

## The Path to More Efficient Motors for Manufacturing



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The AC induction motor has been the workhorse of the industrial revolution. What will the motor of the future look like? To understand where we are going, let's take a look at where we have been and where we are now.

We have seen the conversion from DC technology migrate to AC and the old D line or U frame motors morph into the more power-dense E line induction motor of today. Going back to the early 1900s the induction motors were all standard efficient. The Energy Policy Act (EPA) of 1992 dictated that motor efficiency levels for most of the general purpose 1–200-hp motors reach “energy efficiency” levels, or IE2 levels in European terms. This law applies to motors manufactured for sale in the US effective October 24, 1997. The most recent energy efficiency law is the Energy Independence and Security Act (EISA) of 2007, which became effective December 19, 2010, raising efficiency levels for AC motors up from IE2 to premium efficiency levels (IE3). In addition, most of the motor designs exempted in the EPA legislation got included in the EISA law with mandated efficiency levels of IE2 (energy efficient).

So what is on the horizon for AC motor technology? A lot of discussion is centered on the next level of efficiency (IE4) but that is not going to be easy. Motor manufacturers have already added additional material and changed electrical designs to get the most out of current motor technology. The law of diminishing returns applies, with much higher costs required to achieve small incremental improvements in efficiency.

Copper cast-rotor technology may be an alternative to make induction motors more efficient, but copper is more expensive than the traditional aluminum cast rotor and harder to cast, especially in higher horsepower ratings with longer rotor designs. The motor industry is looking into permanent-magnet (PM) rotor technology that incorporates high-performance magnetic materials such as neodymium-iron-boron (NdFeB) or samarium-cobalt into the rotor. These are synchronous PM designs that offer significantly improved efficiency and/or power density. PM technology has been around for many years in the servomotor market. However, these motor designs generally require a

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drive for speed control and the cost of these high-performance magnets is quite high and, even worse, very volatile. One promising technology is Synchronous-Reluctance (not to be confused with Switch-Reluctance). This technology uses slots in the rotor design to help direct the magnet field and has a very low cost. This technology gets nearly the same efficiency as the PM designs but without the high-cost magnet material. Like the PM synchronous motors these motors use a traditional PWM (pulse width modulated) adjustable frequency drive with special software. Switch-Reluctance

(not to be confused with Synchronous-Reluctance) also uses a very simple rotor construction with lobes, but requires special drive control logic.

One thing is for certain, the industrial and commercial markets of the future will demand higher efficiency levels. Our focus must change from just increasing component efficiency levels to increasing the overall efficiency of the system, be it a pump, fan, compressor or conveyor. Variable speed control offers significant opportunities of energy savings. But the question remains, what motor technology will drive the next industrial revolution?

It is very likely that none of the aforementioned technologies will be the all-out winner.

In fact, it is much more likely that the motor of the future will be a hybrid design that combines several of these technologies into a single product with the efficiency of a synchronous PM or Synchronous-Reluctance motor, along with the operational characteristics of the traditional cross-the-line induction machine. As total system efficiency becomes more important, there may not be just one motor technology that will be the clear winner. Rather various motor technologies will be available, each with its own advantages and disadvantages. This means selecting the “right” motor for the application will become more sophisticated and efficiency will be evaluated on total overall system efficiency, with more applications moving from fixed-speed operation to variable-speed control. ⚡