The new 'smarter' circulators

By George R. Carey

Circulators have been around the Hydronic heating industry dating back to the late 1920s to the early 1930s. They were originally added to existing gravity hot water jobs to "boost" the heat around the system. In fact, Bell & Gossett marketed their circulators as "booster" pumps because they would move the heat from the boiler to the radiators much faster than simply by gravity. These original circulators were often referred to as "three-piece" pumps because they had three distinct sections…the wet end or volute, where the impeller is located, the motor end (which is the driving force) that would mount in a cradle, and a bearing assembly that would connect the two ends together with a coupling assembly. The motor assembly was completely separated from the wet end of the pump by a seal. The bearing assembly would be lubricated with oil to keep the bearings in good working condition. These pumps dominated the hydronics industry for decades and did a very good job.

Sometime in the '70s–early '80s, a new style of pump came onto the scene—one that changed forever the residential (and eventually light commercial) market. These "new" circulators used the system's own water as its lubricant. There was no longer a need for a separate bearing assembly and seal. The physical size of these pumps was considerably smaller and they cost much less than the three-piece style.

At first, there were many skeptics about the new pumps' ability to perform as well as the original larger pumps. But over time, the industry realized these new "water-lubricated" pumps worked quite well, lasted a long time, required virtually no maintenance and were less expensive. So over the years, the technology changed regarding how the circulators were made, but they all accomplished the same thing…move heat (BTUs) from the heat source (boiler) to the radiation by circulating water through a piping network at a fixed speed.

When discussing pumps and their capabilities, we typically look at the pump's curve to determine its performance. This performance is described in flow rate (GPM) vs. TDH (total dynamic head). Circulators are selected to meet a certain set of conditions which include moving a certain amount of heat (listed in gallons per minute GPM) and overcoming a certain amount of frictional resistance, usually referred to as feet of head.

Traditionally, pump manufacturers have made various models, each having its own performance curve, to meet different system requirements. Over the past four to five years, some pump manufacturers have been offering multi-speed pumps which offer a different pump curve for each speed. The most common is a three speed wet-rotor circulator which offers three different performance curves. The benefit is with one pump you can provide three different curves to meet various system conditions. From an inventory stand point, you can stock (on the shelves or in the service truck) one circulator model that can meet a lot of different system applications.

Now imagine instead of three speeds, more like 10 speeds or even 50 speeds…for each speed change you could plot a new pump performance curve. The highest speed would represent the pump's maximum performance and the lowest speed would represent the pump's minimum performance. A variable speed pump can operate anywhere between these two points simply by varying the speed of the motor.

Any wet rotor pump with a permanent split capacitor (PSC) motor can function over an extensive range of speeds with a variable speed controller. This device varies the frequency of the AC signal sent to the PSC motor. By varying the AC signal, the rpm's of the motor (the speed) are changed, which directly changes the flow and head capacity of the pump. The changes, and therefore the pump curves, are unlimited between the fastest and slowest rpm's of the motor.

One application that is very popular uses a standard wet rotor pump controlled by one these variable speed controllers to provide injection mixing for any low temperature heating system. Some pump manufacturers have taken this technology a step further by providing the pumps with this AC frequency signal circuitry built on board the PSC motors as well as control algorithms to provide variable speed injection mixing, temperature setpoint controlling and temperature differential control. So instead of using a standard wet rotor circulator and buying a separate variable speed injection control from the control company, the circulator has everything on board.

What's next?

A new style of "smart" pump is making its way into the North American hydronics market. These are called ECM pumps. ECM stands for electronically commutated motor and they are very different from the PSC (permanent split capacitor) motors we have using in our wet rotor pumps. This new style motor is sometimes called a "brushless DC" motor. The rotor in this ECM motor has permanent magnets instead of wire windings that are separated from the system fluid. The magnets are located inside a stainless steel rotor "can" and react to the magnetic forces created by electromagnetic poles in the stator.

A microprocessor, which "sits on board" the pump, reverses the polarity of the stator poles rapidly (within milliseconds), forcing the rotor to rotate in the proper direction. The faster these poles reverse their polarity, the faster the rotor spins, meaning the faster the impeller spins.

ECM circulators can provide four times more starting torque compared to a permanent split capacitor (PSC) wet rotor pump. This additional starting torque pretty much eliminates the concern of a pump experiencing a stuck rotor after a summer shutdown. These ECM pumps incorporate a microprocessor that has software on board to allow the pump to perform many functions. For example, one application may call for a constant pressure differential where the building is zoned with zone valves. Normally as valves close, the pump would develop additional head pressure across the remaining open zones, causing an increase in flow rate through these zones. This wastes energy as well as causing potential noise problems due to increased velocity.

But with a constant differential in pressure capability, as valves close, the pump momentary senses an increase in differential pressure and quickly slows down the pump's speed to eliminate the change in pressure. The result is no change in flow rate through the remaining open zones, no wasted energy and no velocity noise problems.

Another application that the microprocessor can control is called proportional differential pressure. The circulator control is set for a specific design head loss for a system. Now when the zone valve (or valves) closes, once the pressure differential starts to climb, the circulator reduces its motor speed. The difference here is with proportional control; instead of maintaining a set differential, it will lower the speed and thus pressure differential proportionally to the reduction in flow rate. The result is an increased reduction in energy consumption.

The efficiency of these "greener" circulators is designed to meet the ever increasing efficiency standards that are slowly making their way over to North America. Their "wire to water" efficiency is higher than the current PSC wet rotor circulators, their multiple application capabilities with the on board microprocessors, and their reduction in wattage use make them a very compelling alternative to the industry's current offerings. You should become aware and comfortable with this newer technology.

If you have any questions or comments, e-mail me at gcarey@fiainc.com or call me at FIA. 1-800-423-7187.

Clarification:
In last month's column, in George Carey's article on domestic hot water circulation, we presented a chart showing the BTUH heat loss per 100 feet of tubing and steel pipe. The pipe size range should have read ½", ¾", 1" and so forth. We inadvertently listed the second pipe size as ¼", a size not used for this purpose.
Editor