High Efficiency Circulators

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High efficiency circulators, both residential and light commercial, are here and they are not going away. With energy costs on the rise, utilities trying to reduce unneccesary load on their infrastructure, people trying to reduce their carbon footprint and the "Greening of America" theme continuing to evolve, the environment is right for this "new" technology. When I say new, I mean new to American hydronic systems; Europe and others have been using high efficiency circulators for some time now.

So what constitutes a high efficiency circulator? Well, it all started in Europe. In March 2005, "Europump" (European Association of Pump Manufacturers) launched a voluntary industry commitment to improve the energy performance of stand-alone circulators. This was done to prepare for the legislation that was going to be implemented by the European Commission, which created an Energy Efficiency Label (A, B, C, etc) so they could compare circulators based on their efficiency. They created the Energy Efficiency Index (EEI), which is a number calculated using an established protocol based on testing and subsequent calculations.

Class	Energy Efficiency Index (EEI)
A**	EEI< 0.20
A*	0.20 ≤ EEI <0.30
A	0.30 ≤ EEI <0.40
B	0.40 ≤ EEI <0.60
C	0.60 ≤ EEI <0.80
D	0.80 ≤ EEI <1.00
E	1.00 ≤ EEI <1.20
F	1.20 ≤ EEI <1.40
G	EEI ≤ 1.40

According to the chart to the right, each letter represents a particular range of EEI ratings. To achieve the energy performance upgrades that the Commission wanted, they legislated that certain EEI values had to be attained by certain dates. Up until January 2013, everything was voluntary, but starting in January 2013, only stand-alone circulators with an EEI rating of .27 or lower could be sold in Europe. The next new regulating standard takes place in January 2015 when every circulator has to have an EEI rating of < .23 or it can't be sold in Europe. EEI values less than .27 can only be reached by high efficiency circulators. That means the circulator has to have an ECM motor, because a standard wet rotor circulator with an induction motor can only reach the D or E scale; the EEI value is too high to meet the new performance standards. ECM motors provide higher wire-to-shaft power conversion efficiency. This allows the circulator manufacturers to meet the lower EEI values, which means higher efficiencies.

So what *is* an ECM motor? ECM stands for electronically commutated magnetic motor and they are very different from the permanent split capacitor (PSC) induction motors we have been 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 that "sits on board" the pump reverses the polarity of the stator poles rapidly (within milliseconds), forcing the rotor to be rotated in the proper direction. The faster these poles reverse their polarity, the faster the rotor spins, meaning the faster the impeller spins. By using magnets to help create the magnetic field for rotation, these motors require less energy to operate. The goal of a more efficient circulator is what led the Europeans to move in this direction.

Another benefit of using ECM motors is that these circulators can provide four times more starting torque compared to a permanent split capacitor (PSC) wet rotor pump. This additional starting torque essentially eliminates the risk of a pump experiencing a stuck rotor after a summer shutdown.

When using a microprocessor to operate the circulator, many options become available that didn't exist with standard induction motors. Through software, the microprocessor can control the speed of the rotor, which affects the amount of flow (GPM), which has a direct correlation to the amount of energy consumed. Also, by controlling the speed of the pump, you can control the amount of

Continued on p. 30

High Efficiency Circulators *continued from p. 22*

pressure differential it develops. The microprocessor can operate the pump to maintain a constant speed, constant pressure, proportional pressure, night-time setback, constant temperature control and fixed Delta-T control. Some of the more advanced circulators can accept an external 0-10Vdc signal to control the GPM output of the circulator. This can be very beneficial when applied to Mod/Con boilers that modulate their firing rates based upon load conditions.

The smaller residential ECM circulators usually operate in a mode that is called "The Proportional Pressure Curve." The circulator has many different proportional pressure curves that it can operate on. Because of the microprocessor, the circulator always knows where it should be relative to the particular curve that was selected. These circulators were designed for heating systems that would use a single circulator and several valves (either open/close electric valves or non-electric modulating valves) for zoning. As the heating system is operating, the valves will respond to their respective zone's load. As this occurs, the smart circulators will sense that a change has occurred and then adjust their speed accordingly to stay on the pre-selected proportional pressure curve. In the process, the ECM motor is consuming less energy compared to what our induction motor circulators would be using. The software that is "on board" the microprocessor is designed to measure the watts being consumed by the motor and the RPMs. Comparing these two data points allows the circulator to recognize whether or not it is operating on its proper curve. No additional sensors are required with this type of operation. This keeps the installation as simple and easy as possible.

These "Proportional Pressure Curves" are also very different from our standard induction motor circulator curves. Figure 2 indicates two types of curves. One is the hydraulic performance curve (gpm and feet of head/ pressure differential) and the other set of curves is the Power Consumption Curve, which is very different from what we are used to. One of the main benefits of using this ECM technology is to use less energy. The Power Curve shows us how many watts the circulator is using at any point along the curve. All circulators that meet EEI standards have aggressive flow-to-power consumption ratios. As the speed slows down, there has to be a reduction in wattage consumption. The hydraulic curves are different from what we are used to reading, as well. You will notice that each curve has almost a "hump" or a "peak" somewhere near the middle of its curve. That is what a Proportional Pressure Curve looks like. As the circulator is starting to slow down (moving less gpm), the corresponding pressure drop is reduced and the curve is developed to reflect that reduction in frictional resistance. This process consumes less energy.

These circulators have become the "norm" in Europe where 98% of heating systems use hydronics. They work well, use less energy and as energy costs continue to climb here in the U.S., we will see more of them. In fact, several utilities are now offering rebate money for the purchase of high efficiencycirculators in residential and light commercial applications.

If you have any questions or comments, email me at gcarey@fiainc.com, call me at 800-423-7187 or follow me on Twitter @Ask_Gcarey. ICM

Figure 2