KN SERIES

Turndown and the KN Boiler

You have to be careful about getting your head turned by turndown.

While turndown is important, the amount of turndown has to be balanced against reliability and combustion quality.

The KN-Series with a 5:1 turndown, condensing capability, and patented low loss ignition will approach the lowest energy consumption possible over a heating season in any given application. It is unlikely that any product will consume meaningfully less energy then the KN product. It will achieve this with high reliability and low maintenance.

When natural gas is burned approximately 10% of the energy in the fuel goes into producing water vapor. The 10% that is water vapor is what is available to be condensed.

Looking at Figure 1, in conditions where condensing does not take place (above approximately 120° return water temperature) and above a turn down of approximately 2.5:1 there is very little efficiency difference, since the maximum efficiency possible in non-condensing conditions is 90%.

With decreasing return water temperatures and increasing turndown, an increasing portion of the 10% that is available is recovered. However the % recovered between 5:1 turndown and greater turndown values is insignificant (since at 5:1 the KN-Series is 99% efficient, there is only 1% left).

Figure 1 is based on actual laboratory test data. It assumes constant combustion quality. The question is what is the likelihood of this actually occurring in a real installation?

To maintain a constant combustion quality it is necessary that the fuel and air ratio remained constant. Gas pressure regulation devices operate by controlling the pressure drop through a control orifice. The pressure drop varies as the square of the turndown. Thus at 5:1 turndown the pressure drop would be 1/25 (4%) of that at 1:1 turndown. 4% accuracy is readily achievable with available gas regulators. At a turndown of 20:1, the pressure drop would be 1/400 (0.25%). The regulator accuracies would need the better then 0.25%

The commercial components used in our industry do not exhibit this accuracy.

The same analysis is true for those components delivering air to the combustion process. The consequence is that it becomes increasingly difficult to maintain combustion quality with increasing turndown. *The result is highly variable combustion quality with the potential for bad emissions and carbon development*. The end result is high maintenance.

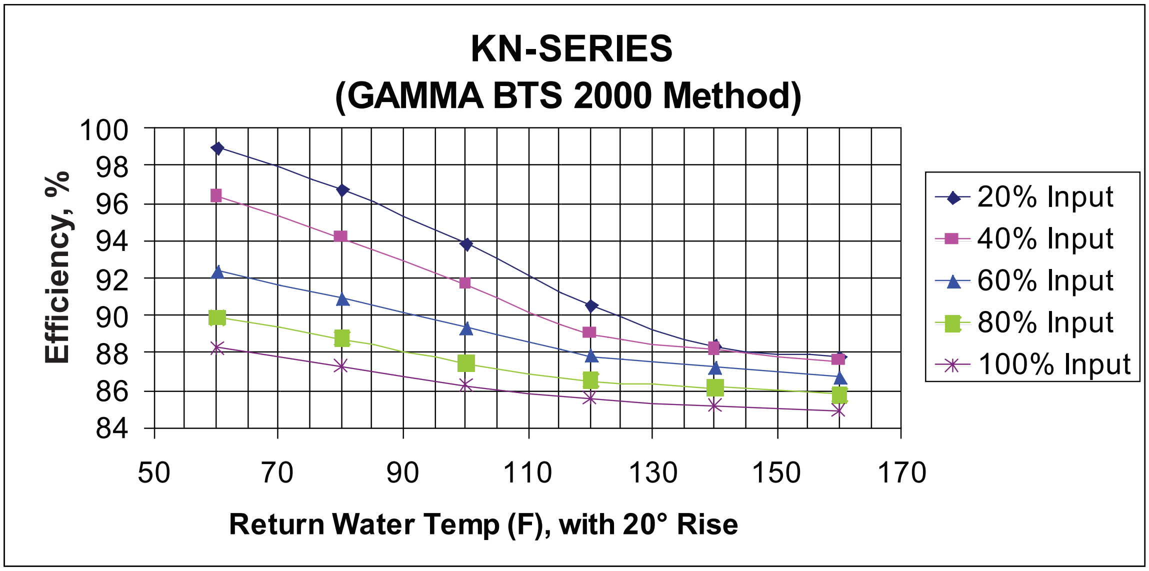


Figure 1

The KN Boiler limits the turndown to keep the pressure drop thru the gas regulator well within its ability to provide precise gas flow. *Also, the KN is Air/Fuel coupled entirely thru its turndown range*. Any variation in weight flow of air through the boiler causes the gas flow to respond in a manner that correctly maintains the Air/Fuel ratio. Thus, the typical variations in air flow due to wind and air temperature have small effect on combustion quality. Even major changes such as blocked flue or air inlet pressure changes will not affect combustion.
The result is high reliability and low maintenance.

It is interesting to note, that the manufacturer that claims high turndown uses a constant speed air blower. With increasing turndown the blower approaches shut off conditions. If we consider power consumption as a component of thermal efficiency (a fair assumption, since it is a “consumable” energy the same as gas), then when compared against the KN Product the efficiency difference in condensing becomes even smaller as indicated in Figure 2.

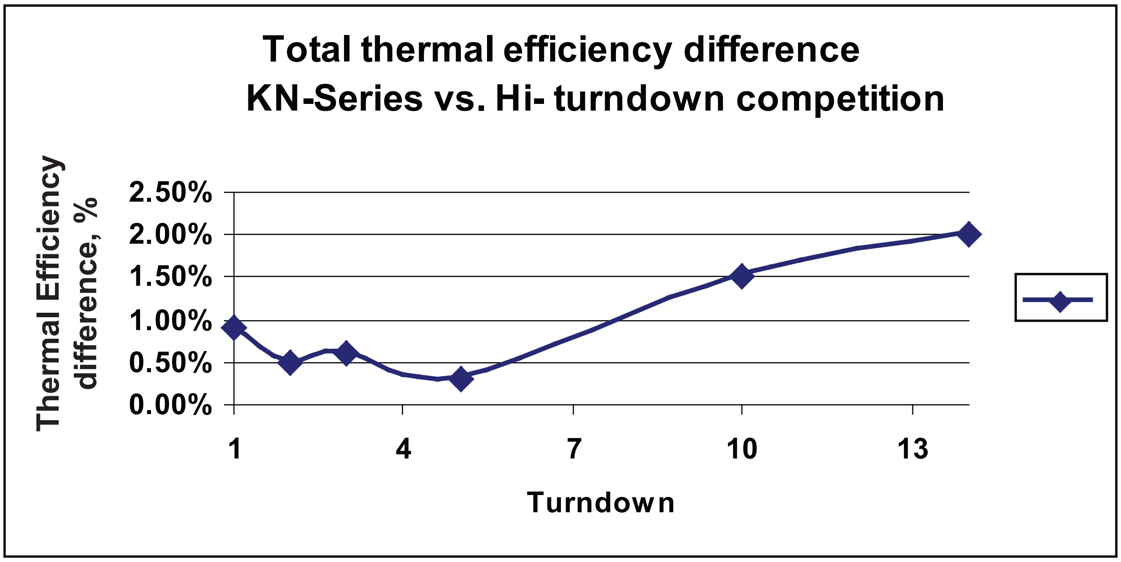


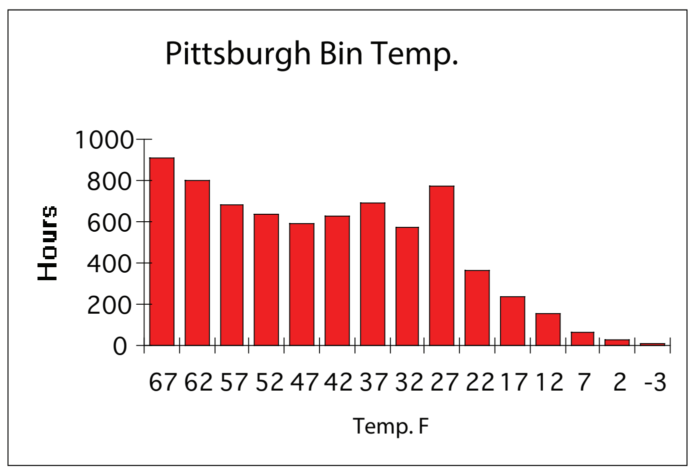
Figure 2

The other advantage to turndown is the reduction of cycling at reduced loads.

The implicit concern is the associated cost of cycling in terms of component wear, and fuel cost. This, in general, is a fair concern. However, for the KN-Series, these issues are minimal.

The KN's patented noiseless ignition system exhibits extremely low ignition losses. Thus, the only losses associated with boiler cycling are the pre and post purge losses. With a small combustion volume, the purge times are very short (25 seconds total).

To determine the seasonal cycles, a conservative analysis was done of a KN boiler with 4:1 turndown in a typical system using Pittsburgh Pennsylvania bin temperature data to determine load profile. (Pittsburgh's bin temperature data, representing an average for the USA, is used by the D. O. E. in their AFUE analysis).



Based on a single KN Boiler, the results are summarized below:

Total. cycles	5649
% of on-off boiler	15.6%
cycle losses, BTU	847,275
cycle losses, % of total BTU	0.04%
$/MBTUH of natural. gas	$15.00
season cost of cycling	**$12.71**

Clearly, this BTU loss is in the “noise”. It is fair to say that there is effectively no cost associated with this number of seasonal cycles for a KN boiler.

The average MTBF (Mean Time between Failures) is minimally 100,000 cycles. This value is required by all components approved by CSA and UL.

Consequently, for the single boiler system discussed above, a component failure could be expected every ~ 17 years. Thus, component failure due to cycling is not a major concern.

Feature Comparison

	KN	**Hi turndown Competitor A**
Turndown	5:1	20:1
Air/Fuel Coupled	Yes	No
Minimum Supply Pressure, in-h2o	2	7
Condensing	yes	yes
Hi Efficiency	yes	yes
Major moving components	2	3
Low noise	Yes	No
Proven Pilot	Yes	No
Fits Thru Doorway	Yes	Yes
NOx <9 PPM	Yes	?
Standby Losses	Low	?

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