BY BILL ROOT

High-Performance Hydronics

A once slow-to-change industry is bursting with innovation

Market forces, chiefly the push for higher and higher energy efficiencies—and demand for equipment to go where no equipment has easily gone before—are driving the pace for new and innovative hydronic solutions. As a result, our once-lethargic, slow-moving industry has seen a burst of innovation that is unparalleled in the hydronics industry.

Improved efficiency and reduced emissions are not the only measures of "high-performance" in boiler systems. Maintenance convenience and accessibility are also important considerations.

The newest generation of hydronic equipment—such as condensing technology that purposefully extracts heat from condensate within the system—has pushed combustion efficiency into the 95-to-99-percent range. Add new and sophisticated controls to the picture and system integration with building automation systems, and you begin to see how quickly this market is moving.

High-performance defined

System features that were once a luxury, if not simply non-existent, are now common in many boilers and accessories offered today. Here's a checklist to summarize "high-performance" system design and function:

- ❏ System efficiency.
- ❏ PID logic system.
- ❏ Modulation or stage firing.
- ❏ Thermal efficiency.
- ❏ Outdoor air temperature reset.
- ❏ NOx emissions.
- ❏ Venting: sealed combustion vs. atmospheric (Cat. I, II, III, IV).
- ❏ Accepts commands directly from BAS.
- ❏ Sends information directly back to BAS.
- ❏ Small footprint size with heating systems that can be racked to increase density of Btus per square foot.
- ❏ Filtered combustion air.
- ❏ Wiring/water and gas connections that can feed from both sides of the boiler.
- ❏ Venting options: sidewall, vertical, and indoor/outdoor options.

With greatly improved efficiencies and features such as these, building owners are starting to pay attention. When the design engineer can calculate a 3-to-4 year payback for new equipment, there's real incentive to install new technology.

There is also a much higher interest in large radiant heat and snow-melt systems, a real revival for what just a decade or so ago seemed to be a dying, replacement-only industry. This is a win for the boiler guys.

Elevating the performance of hydronic heating and volume water heating has occurred as a result of these six key trends in market.

1. System efficiency. How effectively the boiler relates to the total system is determined by its capacity to deliver heat either quickly, or slowly, depending chiefly on the needs of the system and the ability of the boiler to adjust to changes in the system's demand for heat. The common term is to "size to the load." Also, total system performance is greatly enhanced when equipment works at peak perform-

ance—with fuel consumption happening at the highest levels of combustion efficiency—at all levels of heat demand.

Another important factor is PID (proportional-integral-derivative) controls that sample changes over time and "learn" the responses of the system to changes in conditions such as heating load, outdoor air temperatures, and firing stages of the boiler(s).

And, of course, there's modulation or staged firing vs. on-off. The industry has made tremendous strides in this area during the past couple of years. Modulating and staged-fired boilers reduce fuel consumption by "sizing to the load" so that the amount of heat produced by the system matches the need.

There is also the ability to respond to outdoor temperatures, water storage temperatures, and system loop temperatures. This responsiveness is a very important contributor to overall system performance.

Condensing boiler technology is one of the key factors for the dramatic increase we see in boiler/water-heater system efficiency. Condensing boilers are built to encourage the formation of condensate within the system and to withstand the corrosive nature of the liquids that form there. Latent heat is extracted from the moisture that forms in either the primary or secondary heat exchanger, dramatically enhancing combustion efficiency.

But efficiency is only one of the advantages of installing these systems. Application of the boiler can play an even more important role. Condensing boilers have both a tough resistance to thermal shock and the ability to accept low return water temperatures, which opens up many new possibilities for hi-volume, cold-start systems. One example is a commercial snow melt system.

Modulation goes hand-in-hand with the ability to operate in a condensing mode. When boilers can operate with low return water temperatures, and lowered firing rates, the relationship of heat-transfer-surface to fuel-consumed, and the combustion efficiency itself, combine to deliver better efficiencies. When multiple boilers are installed, each one handles only a portion of the heating load, which drives system efficiency even higher. Some systems that require higher operating temperatures most of the time may still benefit from a "lead boiler," which is the condensing boiler, while the remaining boilers that provide the bulk of the heat are non-condensing.

2. Combustion efficiency & thermal efficiency. Just a few years

ago, many of us in the industry considered combustion efficiency and thermal efficiency to be the most important factors in determining overall system performance. That is not the case today. Transferring heat from a boiler into a total system —and in just the right amount and at just the right time—is a truer measure of high performance.

If a high-performance system is the goal, it only makes sense to start with a high performance "engine." Manufacturers today put a lot of engineering effort into maximizing heat transfer to water, and that efficiency is a critical aspect of a boiler's performance. The only thing to keep in mind is that many applications do not call for the highest levels of combustion efficiency (condensing equipment) because the water temperatures are too high.

3. Green boilers are another facet to the high performance equation. Today, when this topic is discussed at industry round tables, we look at emissions—NOx, CO, CO_2 —with the the goal of lowering the levels of the pollutants that endanger our atmosphere and indoor air quality. State and federal mandates will only increase the demand for cleaner systems in the years to come.

4. Information exchange. How well does the boiler act as part of a system in terms of both accepting and responding to external sources of information? These functions play an important role in the exchange of information to and from the system, such as the:

- Ability to accept communication signals from BAS (BACnet, LonWorks, Metasys, and Echelon).
- Ability to report information back to the BAS.
- Collection of data that provides management information about operating statistics and efficiency, such as inlet and outlet temperatures, run time, percent load, domestic tank temperatures, system loop temperatures, etc.
- User interfaces: How well, and how easily can the user change operational settings? How easy is it to learn the boiler's command system? Is it intuitive and customer-friendly? Consider the function and usability of the keypads, displays, and convenience of access: will the installing or service contractor or plant maintenance supervisor find themselves standing in front of boiler at eye level, or on their knees with a flashlight, to see what the temperature is inside the unit?

5. Installation & Serviceability. Ask a field technician or building maintenance supervisor to define "high performance" and they will quickly refer to the frustrating lack of access common to many boilers.

These factors contribute to ease

of boiler installation and service:

• Cabinet access. Can one easily reach and replace key components? Seeing all of the boiler's components is very important, but physically getting them out of, and back into the boiler without standing on your head or skinning your knuckles is often an entirely different proposition. Service-friendly boilers make happy customers.

• Field wiring connections. Wiring-in thermostats, field interlocks, accessory equipment and BAS control wires should be easy and require little additional time.

• Optional water piping, gas and electrical connections. Can you connect water, gas and electricity to different sides of the boiler, if necessary? Gas, water, or electric connections always seem to be on the wrong side.

• Filters. Combustion air should be filtered to prevent debris from getting trapped in fans and burners, and the filter should be washable and reusable.

• Installation. Indoors or outdoors? Many systems require that boilers be placed on a roof or outdoors on an equipment pad to preserve costly interior floor space. And, in many retrofit and fuel conversion projects, adequate boiler room space simply is not provided. This may force the remote location of key heating system components—pushing them outside the building envelope. Of course, venting options are part of the location decision. A high-performance boiler should allow for side-wall and vertical venting and outdoor installation.

6. Plant area floor space requirements. Placing a boiler on a roof or outside on a pad is becoming more common because of the need to preserve interior space for income-generating purposes. Gone are the days when mechanical room space was provided generously. Mechanical equipment must stand up to the scrutiny of space-savers.

Many of today's boilers make efficient use of valuable floor-space. Consider these characteristics:

• Cabinet volume and footprint.

• Required clearances to combustibles.

• Required clearances for service (top, sides, front, rear).

• Racking or multiple boilers—essentially, this translates into how densely Btus can be packed into a given amount of space.

About the author

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