Sum of the Parts

The Department of Energy is expanding its focus to full system efficiency and has released its first ever set of efficiency standards for pumps.

Alex Cannella, News Editor

In the Department of Energy's endless energy efficiency game of whack-a-mole, motors have historically always been one of the go-to moles. They've been in the spotlight since 1992. Over the past few decades, repeated efficiency laws have seen motor efficiency get whacked into tighter and tighter shape.

As far and away the biggest source of global electricity consumption, motors have been an obvious focal point for the DOE's energy efficiency efforts, but at this point, many motors now exceed 96 percent efficiency. Between the increasing cost of developing more efficient motors and the relatively low expenses of utilities, there's a growing argument that we've hit the ceiling on efficiency, or at least gone as far as is practical.

"We've stair-stepped efficiency up to a premium efficiency level and we've extended coverage over a very wide range of motor configurations," John Malinowski, senior manager for industrial affairs at Baldor, said. "So in a typical induction motor, there's not a whole lot more to go. If we raised efficiency higher, we would perhaps change away from squirrel-cage induction motors and go into some other technology. The cost of that technology might not jive with the payback. Payback would take too long in an industrial sense."

But despite all the effort that's been put into making motors more efficient, the International Electrotechnical Commission still reports that they consume 45 percent of all global electricity. How?

A part of the reason is just the sheer number of motors used around the world (and the fact that not all countries have efficiency laws), but even in parts of the world where motor efficiency is at a record high, they're still hampered by the systems—the pumps, air compressors and fans—that they run. While efficiency standards on motors have been repeatedly tightened, the systems themselves have mostly avoided scrutiny and fallen behind, effectively hamstringing the energy savings provided by a top-of-the-line motor.

The DOE, however, has started to address this. They recently released a final ruling on pumps, and they won't be stopping there. They're also planning on releasing a proposal for the fan industry, and the next step after that will be to look at air compressor efficiency.

In the Spotlight

The DOE's ruling on pumps is the first U.S. efficiency law to be imposed on them, and the department's opted for a uniform baseline across multiple pump categories and designations. The new ruling is based on a survey of over 3,000 pumps and is designed to eliminate the 25 percent least efficient pumps currently on the market.

While that may sound like a significant number, it's important to note that the DOE's first ruling targets a narrow section of the pump sector. The only pumps affected by the ruling are clean water pumps (pumps with a maximum non-absorbent free solid content of 0.016 pounds per cubic foot and a maximum dissolved solid content of 3.1 pounds per cubic foot) ranging from 1–200 hp. Of those pumps, only end suction close-coupled pumps, end suction frame mounted/own bearings, in-line pumps, radially split, multi-stage, vertical, in-line diffuser casing pumps and submersible turbine pumps will be affected. The DOE is further limiting the ruling to pumps with a flow greater than 25 gallons per minute, a head less than 459 feet and a design temperature between 14 and 248 degree Fahrenheit (–10 to 120 degree Celsius).

Non-clean water, mixed/axial flow, nuclear, mil spec, sealless, self-priming, prime assist, sanitary, circulator, pool and fire pumps are also exempt in the new standards. For more information on exactly what is and isn't included in the final ruling, the Hydraulic Institute has put together a handy diagram that you can find at *www.pumps.org/DOE_Pumps.aspx*.

For the affected pumps, the DOE has set up a new metric they're referring to as the Pump Energy Index (PEI), which lays out specific efficiency requirements for each target category, with additional distinctions made between 1800 rpm and 3600 rpm pumps and constant load and variable load pumps.

The DOE also laid out test procedures in a second ruling to ensure that affected pumps meet the new standards. They will require that all affected pumps be tested by the compliance date in 2020. The testing method is a modified version of the Hydraulic Institute's HI 40.6 test where the pump's pump energy rating will be matched against a "standard pump energy rating" that is meant to represent the performance of a bare pump of the same equipment class that shares the pump's characteristics, such as flow, hydraulic load and specific speed, and is minimally compliant with DOE's energy conservation standards.

The HI is currently developing a three-part training series on the testing method and calculations. Each part of the series will cover a different topic related to the ruling. The first will go through much of the background behind the rule, the second details the test procedure itself and the third will run through the calculations to check if your pump is up to snuff.

"The general outline is that we want to educate at a high level," Peter Gaydon, director of technical affairs at

the Hydraulics Institute, said. "What is this rule, what does it mean, what's in scope, what's out of scope, etc. Now that you have to test the products, what test procedure do I need? What's important? What do you have to worry about? And when I'm doing these calculations, what do all of these calculations mean?"

The DOE's strategy with pumps seems similar to how they dealt with motors. The current ruling has a narrow focus, but we can expect it to expand in scope in the future.

A Cooperative Strategy

The DOE's ruling sets a good first precedent for the pump industry, giving all involved a clearly established, concrete baseline to shoot for, including those who may not be affected. While the ruling currently has a narrow focus, the DOE seems to be taking a similar approach to what they did with motors, which means that the efficiency standards could be expanded to cover other sections of the industry at a later date.

The DOE's focus has shifted to include overall system efficiency, but technically, none of their rulings, published or under consideration, are guidelines for total system efficiency. Instead, the DOE is raising overall efficiency by targeting each individual major component of larger mechanical systems and regulating them one at a time.

One of the most interesting things about the DOE's process, however, has been how much it has involved outside input. The DOE has been in contact with groups such as the Hydraulics Institute for over five years leading up to the final ruling, gathering data and input from the affected industry every step of the way. The back and forth dialogue has not only led to a ruling that the pump industry can reasonably bear, but also kept the industry informed.

"The pump manufacturing community has been well-versed and well involved in the negotiation and the setting of minimum efficiency levels," Gaydon said. "So I think the overall reaction is that they got what they expected."

The Hydraulic Institute has been working with the DOE since they first showed an interest in improving pump efficiency. Since then, they've helped with the survey that formed the basis of the research behind the DOE's ruling, formed committees to help get further information to inform the DOE's decision, and developed HI 40.6, the testing procedure that became the basis for the DOE's ruling on official pump efficiency testing methods. Throughout the process, the HI has been a go-between for the industry and the DOE.

"Our members negotiated with advocates as far as 'what is an appropriate level that's not too burdensome to the industry, that isn't going to put people out of business, but will still achieve the goal of saving industry to make it a worthwhile standard?'" Gaydon said. Waiting in the Wings

So now that attention is shifting towards system efficiency, where does this leave motors? The DOE will take another look at motors in the future and could put out another ruling tightening efficiency further, but between the time it would take to draft up another ruling and the several years' grace period typically given afterwards to comply, a motor bought today could conceivably last you a long while down the road. At the same time, already mandated rulings are coming into effect (the latest will do so in June). Meanwhile, newer and better motors will likely continue to one-up each other as they're released. While the U.S. has shifted focus, many foreign motor manufacturers (including ABB, whose motors you can get through Baldor) have doubled down on motor efficiency. Not only do they produce IE3 motors (which are equivalent to our premium motors), but also IE4 (super premium) and even IE5 motors, and the race only seems to be gaining momentum. In some corners, people are already trying to define what an IE6, 7 or even 8 motor might look like.

That's all a lot to consider. While super premium and better motors may exist, whether or not you should buy one is a question that will have to be answered on a case-by-case basis after crunching some numbers. According to Malinowski, this is particularly true here in the United States.

"Compared to the rest of the world, we've fundamentally got very inexpensive electricity today and we don't have carbon taxes," Malinowski said. "In the middle part of the United States, electricity's still only about 6 cents a kW/hour. It might be higher on the coasts, certainly it's a lot higher in Hawaii and places where you don't have natural gas for fuel, but in the heartland of the country, energy's really cheap. Where you go to Europe, it might be two or three times that, plus you have a carbon cap on top of it. So what works here and what works in Europe… totally different deal."

Due to those cheaper electricity costs, the already diminished returns from each efficiency level become even slimmer, which makes the super premium efficiency wave that's taking over Europe a harder sell for American businesses. While super premium motors will inevitably save money in the long run, Malinowski believes that payback may be too long to be economical in some cases.

"Does [an IE4 motor] have payback?" Malinowski said. "Well, yeah, it does. Is it going to pay back in two years? Well, maybe, maybe not."

There are other factors to consider as well, such as how often the motor will be running and if it will be doing so at maximum output. A motor that isn't constantly running or doing so at half speed will change your calculations.

The Silver Lining

Whether you work with pumps or motors, or are even waiting for the hammer to fall on fans or compressors, there is a bright side to the new rulings. From their new expanded focus on system efficiency to their collaborative approach, some of the recent rulings from the DOE have marked shifts in both strategy and scope, and they seem to be well-received in the industries they've worked alongside.

"It acknowledges that you can save more energy by controlling a pump properly in specific applications," Gaydon said. "So I think it's a positive that they're looking at the system."

"We find that the proactive way, working together with [the DOE] to develop a standard, is more favorable," Malinowski said.

While rising efficiency standards can be a burden on the industry, the DOE does what it can to make that burden lighter, and that is something to be happy about. **PTE**

For more information:

The Hydraulics Institute
www.pumps.org

Baldor
www.baldor.com