PHC CONTRACTOR

VOLUME 11, NUMBER 4
WINTER 2016

WISCONSIN PHCC PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION

MP/HC Master Plumbers/Heating & Cooling Contractors of Wisconsin

THE OFFICIAL PUBLICATION OF THE PHCC WISCONSIN ASSOCIATION AND MASTER PLUMBERS/HEATING & COOLING CONTRACTORS OF WISCONSIN

MATCH MADE IN HYDRONIC HEAVEN

Variable Speed Circulators and Radiant Heating

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Variable speed circulators are very cool things. They're often referred to as "smart pumps," but I think that's an unfortunate name because it gives consumers the idea that all they have to do is stick one of these things into a system and it'll figure out what it needs to do entirely on its own.

Let's be clear: variable speed pumps are sorta/kinda smart. The algorithms programmed into each circulator's control are pretty sophisticated, but they don't do the thinking for you, nor do they take the thinking out of circulator selection.

Don't get me wrong. These circs *do* have some brains, but for goodness sake they're not Miracle Pumps, OK?

Should you use a variable speed circulator on your radiant heating jobs?

The answer is a definite yes. That is, if you know why you're using it and what you're hoping to achieve for your customer.

There are quite a few misconceptions out there about exactly what these clever little devices can do when installed in radiant systems, so before we get into the why and what, let's dispose of the mythology.

MYTH #1: Variable speed pumps always give me the right flow, so I don't have to know much about circulator sizing.

No, they don't. And yes, you do.

Variable speed circulators operate based on algorithms. Delta-P type circulators vary their speed to try to maintain either a fixed (or proportional – if used with thermostatic radiator valves) pressure differential, or Delta-P, in the system.

If the circulator is programmed to maintain a fixed 10 feet of head pressure differential in the system, well then that's what it's going to do. It's going to work on a fixed performance curve at 10 feet of head. As zones open and close, the system curves of your zoned radiant system will move left or right along that 10 foot of head performance curve. The point where those system curves intersect the performance curve is where the circulator will work.

But the circ has no idea whether that's the right flow for the system. The only thing the circulator will do is go faster when more zones are open and slower when fewer zones are open. There's considerable value to that, but a fixed speed circulator with exact same performance curve would give you the exact same flow rates – the only difference is that it would use a little bit more electricity.

On the other hand, a Delta-T variable speed circulator will vary its speed to maintain a fixed Delta-T, or supply-return water temperature differential, in your radiant system. This will get you a good bit closer to giving you the right flow, but that has to be taken with a grain of salt as well.

Let's say the Delta-T circulator is serving a multi-zone radiant manifold with actuators. You would use the balancing valves on the manifold to, in effect, trick the water into thinking all of the loops are the same length. Will a Delta-T circulator give each loop the exact right amount of flow?

Nope – it can't. No circulator can.

What a Delta-T circulator *will* do is make sure the water temperature difference between what enters the radiant manifold and what leaves the radiant manifold is what you've designed the system for – usually a 10 degree Delta-T for residential radiant.

Delta-T uses sensors strapped to the manifold's supply and return piping to monitor the supply and return water temperatures. With all zones calling, the circulator will be running at a certain speed to maintain that Delta-T. As a zone or two closes, it's logical to expect the Delta-T to get smaller, since we're not taking as much energy out of the fluid. The sensors pick up on that almost instantaneously and the circulator will slow down to bring the temperature difference back to what it was designed for.

The biggest difference between the two in this example is that the performance curve with a Delta-T circulator will actually move to meet the flow and head requirements of the radiant manifold, which changes as zones open and close and as outdoor conditions change. This will give the manifold close to the right flow for much of the time, but each loop will be getting an equal amount of flow – whether it needs that amount of flow or not.

In either case, the installer needs to program each circulator correctly for the application, and to make sure it has the flow and head capacity to handle the situation.

There's no magic button to push that will let the "brains" figure it all out for you.

MYTH #2: I have loops of different lengths on a single zone manifold, a pressure regulated variable speed circulator will even that out.

We've heard this one more than once, which is why it's included in this list.

Residential variable speed circulators fall into the Delta-T or Delta-P categories. They're similar in that they're both circulators, but are very different in how they go about actually varying their speeds.

As mentioned already, Delta-T circulators vary their speed to maintain the designed-for Delta-T, or supply-return water temperature difference, in whatever it's circulating through; for this example a radiant manifold without balancing valves. Sensors tell the circulator if the return water temperature changes, which in turn makes the circulator go faster or slower to keep the supply-return temperature difference constant.

A residential Delta-P variable speed circulator has no sensors. It uses changing resistance against the impeller, and the resulting changes in motor amperage, to go faster or slower along its programmed algorithm. Simply put, when a zone closes, the impeller encounters increased resistance to flow and it ultimately slows down to whatever degree its programming says to slow down.

If a three-loop radiant manifold represents one single zone (no actuators), and one loop is 200 feet, another loop is 250 feet and the third loop is 300 feet, there's no way either circulator – or any circulator, for that matter – can possibly know that.

> ***Variable speed circulators in zoned radiant systems have tremendous benefits, especially in heavily zoned systems.***

When a Delta-P pump is on, the impeller is "feeling" a specific system resistance, and that resistance never changes. It will run at a fixed speed all the time, because the pressure differential in the entire manifold never changes. The flow through the manifold will be the same as if we had a fixed speed circulator; the short loop will get most of the flow, the middle loop will get some and the longer loop will get very little.

The Delta-P circulator can't possibly "fix" this.

A Delta-T circulator, in this same application, will do essentially the same thing. Loops with lengths differing by more than 10% require balancing valves on the manifold to, as stated earlier, trick the water into thinking all the loops are the same length.

MYTH #3: If each manifold is a single zone, then a variable speed pump is useless.

It depends on your definition of useless. And, of course, which circ you use, and what you're trying to accomplish.

As we alluded to earlier, a Delta-P circulator – when used as a zone pump – will never change its speed, because the pressure differential within that zone will never change.

What you will have, however, is an ECM circulator operating at least 50% more efficiently than a circulator with a standard efficiency motor. Before we start spending the kids' inheritance, understand that with the small, wet-rotor circulators we use in residential applications, that's not a ton of money saved – perhaps anywhere from $15 to $30 annually, depending on your KwH rate. Not a nest egg, perhaps, but not bad.

A Delta-T circulator, however, may very well change its speed when used as a zone pump. Remember that it's varying its speed to maintain a fixed Delta-T in whatever it's pumping through – in this case a radiant zone.

What could cause that Delta-T to change? In this example, only one thing: a change in outdoor temperature. As the temperature decreases, the BTUH head loss of the zone increases. That would cause the return water temperature in the system to drop ever so gradually, which, in turn, would cause the Delta-T circulator to speed up, ever so gradually.

Is there benefit to that? Some – greater comfort perhaps, and potentially higher boiler efficiency.

SO, NOW YOU KNOW!

Variable speed circulators – either type, Delta-P or Delta-T – in zoned radiant systems have tremendous benefits, especially in heavily zoned systems.

Yes, your customer saves electricity, which is nice. More importantly, you can smooth out overall system operation and enhance both the comfort and potentially the overall efficiency of the system.

However, it's important to remember that just because lots of folks refer to these things as "Smart Pumps," it doesn't mean they do the thinking for you, or take the thinking out of it. That's why you're there.

And since this isn't Hogwart's, there's no such thing as magic.