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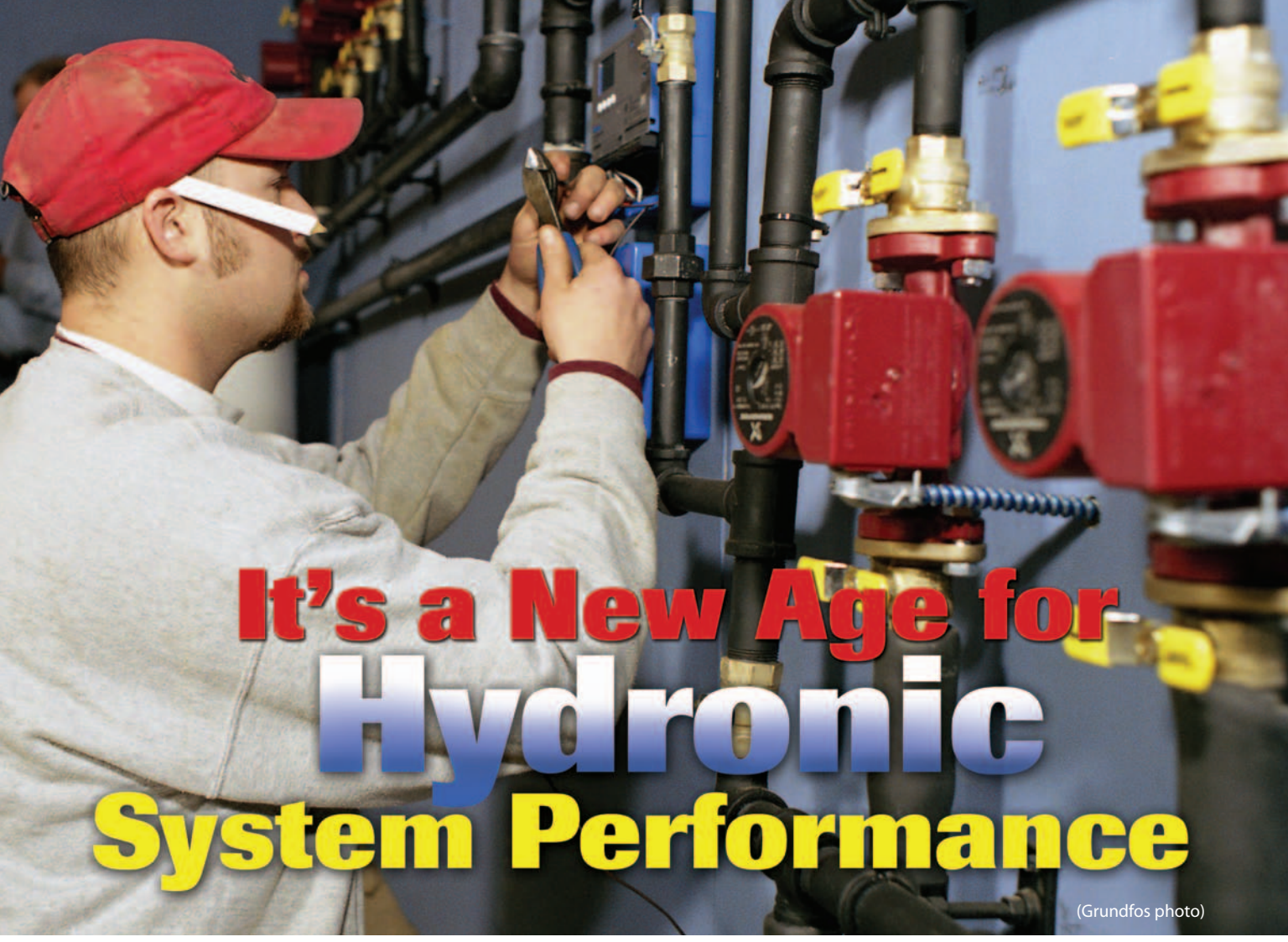


It's a New Age for Hydronic System Performance

(Grundfos photo)

An industry emerges, from bust to robust.

By John Vastyan

If you'd dial your transporter beam back to, say, 1991, and aim your arrival for the hydronics industry, you'd quickly find a sad and forlorn marketplace. Just 15 years ago, manufacturers were barely treading water, cranking out replacement boilers at a slower pace each year. The burgeoning new construction market wouldn't have anything to do with hydronics. It was a pretty dismal scene.

Today, the hydronics industry has emerged with an extreme makeover—moving at warp speed with confidence and clear direction. New equipment and market conditions have driven manufacturers to new levels of engineering excellence.

Without question, 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.

The newest generation of equipment—such as condensing technology that extracts heat from condensate within the system—has pushed combustion efficiency into the 95% to 99% range. That's *smart* use of energy. Add new and sophisticated commercial controls to the picture, as well as system integration with building automation systems, and you begin to see how quickly this market is moving.

With performance like that, building owners are now at attention. When the design engineer can calculate a three- to four-year payback for new equipment (or perhaps even shorter than that in some instances), there's real incentive to install new technology.

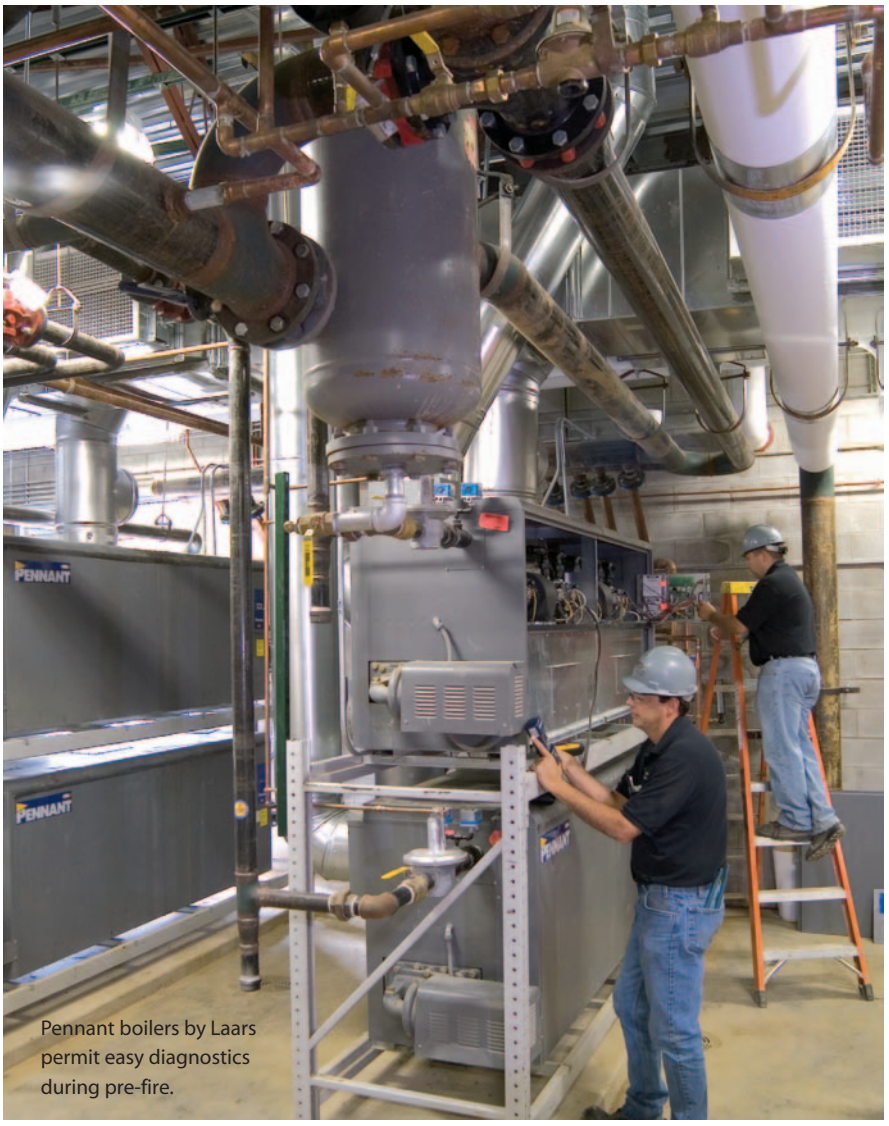
To help explain this phenomenon, we've tapped the experience and expertise of several industry experts, including:

- Bill Root, vice president of sales and marketing, Laars Heating Systems Co.
- Mike Chiles, president and general manager, Watts Radiant.
- Tony Radcliff, building services product segment manager, Grundfos Pumps Corp.
- Tim Rosen, P.E., Concept Mechanical.
- Mark Olson, CEO and general manager, Caleffi Hydronic Solutions.
- Joan Mishou, manager of applications engineering, Laars Heating Systems Co.

You'll learn that high-performance hydronic heating and volume water heating depend on the interrelationship of the following six key facets of the boiler system.

1. System Efficiency

How effectively the boiler relates to



Pennant boilers by Laars permit easy diagnostics during pre-fire.

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 the equipment works at peak performance—with fuel consumption happening at the highest levels of combustion efficiency—at all levels of heat demand.

According to Joan Mishou of Laars, another important factor is the use of more sophisticated 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 there's modulation or staged firing vs. on-off," said Mishou. "Modulating and staged fired boilers reduce fuel consumption by 'sizing to the load,' so that the amount of heat produced by the system precisely matches the need."

Piping and pumping are also key factors in building an efficient system. The most efficient boiler in the world can't make an entire system efficient if the system is not piped and pumped correctly.

And, there's response to outdoor temperatures, water storage temperatures, and system loop temperatures. These, too, are very important contributors to overall system performance. Control systems should take these key variables into consideration.

"Condensing boiler technology is one of the key factors for the dramatic increase we see in boiler/water heater system efficiency," added Bill Root, also of Laars. "Our condensing commercial boilers, such as the Rheos+, 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," he said.

But efficiency is only one of the advantages of installing these systems. Application of the boiler can play an even more important role. "Their resistance to thermal shock and the ability to accept low return water temperatures puts condensing systems in a category of their own, ideally suited for high-volume, cold-start systems," he said.

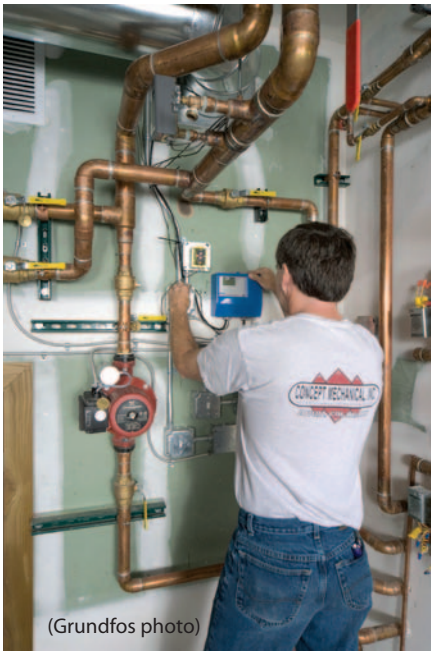
Modulation goes hand-in-hand with the ability to operate in a condensing mode. When boilers can operate with low return water temperatures and lowered firing rates, the relationship of heat transfer surface to fuel consumed, and the combustion efficiency itself, combine to deliver maximum efficiency. And, when multiple boilers are installed, each one handles only a portion of the heating load; that drives system efficiency even higher.

"Some systems that require higher operating temperatures most of the time may still benefit from a 'lead boiler' that's a condensing boiler," continued Mishou, "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's not the case today.

According to Root, transferring heat from a boiler into a total system—and


(Grundfos photo)

in just the right amount and at just the right time—is a truer measure of system performance.

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. Designing systems with staged firing, modulation, and/or multiple boilers can often produce higher system efficiency than trying to use a single condensing boiler that claims higher combustion efficiency.

"Green" Boilers

"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 real desire see lower levels of pollutants that endanger our atmosphere and indoor air quality," said Mishou. "California's South Coast Air Quality Management District (SCAQMD), the states of Nevada and Texas, and selected projects in almost every other state have set limits for emissions, especially NOx. And, being able to take 100% of the air for combustion from outside the building is also required in many installations."

3. 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? "Information exchange," if we really put it to the test, refers to the boiler's ability to both receive external information—such as outdoor air temperature, new instructions from a BAS, and system zone information—and to send information back to the BAS—such as inlet and outlet water temperatures, operating cycles, fuel consumed, pump operation, etc.

According to Root, 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, LON, Metasys, Echelon);

• Ability to report information back to the BAS;

• Collection of data that provide management information about operating statistics and efficiency, such as inlet and outlet temperatures, run time, percent load, domestic tank temperatures, system loop temperatures, etc.; and

• User interfaces—how well, and how easily the user can change operational settings, is important. Consider how easy is it to learn the boiler's command system. This also includes function and usability of keypads, displays, and convenience of access.

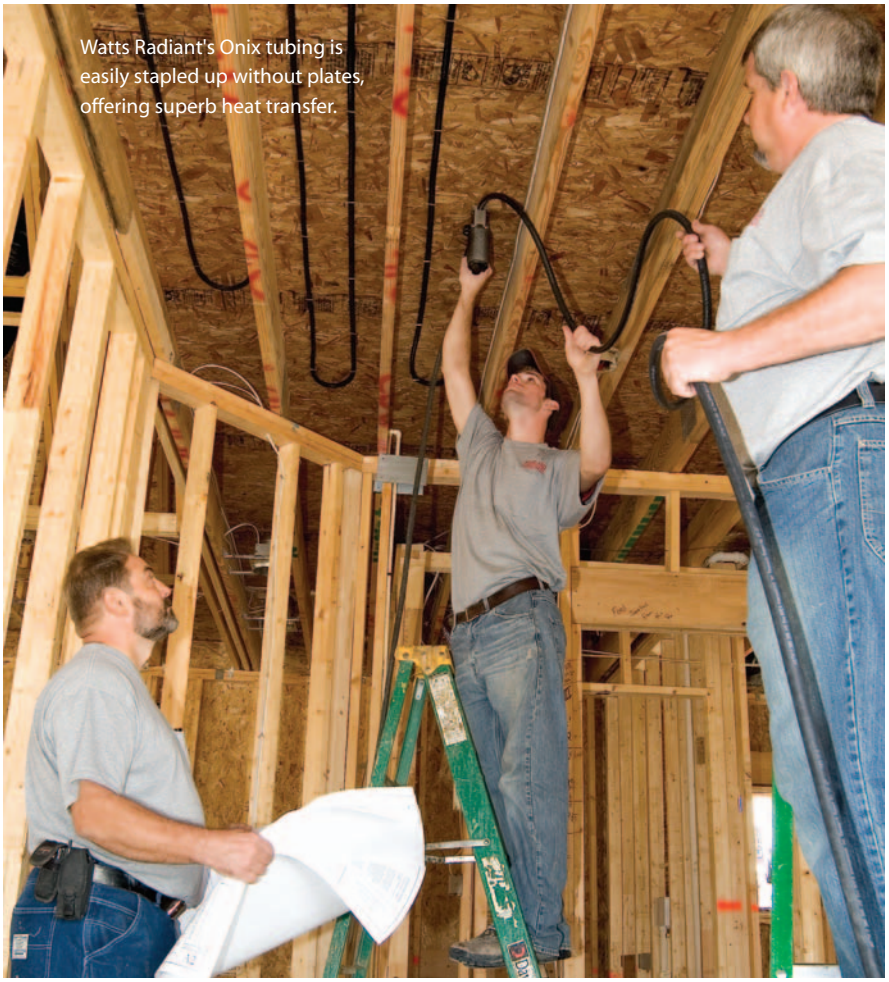
4. Installation and Serviceability

High on a field technician's or building maintenance supervisor's wish list will be:

• Easy access to all components;

• Easily accomplished field wiring of

Installer Hot Rod Rohr prepares several three-speed circulators for connection to a Caleffi HydroLink low-loss hydronic header. (Grundfos photo)



Watts Radiant's Onix tubing is easily stapled up without plates, offering superb heat transfer.

thermostats, field interlocks, accessory equipment and BAS control;

• Convenient access to water, gas and electric at different sides of the boiler;

• Combustion air that's filtered, with filters that can be washed and reused; and

• Options that include sidewall and vertical venting, as well as a boiler's installation outdoors.

5. Multi-Speed Circulation

One of the most important facets to optimal circulation for hydronic systems is for design engineers and installing contractors to match a pump's performance or flow characteristics to the specific job that it needs to perform within the system.

According to Radcliff, a single-speed pump has one performance curve. But new multi-speed circulators, such as Grundfos' SuperBrute, and the larger VersaFlo, offer a much broader range of performance. With the flick of a switch, various speeds can be chosen, easily changing head and flow to meet the specific needs of the system.

"We've standardized on multi-speed circulators because we feel they do the best job," said Tim Rosen, P.E., a partner in the plumbing and mechanical contracting firm, Concept Mechanical. "Three-speed circulators give us greater control and versatility."

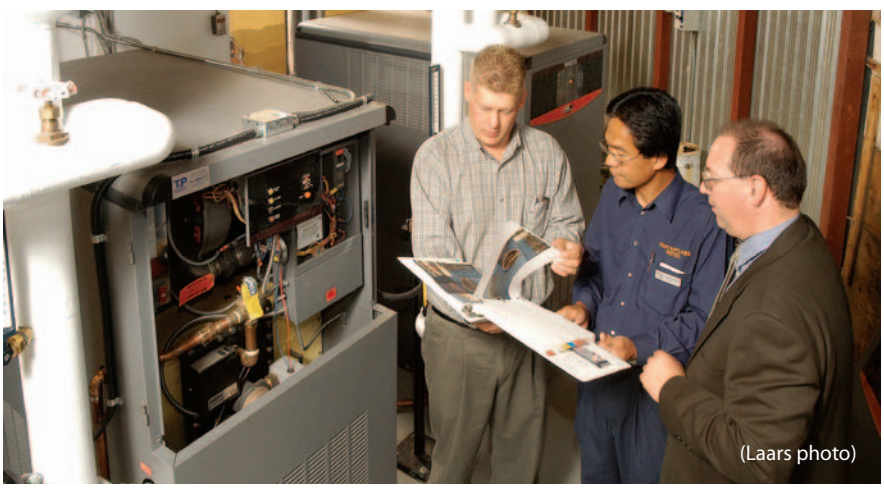
Rosen said that he always does the math, calculating heat loss, flow rate, and pressure drop for each pump.

"I use this information and the stated pump curve to select the proper pump for each load," he continued. "In the past, we might have three or four different pump models on one job, all selected to match the exact needs that we've determined. With multi-speed pumps, I can use one pump and select the speed to match the flow and head that we want. And, the use of multi-speed pumps allows for future expansions, changes and retrofits in stride."

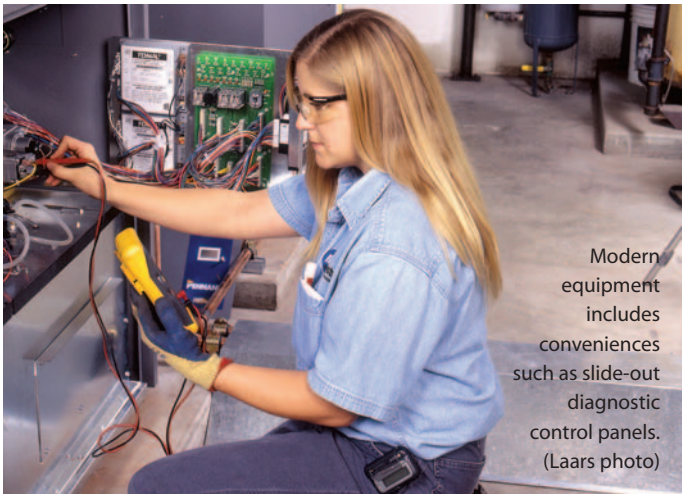
Enhanced Piping Solutions

Another advanced device combines a hydronic separator and distribution manifold. Called the HydroLink, from Caleffi, the unit is attached to hydronic heating or air conditioning systems to permit different heat adjustments for multiple zones when there is only one boiler or chiller.

Its configurations are compact and can easily be designed into any type of hydronic circuit. According to Mark Olson of Caleffi, the key operating principle is that when a single system contains a primary generating circuit with its own circulator and a secondary circuit with one or more distribution pumps, conditions may permit interaction between the circulators,



(Laars photo)



Modern equipment includes conveniences such as slide-out diagnostic control panels. (Laars photo)

creating unwanted flow rate and pressure abnormalities.

The device provides a low-pressure loss zone, enabling both primary and secondary circuits to be hydraulically independent of one another. Yet the unit combines both a low loss header and a distribution manifold. A low loss header is critical for high-flow-resistant low-mass boiler installations because it moves the point of lowest pressure drop from the boiler to the unit's low-pressure chamber. The distribution manifold has closely spaced tees that connect the secondary circuit to the primary loop internally, so that flow in the primary loop has very little tendency to induce flow in the secondary circuit.

"Because the unit's openings are so close together, there is almost no pressure difference between them, thus the pressure differential across the internal headers is close to zero," added Olson. "The pressure increase created by a given zone circulator is almost entirely depleted by the time the flow returns back to the distribution manifold. This arrangement prevents interference between the boiler circulator and whatever zone circulators are operating."

6. Heat Distribution

The hydronic industry's renaissance is, in part, due to the reemergence of the radiant heat industry. In the commercial sector, large radiant heat systems place unique demands on a boiler, or series of boilers. According to Mike Chiles of Watts Radiant, these systems were historically characterized by cold starts with long boiler run times, high water volume, high mass, cooler required supply water temperatures, and short boiler cycle-times when the mass is at temperature.

Of course, large radiant systems require a boiler or boilers with high output. A key advantage is that when the thermal mass of a floor or heated surface has reached temperature, shorter and less frequent boiler cycle-times are required. Better yet, a boiler system with modulation permits the heating, and later, heat-maintenance of the heated surface. Either a fully modulating burner, or the lead-lag staging of boilers, would allow a system to meet ever-changing load requirements for optimal system efficiency. Another option is to add mass to the piping system to increase boiler run times during periods of low demand. For this, water tanks can easily add mass to a piping system.

"Snowmelting systems pose a different challenge: high demand and high mass with extremely cold water/glycol temperatures," added Chiles. "Here, the challenge is not short-cycling of the boiler. Thermal shock happens when freezing return-water temperatures come crashing into the heat exchanger in a long, hard, cold start."

Fortunately, the new generation of condensing boilers takes this brutal jab in stride. Many modern boilers aren't susceptible to thermal shock, due to the materials of their waterways and heat exchangers. Others can be easily protected from thermal shock with the use of a boiler bypass, which can be built to operate automatically with the addition of a control system, or they can be manual, fixed temperature systems.

Quite a difference in just 15 years. We now have smart technology that's getting smarter, inspired professionals responding to market needs, and customers who see the value of contemporary hydronic solutions. Anyone for a spin in the transporter to the year 2021? PME

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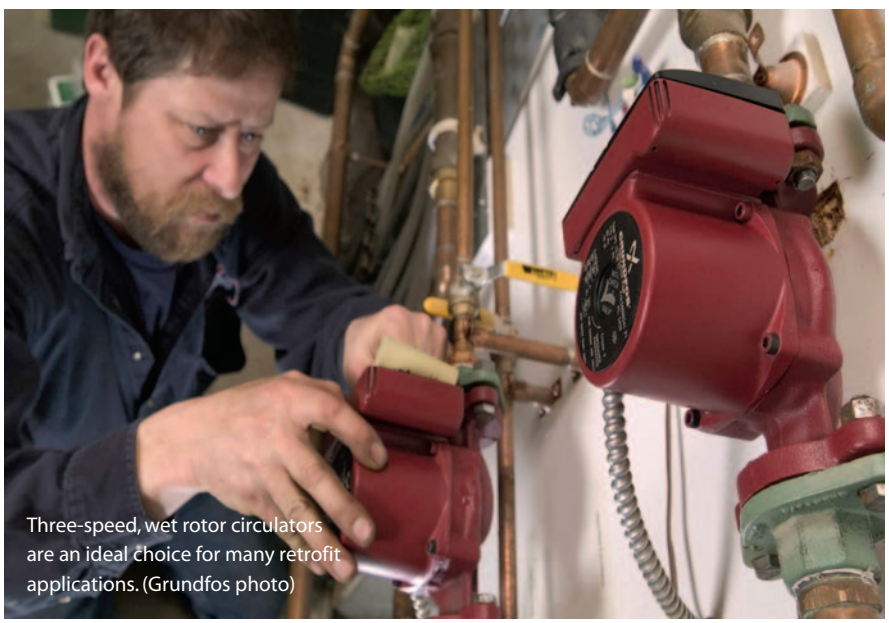

Three-speed, wet rotor circulators are an ideal choice for many retrofit applications. (Grundfos photo)