



Formerly A. O. Smith Electrical Products Company

HVAC Motor Doctor®
a distribution HVAC newsletter

Understanding Motor Speed

An important part of determining the correct replacement motor for a particular application is understanding motor speed.

Every motor has magnetic poles, just like a permanent magnet. These poles are created by bundles of magnet wire wound together in the slots of the stationary part of the motor (the stator core). Look inside an electric motor, and you can count the number of poles or windings. The number and alignment of these bundles of wires creates magnetic poles, and the number of poles in the motor determine the motor's speed, stated in revolutions per minute. Keep in mind, no-load RPM is a factor of motor poles and power frequency, not voltage, horsepower, or motor diameter.

With that knowledge in mind, you may surmise that every four-pole AC induction motor runs at the same speed. This is in fact the case, and you can determine this speed by using the following formula:

For 60 hertz electrical systems: 7,200 divided by the number of poles in the motor gives you the no load RPM. For 50 hertz systems: 6,000 divided by the number of poles gives you the no load RPM. In North American, motors run on the 60 hertz system.

Another important element to note is that under load, the rotating parts of the motor fall behind or "slip" the magnetic speed. Using the standard formula, you can determine that a four-pole motor operating under no-load conditions will run at 1,800 RPM (7,200 divided by four poles). Loaded, the motor will slip to between 1,600 and 1,750 RPM. Four pole designs are the most common pole configuration for AC induction motors and are typically found in belted applications such as blowers, fans, air-handling equipment, compressors, commercial garage door openers, and conveyors.

A two-pole motor will operate at 3,600 RPM unloaded and between 3,000 and 3,450 RPM under load. Such speeds are commonly found in pump applications, such as submersible pumps, sump pumps, and pool or water recirculating equipment. Another typical application is small ventilating fans. To the untrained ear, two-pole motors appear to need servicing because they sound somewhat noisier when running. This is principally due to the higher RPM, and as a service technician, you should be aware of the different "normal" sounds a motor makes that are related to speed.

Six-pole motors run at 1,200 RPM unloaded and between 1,050 and 1,175 RPM loaded. They are often used for air-handling equipment, direct-drive applications, window fans, furnace blowers, room air conditioners, heat pumps, residential garage door openers, and other equipment.

As you can imagine, lower mechanical speeds often result in quieter designs, which makes an eight-pole motor well-suited for many residential applications where noise is a factor. These motors operate at 900 RPM unloaded (between 800 and 875 RPM loaded) and are being used more extensively today in room air conditioning, outdoor heat pump, and residential garage door openers.

A less common design is the 12-pole motor. This motor, which runs at 600 RPM unloaded, is used in washing machines and other equipment that require a slow cycle.

Here's the important point to remember: when replacing a motor, you must select a replacement with the same number of poles as the original. Changing, say, from a four-pole to a six-pole design, the speed mismatch is likely to create significant problems.