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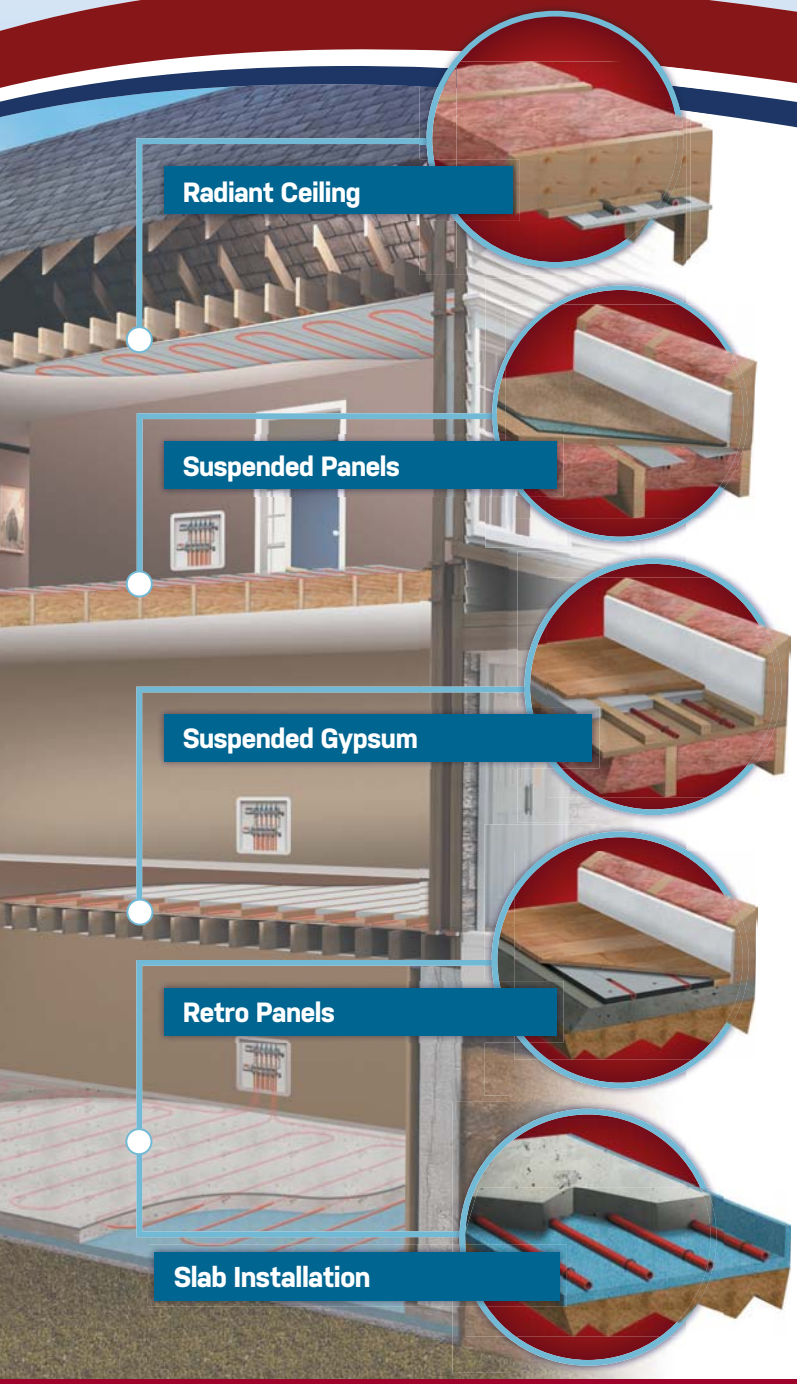

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CONTENTS

On the cover:
Colorado residence features an electric heat source for its hydronic radiant system.

Exceeding expectations with hydronics

BY MARK CHAFFEE, CHAIRMAN, RADIANT PROFESSIONALS ALLIANCE

Hydronics stands at the intersection of efficiency and innovation. For many industry stalwarts, that may seem like a street that has long been bypassed by the new highway paved with VRF and refrigerant-based heating and cooling systems. But I say that means you're driving on the wrong road into the future. The future is bright for hydronics and the world will be more comfortable and use fewer resources because of it.

Technology has moved this industry forward over the past decade into places where hydronics — water-based heating and cooling — is driving the designs of the most innovative new buildings. Today's designers and owners are pushing the envelope of green building, stretching for LEED gold and platinum status, and incorporating renewable resources, all while maintaining the highest of comfort levels.

When it comes to comfort, Community Medical's 30,000-sq.ft. cancer care facility in Missoula, Montana, is a fine example of how patients receive comfort with treatment. The building sits a mere 40 feet above the Missoula Aquifer. With the water consistently around 50° F, the oncology center uses a groundwater cooling system to tap the aquifer. Water is drawn from the ground, pumped through a large plate-and-frame heat exchanger, and injected back into the aquifer.

While the groundwater system is a unique and very efficient way of cooling the building, the heating side includes its own uncommon elements. 1.5M BTU of state-of-the-art condensing boilers feed a 300 MBH brazed-plate heat exchanger, which pulls heat from the building's 180° F, 6-in. primary heating loop to supply 120° F water to radiant panels. Also fed off the heat exchanger is 2,400 sq.ft. of radiant sidewalk outside the main doors, adding patient comfort, safety, and convenience.

In the common areas, offices, and supplemental heat to infusion rooms, high-temperature water is pumped to the rooftop air handler and multiple VAV boxes throughout the building. Besides earning a $43,000 rebate from the local utility, the managers there calculated that the system also provides an energy savings of around 150,000 kWh per year when compared to a traditional system.

Exceeding expectations is the hallmark of hydronic systems, but now doing that efficiently, cost-effectively, and pushing the boundaries of innovation can be standard. What better place to install cutting-edge technology than one of the world's most advanced military technology centers at Joint Base Elmendorf Richardson (JBER) near Anchorage, Alaska?

Though only 8,000 sq.ft. in size, the Emergency Operations Center (EOC) has computers and work stations for more than 100 officers. The facility serves central command and control operations for strategic preparedness and management in an emergency.

With all of the high-tech equipment inside the building, the facility requires substantial cooling when under load, even during an Alaskan winter. Although there were many options, hydronic chilled beam technology was ultimately selected to heat and cool the EOC.

Because the active chilled beams chosen for installation (capable of 400 BTUs per sq.ft.) at the EOC are ceiling-mounted and do not require the use of drain pans, chilled water supply temperatures must be above the ambient dew point. As a result, dehumidification, or latent cooling, is usually handled by a separate, dedicated outdoor system (DOAS) supplying dry, conditioned air to the space.

Until recently the challenge has been that pump energy demand doubles when compared to a VAV system. But with advances in packaged pumping systems with variable speed injection circulators on the chiller side of the mixing block and a constant-speed zone circulator on the beam side, the electrical energy demand compared to an all-air system has been reduced by up to 40%. The injection mixing alone accomplishes heat transfer with only one-third of the energy needed by chilled beam systems without injection mixing, while eliminating the need for a separate chiller or air-conditioning system to handle the latent load.

Now that's high-tech control, comfort, and innovation. It's what hydronics can deliver, and the Radiant Professionals Alliance helps advocate for education on, and support of, such systems. Play a role in the design process for the next generation of systems by being part of the RPA.

The **RPA** is NETWORKING

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"Most of what I know about hydronic radiant heating I learned from my brothers and sisters in the RPA. Whenever I've had a question about a system I'd never seen, or a new product just on the market, I would call or email my network of friends. They have always raised me up. I can't put a price on that sort of braintrust. They have made me a much better writer."

Dan Holohan | Founder of HeatingHelp.com

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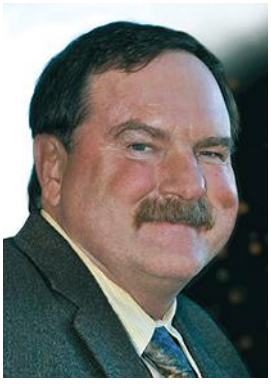


Hydronics and technology go hand in hand

BY MARK EATHERTON
EXECUTIVE DIRECTOR, RADIANT PROFESSIONALS ALLIANCE

When I first became involved in the hydronic heating business, many years ago, we were dealing with conventional "bang-bang" thermostats, standing millivolt pilots, and three-piece oil-lubricated (complete with oil slicks) circulators. And at that time, I was overwhelmed by the general efficiency of these systems. I should say enamored, not overwhelmed. And today, I am still enamored, and at times overwhelmed. This is not your grandpa's hydronic heating system.

The common modulating condensing boilers have more computerized controls on them than the spaceships that went up to, orbited, and landed on the moon. That, in and of itself, is simply amazing. Heck, I suspect there is more computing power in our wall-hung thermostats than there was on the Apollo missions.

The common modulating condensing boilers have more computerized controls on them than the spaceships that went up to, orbited, and landed on the moon.

Today, we have thermostats that watch our every move, record when we wake, when we go to sleep, how fast our homes lose heat, how fast they can recover, and how many loads of laundry and dishes we are doing. Seriously, do yourself a favor and read up on the Internet of Things (IoT). It's bigger than the Internet proper, and it's a part of our daily lives.

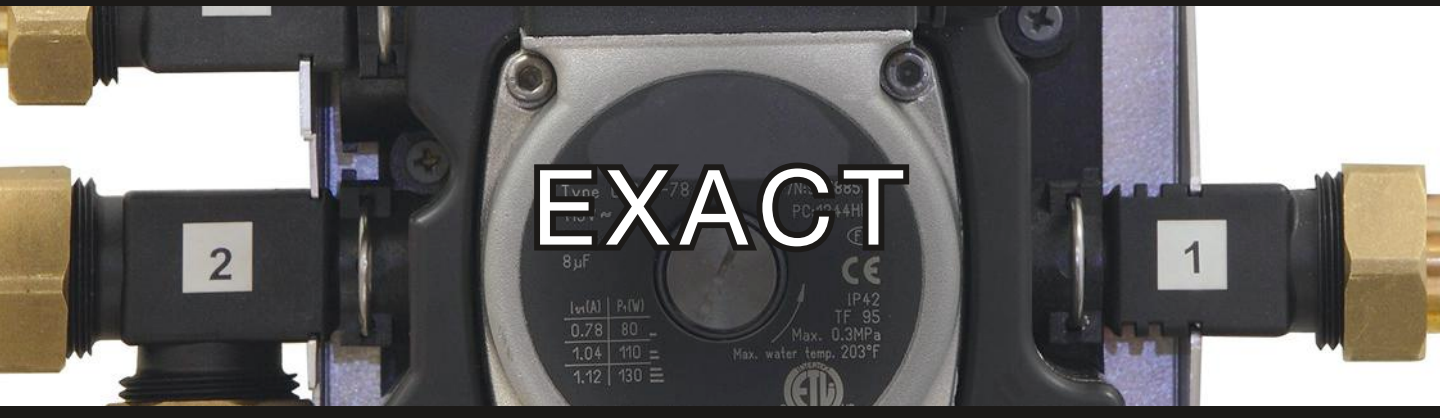
Our thermostats speak a special language, but our boilers and pumps speak a completely different, but similar language over the same Internet. Boilers have the ability to recognize a problem and warn the contractor and/or homeowner before it becomes a serious issue. Imagine calling your customer to let them know that their boiler sent you an email this weekend and that it needs to see you — can't do that with a millivolt-powered boiler!

And circulators are nothing short of amazing. Let's face it, we as hydronic designers design our systems to operate at peak efficiency for that 2% of the time that the dwelling is being exposed to worst-case scenarios. Outside of that 2% realm, we are technically driving thumbtacks with sledgehammers. It gets the job done fairly quickly, but it isn't a real efficient use of energy. WHAM. Watch your fingers! These days, circulators are intelligent enough to realize, without the benefit of an end switch, whether or not zone valves are open or closed. If opened, they have the ability to "watch" the temperature differential across the system and determine whether or not the current pumping power is adequate, inadequate, or functioning at all. And they can make adjustments to ensure that comfort delivery and efficiency at peak performance are being maintained.

I mentioned earlier that thermostats know how many loads of clothes and dishes you are doing. Do you really think that Google had a vested interest in keeping people comfortable? I don't. I think you don't pay billions of dollars for that opportunity. I think you pay that kind of money for the opportunity to retrieve information about people's life styles and living habits. Heck, they are even looking at the possibility of giving the local utility the opportunity to interface with their systems to control peak electrical demand during cooling periods. This is the Internet of Things. The thermostat is just a gateway. It's in constant communication with all of the other appliances in your home that are wirelessly connected to each other.

The times, they are forever changing, and if you'd like to learn more about the hydronics technology of today, join the Radiant Professionals Alliance – and let us show you what we've learned over the past 25 years.

ZONE VALVES



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THE GLOBAL LEADER IN PLUMBING, HEATING AND PIPE JOINING SYSTEMS

Showcasing contractors' creativity

BY ROBERT P. MADER
EDITORIAL DIRECTOR

This issue of *Radiant Living* is different. We're looking at heating technology in some offbeat ways, compared with the standard boiler-piping-radiant panel type of system. This issue showcases how creative hydronic heating contractors can be.

For example, let's go to south-central Colorado where Lance Harvey runs Flow Right Plumbing, Heating and Irrigation. Flow Right has a good reputation for being able to install complicated hydronic systems, but one of their latest had a twist — it was all-electric, but not in a conventional manner.

"Designing a hydronic radiant system for premium comfort and efficiency isn't hard when your heat source is propane, gas, or oil," says Mike Merryman, hydronic division manager at Flow Right. "It's a bit trickier to meet both those requirements with an electric heat source. We needed to carefully consider each component, and the way we were installing all of them."

This issue...is different. We're looking at heating technology in some offbeat ways.

The 10,000-sq.ft. home was tight — concrete, foam insulation, and high-end windows — and there was plenty of thermal mass to work with, even with the PEX on 9-in. centers. Instead of using standard electric boilers, they opted for two large off-peak, electric thermal storage units, which "charge" overnight when the local San Isabel Electric Association offers an off-peak discount.

"Putting the electric units in was a unique experience," says Luke Drummond, Flow Right technician. "First you set the super-insulated shell, then you stack it full of ceramic bricks."

Electric elements charge the bricks in the middle of the night to 1,250° F. A fan in the bottom of the units blows the hot air through and air-to-water heat exchanger. ECM circulators pump the heated water through the distribution system. The main system pump feeds nine zones. The distribution system includes a large set of manifolds, with each zone actuated by a 3/4-in. zone valve. This manifold feeds remote, 1/2-in. injection manifolds throughout the home.

For our next story, we head up north to Beaver, Alaska, a small, Native American village of 80 people along the Yukon River that's accessible only by plane or boat. The residents were spending a fortune on diesel, so Michael Hirt, the owner of Alaska BTU in Fairbanks, figured out a way to pipe up a hydronic district heating system for the residents' shared services.

Diesel-fired generators and boilers provide electricity, heat, and hot water. Many of the homes lack running water, so the town features what's known as a "washeteria," which provides showers and laundry facilities for residents. Hirt realized that there was way too much waste heat that could be put to good use. Hirt also had experience working with a manufacturer of integrated controllers that could control a complex system.

The energy efficiency upgrade for the Village of Beaver now combines multiple heat sources to service the needs of several common facilities. The system captures waste heat from the boilers and generators in a highly insulated, 3,000-gallon water storage tank. Heating loads include space heating for the washeteria, as well as a shop and water treatment facility.

The system also provides domestic hot water for the washeteria's showers and washing machines, as well as fan-coil heated air for the clothes dryers.

Additional loads include freeze protection for a 60,000-gallon potable water storage tank outside the water treatment plant and heating for the utility corridor that provides access to water, sewer, and utilities for the local school.

"Basically, the system is what we call a primary loop," notes Hirt. "In this case, it's a big rectangle, and starting at one point there are inputs into that loop from various energy sources, and then outputs for the heating loads."

The RPA Participates in High-Performance Building Week

The RPA Board recently participated in the High-Performance Building Week in Washington, DC. The annual event seeks to inform and stimulate discussion about the benefits — water/energy conservation, improved safety/environmental quality — derived from high-performance buildings and practices.

With events, briefings, and congressional receptions nearly every day, the event brought together the best and brightest minds from the building and construction industries. The High Performance Building Coalition, comprised of 200+ organizations and chaired by IAPMO's Dain Hansen, learned of the many initiatives being supported by the industry.

Rep. Peter Welch (D-VT) said that the event raised awareness of the major impact buildings have on public health, safety, and the environment. He added that it also provided an opportunity to discuss the challenges and opportunities faced in improving building performance.

New Certification Coming Your Way

The RPA's Mark Eatherton is working with numerous IAPMO/ASSE employees on the new ASSE Standard 19210 Hydronic Heating and Cooling System Installers training program. This is a huge undertaking, but it is necessary in order to comply with the ANSI recognized program.

The former RPA had a certification program available, but it only focused on the radiant aspects of hydronics. With the new 19210 standard, the RPA is required to train and test to a hydronic heating and cooling standard, which does include radiant heating and cooling.

As our industry friend John Siegenthaler noted recently, "Attempting to do calculus without understanding the basics of algebra doesn't work too well." Likewise, a person really can't do radiant without understanding the technical side of hydronics.

The RPA's goal is to have the entire training program complete and ready for its first delivery in October 2016. The first class will be taught at the Taco Comfort Systems training facilities in Cranston, Rhode Island, October 17, 18 and 19.

Mark Eatherton, RPA executive director, says, "Once you've achieved this goal, you can then tell the world that you took the time necessary to achieve the status of being tested and certified to an ASSE standard that was developed using ANSI recognized guidelines. That's a pretty big achievement in most people's opinions, and definitely something worth touting."

Look for formal announcements and registration details in the near future.

Historic Archives Are Now on the RPA Website

For your personal education, the RPA is providing some historic documents showing how hydronic and radiant have progressed since their inception many years ago. Materials, manners, and methodologies have advanced significantly since its inception many years ago.

This information should not be construed as a "How To" guide but rather as an historical perspective on the trade. Special thanks to RPA members Dan Holohan and Lance MacNevin of PPI for allowing the RPA to present these historic documents.

We show RPA members the current state-of-the-art materials and methods used today to deliver what is arguably the most comfortable and efficient method known to mankind for providing excellent human comfort.

Please follow this link to take a look back at some historic manuals about your craft. *www.radiantprofessionalsalliance.org/Pages/AntiqueRadiantApplications.aspx*

RPAU Presents Fall Lineup

The RPA has many interesting classes available this fall and will continue to offer additional new classes online. For example, the Fundamentals of Radiant Design is a recommended prerequisite class for the Hydronic Installer Certification program to be unveiled this fall. If you are new to the industry, it is strongly recommended that you attend this class.

There are numerous FREE classes that you can take to get a feel for the excellent instructors who have put these classes together; they will also give you a taste of the educational offerings the RPA has developed with you, the contractor, in mind. Education is key to fine-tuning a profitable business and is necessary to maintaining a sustainable business for years to come.

Join us in our educational efforts. The RPAU class schedule can be found at *www.heatspring.com/partners/radiant-professionals-alliance*.

Upcoming courses include:

Fundamentals of Radiant Design
September 12 - October 23, 2016

Solar Approaches to Radiant Heating
October 3 - November 13, 2016

Condensing Boilers in Hydronic Systems
October 3 - November 13, 2016

Mastering Hydronic System Design
October 3 - December 11, 2016

Integrated HVAC Engineering
October 3 - December 11, 2016

BY CHRISTOPHER KING

REMOTE CONTROL RADIANT

Retrofit Hydronic System Keeps Isolated Alaskan Village in the Loop

The remote villages in Alaska pose challenges to contractors not seen in most of the country, but they are familiar to Michael Hirt. Hirt, the owner of Alaska BTU, a plumbing and heating company located in Fairbanks, is a 30-year veteran of the industry who has worked on a variety of hydronic heating projects. He also is an instructor at the University of Alaska Fairbanks and teaches heating classes in the interior villages, so he was not surprised when the people of the Village of Beaver reached out to him for help with their community heating system.

The Village of Beaver is located about 100 miles north of Fairbanks on the Yukon River. It's acces-

The Village of Beaver, Alaska, is located on the banks of the Yukon River. Accessible only by boat or plane, the village is off the grid, so electricity and heat are provided by diesel-fired generators and boilers. Photos by Annie Enderle.

sible only by boat or small plane. The Native American community there is comprised of 80 residents, who hold some central buildings and utilities in common. Many of the homes lack running water, so the town features what's known as a "washeteria," which provides showers and laundry facilities to residents. Electricity, heat, and hot water are provided by diesel-fired generators and boilers.

Diesel fuel was not only expensive but also hard to deliver. While fuel could be brought in by barge in the summer, it had to be flown in during the winter. "They were going through a tremendous amount of fuel, and the price often exceeded $10 a gallon," Hirt recalls. "They wanted to look at ways to cut fuel costs, and they were considering installing a biomass system. They flew me up there to look at it."

The run times for the fuel oil boilers have been dramatically reduced by the new system configuration.

When he arrived, Hirt realized that the majority of the waste heat from the boilers was simply being expelled from large radiators. This posed a big opportunity. "At the time, most of the heat was just being blown into the wild blue yonder," Hirt says. "I said, 'Before we look at biomass, let's control the energy that you have, then look at the options.'"

Hirt had worked with AllTherm/SolarLogic on several projects in the past, and he knew if he could set up the components properly, he could use the SolarLogic Integrated Controller (SLIC) to operate the entire system. He consulted with Bristol Stickney, chief technical officer at AllTherm/SolarLogic, which is headquartered in Santa Fe, New Mexico.

The two came up with a design for a district-wide hydronic heating retrofit system. Hirt then teamed up with Rex Goolsby, the owner of Lars Construction, a general contracting firm in Tok, Alaska, to implement the plan. "Because part of the project overlapped with my teaching, I needed someone who could take over," explains Hirt.

The hydronic heating system in the Village of Beaver connects to two buildings. One of them is the washeteria, which provides washing machines, clothes dryers, and showers for local residents. The hydronic system also provides freeze protection for the large potable water tank next to the building.

The flat plate heat exchanger (shown at the right) is connected to the primary loop to recover waste heat from the diesel generators.

"Rex really did the bulk of the installation."

Hirt points out that while this project is unique, the principles and products used are ones that can be applied almost anywhere. "My philosophy is, before you consider an alternate fuel source, you want to control your heat energy first," he says. "As a matter of fact, I give a talk on that, and I say that everyone should become a CHEF, which is an acronym for Control Heat Energy First. This project is really the epitome of that philosophy. "

The Village of Beaver efficiency upgrade was completed by Rex Goolsby of Lars Construction (left) and Michael Hirt of Alaska BTU, pictured here by the washeteria complex.

The New System

The energy efficiency upgrade for the Village of Beaver now combines multiple heat sources to service the needs of several common facilities. The system captures waste heat from the boilers and generators in a highly insulated, 3,000-gallon water storage tank. Heating loads include space heating for the washeteria, as well as a shop and water treatment facility.

The system also provides domestic hot water for the washeteria's showers and washing machines, as well as fan-coil heated air for the clothes dryers. Additional loads include freeze protection for a 60,000-gallon potable water storage tank outside the water treatment plant and heating for the utility corridor that provides access to water, sewer, and utilities for the local school.

New equipment installed includes Grundfos variable-speed pumps, which can quickly ramp up or slow down to maximize efficiency. During the installation, Hirt also stubbed out areas where biomass and solar systems could be tied in if needed in the future.

"Basically, the system is what we call a primary loop," notes Hirt. "In this case, it's a big rectangle, and starting at one point there are inputs into that loop from various energy sources, and then outputs for the heating loads."

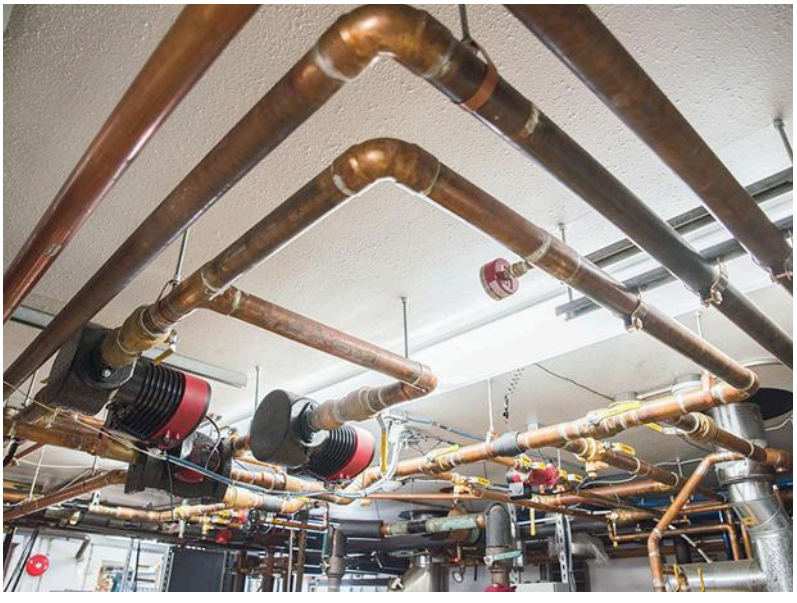
Water and, in some cases, glycol circulate through copper piping or Uponor Pex piping, and the control system constantly evaluates what is needed for the items on that loop and makes adjustments. According to Stickney, the SolarLogic technology was originally developed for use in solar thermal systems, but it has so many other possible uses, a sister company named AllTherm was formed to cover other types of renewable energy sources, alone or in combination with conventional boilers, ground-source heat pumps, generators, and air conditioning units.

"The SolarLogic computer controls all of this and maximizes the energy usage constantly," notes Hirt. "We can also remotely bring up the SolarLogic panel on our computers, wherever we are, as long as we have Internet access, and see where it's all going. If there's a problem, we can troubleshoot it. For example, if a pump isn't working, we can easily switch over to a backup pump and service or replace the pump on our next visit, saving us a flight up there."

Refining the Design

Hirt worked with Stickney to develop the game plan for the retrofit system. They sent an AutoCAD piping diagram back and forth, editing and refining it. "Finally we had a piping diagram that we both agreed we could use to cut apart the heating equipment at Beaver Village and put it back together using the primary loop configuration," explains Stickney. "That's what we do here at AllTherm/SolarLogic. We create standardized designs, and we make those standardized designs compatible with a prefabricated control system. That way, if you use a standardized design, you can plug in a very holistic, com-

Electric power for the village is supplied by these diesel generators. The new district-wide hydronic heating system recovers the waste heat, which is stored in a 3,000-gallon water tank for use when needed.



Most of the piping in the primary loop is made up of copper, complemented by Uponor Pex. Water (and in some cases glycol) circulates through the loop, and the SolarLogic control system constantly evaluates where heat is needed and makes adjustments to meet the needs as efficiently as possible.

plex control system very easily. Just plug and play, without any software programming."

Stickney worked with Hirt remotely as the installation progressed. "Anybody who has the software can view it simultaneously," Stickney notes. "When Mike hooked up something, we could see it go live, even though we were in Santa Fe and he was in Alaska. We do the final commissioning with the installer, watching over the Internet to see what they are doing and coaching them to make sure they get everything just right."

Hirt appreciated the help. "The people at SolarLogic are a very valuable resource," he says. "They coached us all the way through, as I've never done a system quite like this one. I've done a lot of it, and I even teach some classes in it, but this one was a little bit over the top."

A Rewarding Installation

The remote location made for some logistical difficulties. To make matters worse, the timing of the project was not optimal. Winter was approaching, but some of the existing equipment was in such poor shape that they decided not to wait until the following summer. Hirt was able to get the water storage tank on the last barge to run that season.

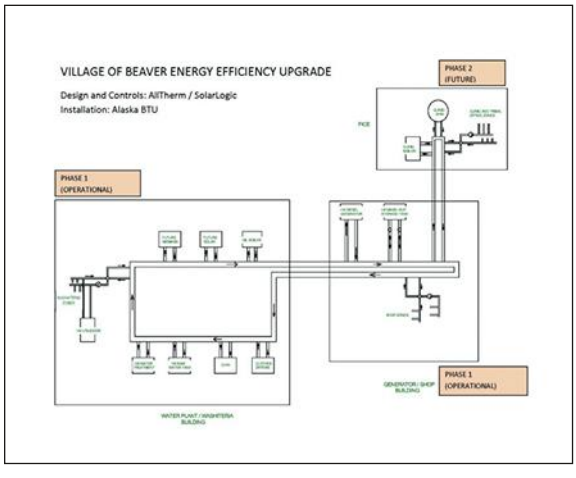
Weather can be very precarious that time of year. "It was difficult traveling there," Hirt recalls. "Luckily, Rex is a pilot, and he has his own plane, so we were able to get in and out of there with our supplies easily most of the time."

The plan to phase out parts of the system was accelerated when some pieces began to fail. "We had to go into panic mode," Hirt says. "The water heater sprung leaks, the piping was full of sludge from the old glycol, and the boilers failed. It was one thing after another. Goolsby even had to rebuild the generator twice. His multiple talents were invaluable in dealing with failure of the existing system while installing the new one. We didn't get things finalized with the SolarLogic system until May of 2015."

The new system has been in place for more than a year, and the results have exceeded expectations. According to Hirt, fuel usage has been reduced from 12,000 gallons per year to less than 400 gallons. "That's a 97% improvement in energy consumption," he says. "I don't think I've ever had a job with results that have been quite that dramatic."

Hirt often sees systems with generators that are not tied in properly and fail to achieve maximum performance.

"There are a lot of opportunities for savings out there," he concludes. "This example can hopefully show people the point I'm always trying to make – that controlling your heat energy is the top priority. You should always do that first before you look at an alternate fuel source, regardless of what the alternate fuel source is."



This schematic shows the Village of Beaver district heating system, which was set up in what's known as a primary loop configuration.

Christopher King is a writer and editor who has covered the construction industry for more than 15 years. He can be reached at kingc61@gmail.com.

SPECIAL TO RADIANT LIVING

ALL ELECTRIC, OFF PEAK PRECISION RADIANT

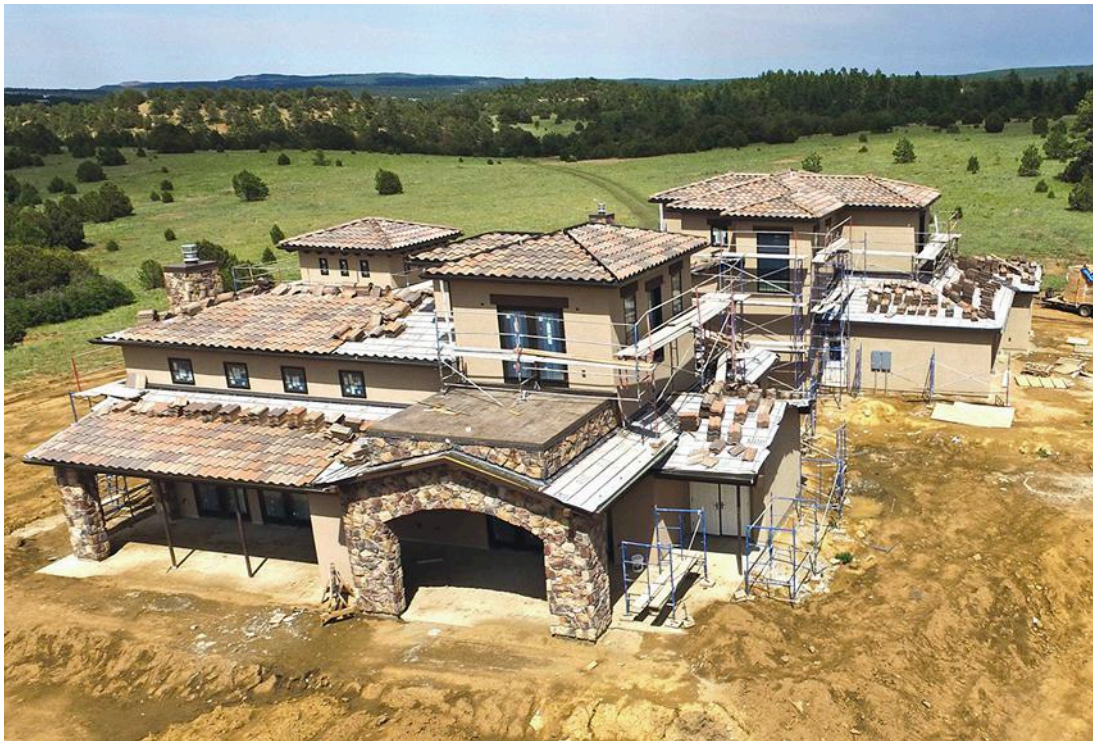
Flow Right Plumbing, Heating and Irrigation designs a hydronic radiant system for premium comfort and efficiency with an electric heat source.

If you're good with a pipe wrench, Pueblo, Colorado, isn't a bad place to call home.

The steadily growing economy ensures ample plumbing work. Out of town, the surrounding mountainsides are dotted with high-end homes, many with in-floor heat. Irrigation work, both residential and commercial, offers a professional change in pace.

As the name suggests, Flow Right Plumbing, Heating and Irrigation has grown rapidly as a result of its ability to handle just about any piping challenge that arises in south-central Colorado. Founder Lance Harvey combined his father's irrigation company with his own plumbing company eight years ago.

The wide variety of work, big territory, and the company's reputation for designing and installing



The 10,000-sq.ft. home near Walsenburg, Colorado, features an all-electric, hydronic in-floor radiant system.

intricate hydronic systems usually lead to several unique applications each year. Most recently, the company was contacted about an all-electric radiant system for a new home 125 miles south of the Flow Right shop.

Thermal Mass

"Designing a hydronic radiant system for premium comfort and efficiency isn't hard when your heat source is propane, gas, or oil," says Mike Merryman, hydronic division manager at Flow Right. "It's a bit trickier to meet both those requirements with an electric heat source. We needed to carefully consider each component, and the way we were installing all of them."

The design process began in December of 2014 when Flow Right managers sat down with Pioneer West Homes to review blueprints. The sprawling floorplan is primarily single-story with cavernous ceiling heights, but two second-story suites are included on opposite sides of the home. Concrete construction with foam insulation and high-end windows provided a tight building envelope.

(L-R) Mike Merryman, hydronic division manager, Lance Harvey, owner of Flow Right Plumbing, Heating and Irrigation, and Derek Leveque, hydronic technician.

The plan was to use a lightweight concrete slab and 12,000 lineal feet of PEX to handle the home's heat load based on a design temp of -10° F. This allowed Flow Right to provide substantial thermal mass despite the entire structure being built over a crawlspace. Even with PEX on nine-inch centers and relatively low supply temperatures, the system provides a very consistent floor temperature and high comfort levels.

(L-R) Mike Merryman and Lance Harvey discuss zones and flow rates.

Thermal mass was the name of the game when it came time to select a heat source. Instead of using standard electric boilers, managers opted for two large off-peak, electric-thermal storage units, which "charge" overnight when the local San Isabel Electric Association offers an off-peak discount.

The last, but arguably most critical piece of the puzzle was how to circulate water accurately and efficiently.

"We needed an ECM circulator as the main system pump for its ability to supply precise flow rates – exactly variable to system demand," says Merryman. "With a well-insulated home like this, and Colorado's big temperature swings, it would be far too easy to overshoot the slab and turn the whole house into a sauna. The pumps were selected for comfort first, then efficiency."

The main system pump, which feeds nine zones, is joined by smaller ECM circulators on each of the two boilers. While the energy needed to move heat is small in comparison to the power needed to create heat, ECM motors provide up to 85% energy savings over a conventional (PSC motor) circulator.

Against the Elements

Last October brought the first Flow Right crews to the jobsite. While the plumbing division started rough-ins, the hydronic techs were laying half-inch Mr. PEX tubing, soon to be covered in a self-leveling gyp-crete. Snow and mud became a huge obstacle for the duration of the project, often halting progress altogether.

In the mechanical room, near-boiler piping was prepared while PEX was going down. A single Taco VR 3452 high-efficiency circulator was spec'd to provide flow for

Hydronic Technician Derek Leveque installs a Taco VR3452 as the home's main system circulator.

all nine radiant zones. The pump can operate anywhere between 10-180 watts, so whether one zone or all nine are calling, the correct amount of heat goes out to the system.

"Our smallest zone is only 190 ft. of tubing," says Merryman, "so we needed a pump that could drop really low while also pumping the whole house in the dead of winter. Plus, we needed the option of adding a few more zones in the near future, whether that be an indirect water heater, snowmelt for the courtyard, or unit heaters in the garage."

Flow Right kept the VR3452 (34 feet of head, 52 GPM) in automatic mode, although it has three other modes and night setback for a variety of applications. The light-commercial circulator has an LED readout and industry-standard flange width. An optional communication module provides Ethernet communication, Modus RTU communication, and allows for simple twin-pump installation if redundancy is needed.

The distribution system includes a large set of manifolds, with each zone actuated by a 3/4-in. Taco Zone Sentry zone valve. This manifold feeds remote, half-inch injection manifolds throughout the home.

The Steffes boilers – or electric thermal storage devices, as the manufacturer calls them – are piped together and run in unison at all times.

"Putting the electric units in was a unique experience," says Luke Drummond, Flow Right technician. "First you set the super-insulated shell, then you stack it full of ceramic bricks."

Off-Peak Performance

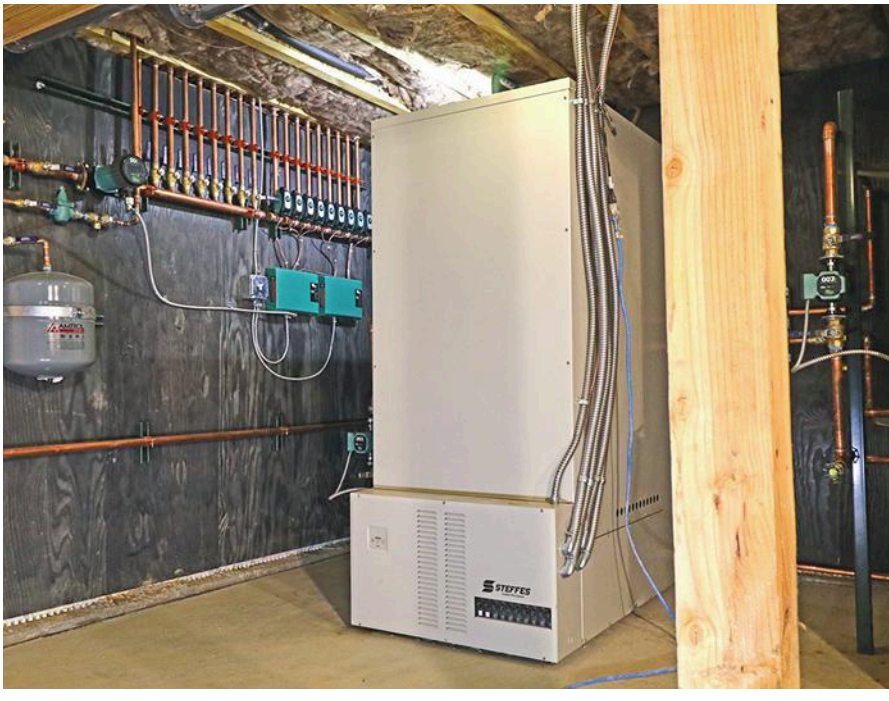
The larger of the two off-peak units in the mechanical room is rated at 45.6 kW, and will provide 65-110 MBH throughout the course of a day, based on a 12-hour charge cycle. The smaller unit can provide 50 to 75 MBH.

"During off-peak hours, typically overnight, the home's electric meter signals the units to charge," says Jim Dechert, vice president of solutions and automation at Steffes Corp. "Electric elements heat the bricks and surrounding air inside the units to more than 1,250° F. A fan at the bottom of the cabinet forces air through an air-to-water heat exchanger, with the radiant system as the heat sink."

The units store the heat and run only as needed. When the fan runs, so does the Taco 007e boiler pump, sending heat to the system's primary loop.

"We installed 007e circulators on the boilers because, at this distance from the shop, we wanted the dependability of the 007e," says Hydronic Technician Derek Leveque. "But, with our need to cut every watt of power consumption out of the installation, we chose the new ECM version."

An outdoor reset control is included



Two large Steffes electric thermal storage units, or boilers, supply the large home's 9-in. floor zones.

Hydronic technician Luke Drummond installs a Taco 007e circulator on each electric thermal storage unit.

on the thermal storage units. Much like a conventional boiler, the outdoor sensor modulates the fan speed in order to provide the correct supply water temperature. In addition, the length of the boilers' charge cycle depends on the outdoor temperature; outdoor ambient determines how hot the bricks become.

"The bricks carry a tenfold thermal storage advantage over water," says Deichert. "The same brick is used across our various hot water and hot air furnace lines. It's a mixture of iron and clay, pressed and baked into a durable, stackable form."

Constant Heat

A 20° F Delta T was used for the radiant system. Ironically, that's as good a number for the off-peak units as it would be for a condensing boiler. With the home's gypcrete slab, cycles are long and few, although when outdoor conditions drop to design temp, circulation is nearly constant.

"The circulators can obviously run all day, but they don't draw much power," says Merryman. "Most of the energy is consumed when power is at a 50% discount. The result is full-time comfort with part-time expense."

After battling the elements through the winter, Flow Right finished work at the remote home in May. But conversations with the customer about solar thermal and photovoltaic hinted at several return trips. No sweat, it's only 125 miles away.

SPECIAL TO RADIANT LIVING

SIZING PLASTIC PRESSURE PIPES

New software tool available for designing piping systems

Courtesy REHAU

Sizing pipe or tubing seems easy enough – make it large enough to carry the required fluid. In reality, designers of hydronic heating/cooling, geothermal, and other piping systems need to understand quite a few factors to make good decisions for sizing pipes, such as the specific fluid type, the required flow rate, fluid temperature, and the length. What else is part of the design process, and how do we calculate this accurately?

Obviously, one consideration is friction, and overcoming friction requires pressure. In plumbing systems, there is only so much pressure available from the municipal water main. In closed loop hydronic systems, circulating pumps provide the pressure. Their electrical demand is an important operating cost for the building over many years.

Another design consideration is velocity – if this is excessive, it can be quite damaging and costly. Steel and copper pipes have maximum velocities for hot water, typically 4 and 5 fps, respectively, to prevent corrosion, noise, and vibration. A benefit of plastic pipes like PEX, PE-RT, CPVC and PP-R is the inherent resistance to these issues. This means that higher velocities are tolerated by the pipes without harm. In fact, velocities twice as fast as those allowed in metal pipes are handled by these plastic pipes, but such velocities may result in very high friction and pressure loss, not efficient system design.

The easy answer is to select larger pipes to reduce friction. But this increases cost, not just of the pipes but also of fittings, valves, hangers, lifts, and even transportation. For pipe or tubing intended to transfer heat through its wall, such as pipes used in radiant heating/cooling, geothermal, or snow and ice-melting systems, there is another concern: If those pipes are oversized and the flow rate is too slow, laminar flow can develop.

Laminar flow sounds great, but the potential problem is that slow-moving fluid can cling to the inside of the pipe wall in a so-called boundary layer, effec-

tively insulating the faster fluid in the middle of the pipe and reducing heat transfer through the pipe wall. It's like the BTUs are trapped inside the pipe and can't get to the wall to escape.

Imagine a busy five-lane highway with access ramps on the left and right; the middle lane would move the fastest, but it would be difficult to merge from the middle lane to get off the highway. Having all traffic flowing at the same speed eases merging, just as having turbulent flow within a pipe helps heat transfer through the pipe wall, since all the water molecules have a turn to touch the inside of the pipe wall. Whether flow is laminar or turbulent can be predicted by designers by using the complex Reynolds Number formula. If they think of it!

So, when sizing plastic tubing and pipes, we need to do some important calculations to find the optimum size – to deliver the balance of cost, pumping, and thermal efficiency.

Pipe designers can refer to manufacturers' tables or graphs to calculate velocities and friction loss, but there is always the chance of miscalculating the total loss for the exact length of pipe involved. Also, using an antifreeze mixture alters the frictional loss. So does the fluid temperature, as viscosity changes. Designers can do manual calculations: armed with intimate knowledge of the pipe's exact inside diameter and smoothness, the specific characteristics of the exact fluid being used (e.g., viscosity, density), and the fluid temperature. There are many variables, so that's a lot of data, and another chance to miscalculate.

PPI Plastic Pressure Pipe Design Calculator

To streamline plastic pipe and tubing design, designers can go to *www.plasticpipecalculator.com* for a new online software tool that does these calculations quickly. Developed by the Plastics Pipe Institute's Building and Construction Division (BCD), this free calculator allows users to calculate values such as pressure or head loss for PEX, PE-RT and CPVC piping systems.

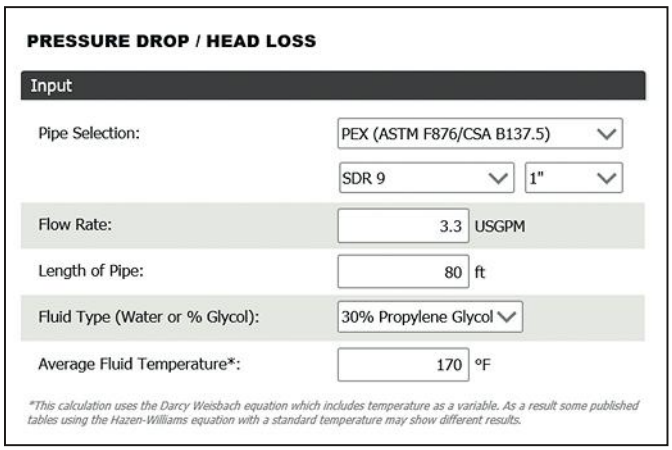
Programmed by Avenir, a developer of software for the mechanical and plumbing industry, the Plastic Pressure Pipe Design Calculator gives users access to significant calculating power. The calculator utilizes data from ASTM and CSA standards for the three most commonly used plastic pipes in plumbing, fire protection, and hydronics, so it knows the exact dimensions of each type of pipe or tubing for pressure loss calculations. The calculator can also calculate thermal expansion/contraction, surge pressures, plus pipe weight and volume. It can even help designers specify the lengths of expansion arms or loops, which are especially important for larger diameter piping systems.

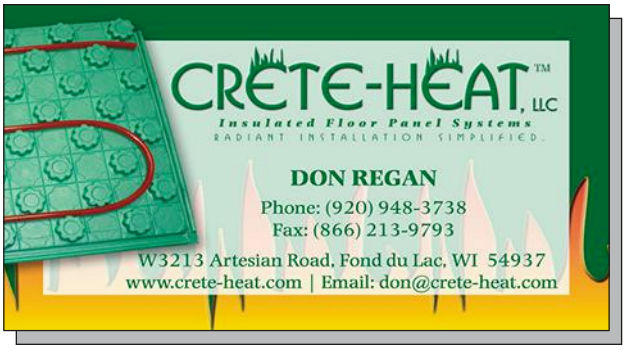
Michael Ridler of EDEN Energy Equipment, Guelph, Ontario, says, "I get involved with designs of many types of hydronic systems using plastic pipes, and this new BCD calculator makes it easy to determine the head loss in distribution piping, no matter which type of fluid we'll be using. It's practical for supply lines for radiators and fan coils, as well as snow and ice-melting systems. As we increase our use of large-diameter PEX for commercial piping, the thermal expansion and expansion arm design functions will be helpful. The BCD calculator makes it easier to design our hydronic systems using plastic pipes."

Using the Calculator

Let's use a hydronic distribution example, where we are sizing a pipe to carry 180° F fluid from a boiler to a fan coil that requires 30,000 BTUs. The owner wants to use 30% PP glycol to prevent a frozen system in case of an extended power outage. The universal hydronic flow rate formula tells the designer that the fan coil needs at least 3.3 GPM to maintain a temperature drop of 20° F or less (about 10% greater flow rate than if the system used straight water). The fan coil is 80 ft. from the boiler. We'll start the design using 1 in. PEX tubing, and determine if this is the optimum size.

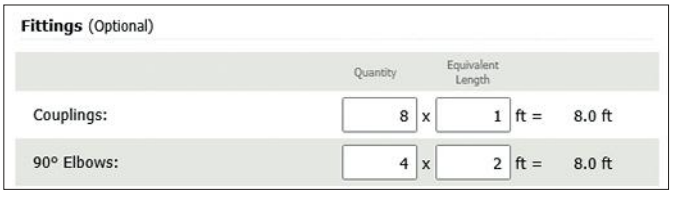
This screen shot from the calculator shows the inputs that are used:



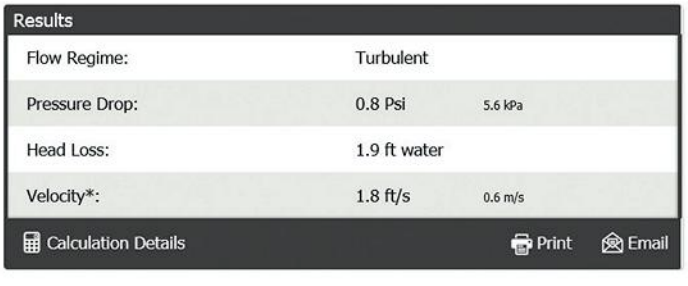


Sizing Plastic Pressure Pipes – continued

We can also include eight couplings and four elbows in the pipeline, taking the head loss through the fittings from the manufacturer's data, expressed as equivalent pipe length. This shows that adding these fittings is equivalent to adding 16 ft. of pipe length.



When we click CALCULATE we get our Results:



The Envelope Please...

This is exactly the data we needed to determine if 1 in. PEX is the right size. Using 1 in. PEX for this pipe will result in a head loss of just 1.9 ft. per 80 ft. of pipe length, a total of 3.8 ft. of head loss. The velocity is just 1.8 ft./sec., not a concern. The flow regime is turbulent, but that's not a concern for a heat distribution pipe. The pipes will be insulated. To see which formulas were used for these calculations, the user clicks on Calculation Details.

Could we downsize to 3/4-in. PEX to reduce material costs? It would take only a few seconds to compare the results. In fact, dropping the PEX size to 3/4 in. results in a head loss of 6.1 ft. per 80 ft. of pipe length, a total of 12.2 ft. of head loss at a velocity of 3.0 ft./sec. With a larger circulator, this size can work, but the customer will be paying more in pumping power forever. Probably not the best choice.

If needed, we can click Email to send this data directly to the customer, who might be making this decision on the job. It works great on mobile devices, so users can also do this in the field.

This is just one simple hydronic example, but the calculator is just as relevant for plumbing, fire protection and geothermal applications.

Summary

There are many aspects to designing hydronic pipe and tubing systems, but the BCD calculator should make it a bit easier. If you are a frequent designer of piping systems, this calculator can provide accurate and precise answers to save a lot of time. Give it a try and share your feedback.

RADIANT DIRECTORY & BUYERS' GUIDE

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Welcome to the Radiant Directory.

The radiant industry has had steady growth over the last few years, which means suppliers and providers of radiant systems continue to multiply. The Radiant Professionals Alliance, along with *Radiant Living* magazine, has produced a directory to help you locate and contact manufacturers in the perpetually growing radiant industry. *Radiant Living* also is listed online; you can view the digital edition by visiting **http://contractormag.com/** and clicking on the Fall 2016 link on the Home Page.

A

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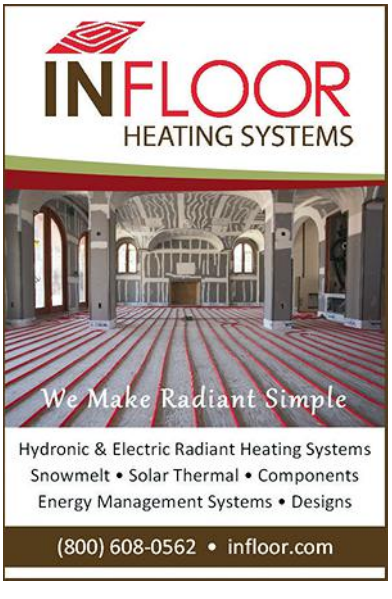

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