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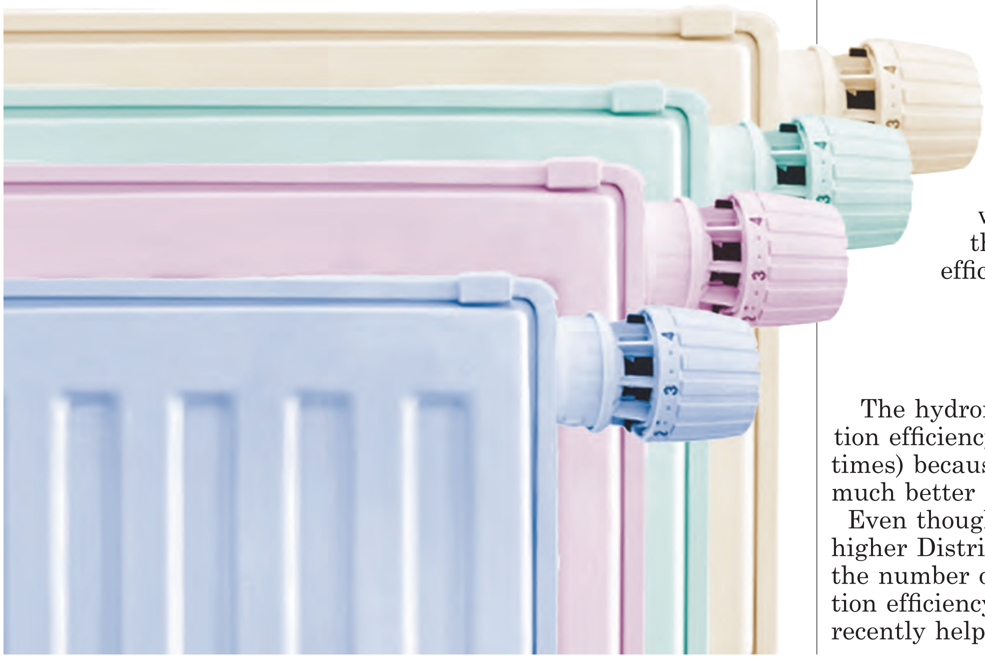
Don't forget distribution efficiency...

The heating industry, for the past decade, has focused on improving the combustion or thermal efficiencies of the heat source. Every major boiler manufacturer, both domestic and import, has a series of modulating/condensing boilers in their product offering. The number of mod/con boiler installations is higher than it's ever been and is projected to continue in this direction. Some of the boilers, when installed in the right application, are achieving efficiencies in the 95% + range. People in our industry are under the impression that with thermal efficiencies this high, there isn't any room left for improving a hydronic heating system. And they would be correct, if combustion efficiency was their only goal. But there is another efficiency that the industry has ignored for years and that is the hydraulic efficiency of the distribution system. We should be looking at overall system efficiency, which includes how efficient the boiler plant converts fuel into heated system water—but also how efficiently is this heated water being delivered to the building.



Let's first define what distribution efficiency is…

$$\text{EFFICIENCY} = \frac{\text{Desired OUTPUT quantity}}{\text{necessary INPUT quantity}}$$

In basic terms…how much energy is needed to get the desired output? When we apply the definition of distribution efficiency to a heating system, it looks like this;

$$\text{DISTRIBUTION EFFICIENCY} = \frac{\text{rate of heat delivery}}{\text{rate of energy use by distribution equipment.}}$$

So if a heating system provides 130,000 Btu/h at outdoor design conditions and there are five circulators that consume 80 watts each, the distribution efficiency for that system is:

DE = 130,000 Btu/h/ 400 watts
= 325 Btu/h / watt

Compare that to a warm air furnace where the blower motor consumes 1,050 watts while delivering 100,000 Btu/h through the duct system. The distribution efficiency for that system would be:

DE = 100,000 Btu/h / 1,050 watts
= 95 Btu/h / watt

The hydronic system has a much higher distribution efficiency than the warm air furnace (almost 3½ times) because the physical properties of water are much better for conveying heat than air.

Even though hydronic systems generally have a higher Distribution Efficiency than air systems, when the number of pumped zones increases, the distribution efficiency can quickly dissolve. For example, I recently helped troubleshoot a heating problem at one of those “McMansions” that had 35 zones, all with water lubricated circulators consuming 85 watts each. The house had a design load of 350,000 Btu/hr. When you run the numbers to determine the distribution efficiency:

$$DE = 350{,}000 \text{ Btu/hr} / 35 \times (85 \text{ watts})$$
$$= 117 \text{ Btu/hr} / \text{watt}$$

As you can see, a hydronic system, when taken to the extreme without a lot of thought, can become an inefficient distribution system! And these systems have been installed for years with no real concern for operating costs. But as energy costs have continued to rise, not only has it has impacted both fuel costs for transportation and heating homes, but electrical costs are being impacted. Power plants that produce electricity have to use some source of energy. The majority have used coal for years, but through legislation, many are being closed down or converted to natural gas. Nuclear power has been another energy source for power plants, but they too are being threatened for closure through legislation.

This is putting tremendous pressure on the ability of the power plants to manufacture electricity. The result? Higher electric bills! This is nothing new over in Europe where they have experienced much higher energy costs than we have for years. They were forced to come up with better and more efficient ways to heat the water and more importantly, how to deliver the heated water to the heating terminal units. One of the technologies they have embraced for the past decade or so is electronically commutated magnetic motors, also known as ECM. Europe heats predominantly with hydronics, so they have incorporated ECM technology into their circulators. In fact, nowadays, only circulators with ECM motors are allowed to be installed in Europe.

Since the beginning of forced hot water heating, circulators always used AC induction motors as the technology of choice to rotate the impeller inside the pump’s volute. The rotating impeller caused the water to circulate throughout the system faster than by gravity which, up until that time, was the only method available. Some of the advantages of AC induction motors were that they were of a simple yet rugged design, they were easily mass-produced and relatively speaking, were low cost and were able to connect directly to AC power. In our next issue, we will discuss the differences between induction motor technology vs electronically commutated magnetic motor technology and the inherent benefits that come with ECM circulators. **ICM**

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