Why Electronically Communicated Magnetic motors *make* $ense...

By George R. Carey, Jr.
Vice President,
Fluid Industrial Associates, Inc.
gcarey@fiainc.com
twitter: @Ask_GCarey

I was recently informed that some of the larger utilities in the Northeast are providing rebate incentives for residential electronically communicated magnetic motor (ECM) circulators. It seems they are very interested in having the hydronic industry move away from the old, inefficient induction motors and towards ECM technology.

Plumbing and heating wholesale distributors sign up and become part of the utilities' high performance circulator programs. They then can offer a $100 discount off the price of any of the participating ECM residential circulator. There is no limit to the number of circulators that qualifies for these programs; if a customer has one zone, two zones or twenty zones, all of those inefficient older circulators can be replaced with new ECM technology.

When I see something like this, I always ask *"Why?"* Why would they provide such a generous incentive? The answer lies with energy costs and energy consumption. As energy costs continue to rise, the impact affects everyone. Production costs go up, distribution costs go up and the net result is higher utility bills for the end user. What's the big deal with ECM versus induction motors anyway?

To answer that question, all you have to do is look across the Atlantic to Europe, where hydronic heating is dominant. In fact, 90–95% of heating systems in Europe heat with hot water. For the past decade, pump manufacturers in Europe have combined efforts to improve the efficiency of circulators for hot water heating systems. They came up with an efficiency index that the all of the pump manufacturers had to reach: the Energy Efficiency Index (EEI). In 2010, the European Union created legislation that adopted this EEI standard. While trying to reach these efficiency marks, manufacturers quickly realized they could not achieve the necessary levels with induction motor technology. It just proved to be too inefficient, so they moved to ECM motor technology.

So what *is* an ECM motor? They are very different from the permanent split capacitor (PSC) induction motors we have been using in our wet rotor pumps. 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 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. By creating a magnetic field for rotation, these motors require less energy to operate. This is why the Europeans moved in this direction, to have a more efficient and less-energy consuming circulator.

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Another benefit of using ECM motors is that these circulators can provide four times more starting torque compared to a PSC wet rotor pump. This additional starting torque pretty much eliminates the concern of a pump experiencing a stuck rotor after a summer shutdown.

With a microprocessor operating the circulator, a lot of options become available that didn't exist with standard induction motors. Through software, the microprocessor can control the speed of the rotor, affecting the amount of flow in gallons per minute (GPM) which has a direct correlation to the amount of energy consumed. This is why the utilities are interested in moving the industry towards this type of circulator.

In most residential applications in the Northeast, zoning with a circulator has become the standard. If you had two zones, you used two pumps; four zones, four pumps and so on. Unfortunately, most of the circulators used were technically too big and pumped more GPM than needed even though the circulators were the smallest available.

Up until now, there really wasn't much a contractor could do other than install the circulator, make sure it didn't leak or make any noise when it turned on and go on to the next job. With these new ECM residential circulators, however, several different speed control settings are provided, and speed control has a direct relationship to GPM capacity. Now, as a contractor, you have the ability to "dial" the pump's speed to match the zone for which it is pumping. The benefit, of course, is a reduction in the amount of energy consumed by the circulator. Here is an example:

- A Zone has 30' of ¾" copper baseboard. How many BTU's is this? A standard ¾" baseboard has an output of about 580 BTU/H per foot.
- 30' x 580 = 17,400 BTU/H. How many gallons per minute (GPM) is this?
- Typical residential systems are designed around a 20°F temperature drop.
- GPM = BTU/ 8.33 x 60 x 20 (BTU/ 10,000 = GPM)
  - 8.33lbs = the weight of a gallon of water
  - 60 = no. of minutes in one hour
  - 20 = design temperature drop in °F of heating system
- 17,400/10,000 = 1.74 gpm
- This zone has a total of 150' of ¾" copper pipe, including the 30' of baseboard.
- What is the pressure drop or frictional resistance of 1.74 gpm circulating through 150' of ¾" copper pipe?
- There are frictional resistances charts and tables available, or you can use a B&G System Syzer Wheel or smart phone/tablet app.
- The pressure drop is about 1' per 100' of pipe, so in this example the total pressure drop for this zone would be 1.5' of head loss.

With a standard wet rotor induction motor circulator, there is little to no speed adjustment, so the contractor would put a standard circulator in and it would pump more GPM than necessary. By switching to an ECM, the contractor can dial down the circulator's speed to more closely match that particular zone's requirements. If you look at **Figure 1**, you will see a collection of pump curves, but you will also see a collection of power curves for each corresponding pump curve. For this example that we just worked through, you can see that by setting the circulator at pump curve one, the flow and head closely match the zone's conditions. What the utilities really like, however, is the power consumption; the ECM circulator is only consuming about *five* watts of energy. By comparison, a standard wet rotor will consume about 90 watts in that same system. That's where the real savings come into play:

- The heating season in the Boston area, for example, is about 4,600 hours. Let's say a zone pump operates for half that time, 2,300 hours.
- A standard induction motor consumes 90 watts x 2,300 hours = 207,000 watts
- 207,000/1000kw = 207 KW for one zone pump for the heating season.
- 207KW x 0.20 cents per KW = $41.40, the cost to operate one induction motor circulator.
- An ECM motor consumes 5 watts x 2,300 hours = 11,500 watts
- 11,500/1000 = 11.5 KW for one zone pump for the heating season.
- 11.5 KW x 0.20 cents per KW = $2.30, the cost to operate one ECM circulator for that zone.

This is the reason why the utilities have become very interested in creating rebate incentives. There can be significant savings achieved with this "new" technology.

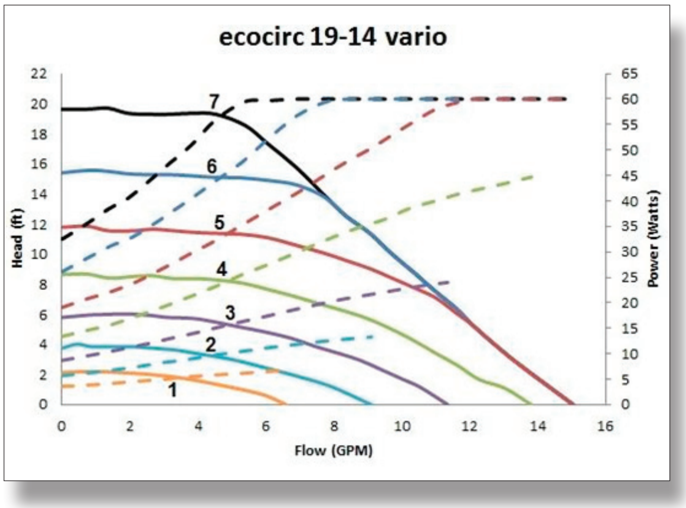

Figure 1: *A collection of pump curves and corresponding power curves*

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