 deg F or even lower depending on the design. Conventional Boilers exhaust the products of combustion along with about 15% to 18% of the heat input up the stack. Condensing Boilers introduce additional heating surface area to allow the flue gases to continue to transfer all of the sensible energy in the gases until the dew point is reached. So, when Condensing Boilers are operating at their peak efficiency, they exhaust the products of combustion along with about 5% to 10% of the heat input up the stack. So a Condensing Boiler can be around 90% to 95% efficient while a Conventional Boiler is around 82% to 85% efficient .

When Are Condensing Boilers The Wrong Choice:

The thread that holds all of this together is the ability to operate under the dew point. Basic heat transfer dictates that energy can only be transferred until the lowest energy state is reached. In the case of a hot water boiler the limiting factor is the inlet water temperature. If the inlet water temperature to a boiler is above the dew point the boiler can never operate in a condensing range therefore can never offer the types of high efficiencies that may be expected. Far too many professionals at best fail to consider simple thermodynamics when considering new boiler installations and at worst ignore the engineering realities of such installations simply to earn another order for a Condensing Boiler. Many utilities and government agencies offer financial incentives to upgrade to higher efficiency boilers. Unfortunately many installations can

never achieve the expected efficiency gains because of the reality of the already clearly defined operating parameters.

When Are Condensing Boilers The Correct Choice:

Condensing Boilers, when utilized within the parameters for which they have been optimized, are unequaled at providing fuel savings and emissions reductions. They can be very effective in conventional efficiency systems such as the shoulder seasons (spring and fall), less cold days, during cold starts when the system wants to condense, or as part of a "hybrid" system. A Hybrid System is a relatively new concept that combines Conventional and Condensing Boilers. The Conventional Boilers will fire during colder periods, such as deep winter, and Condensing Boilers will fire during other times. Hybrid systems allow for lower capital costs by not relying solely on expensive Condensing Boilers, yet provide fuel savings during the shoulder seasons, while keeping occupants comfortable during the colder periods.

Summary

Condensing Boilers can be a very efficient alternative when used in the right situations – but their misapplication occurs way too frequently in the commercial boiler industry. When incorrectly applied, they offer no better performance than Conventional Boilers, yet can be substantially more expensive to purchase and maintain resulting in the inefficient utilization of capital resources.