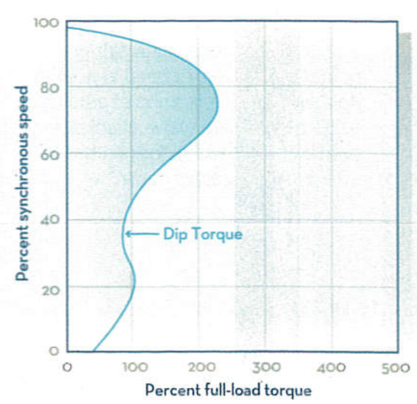
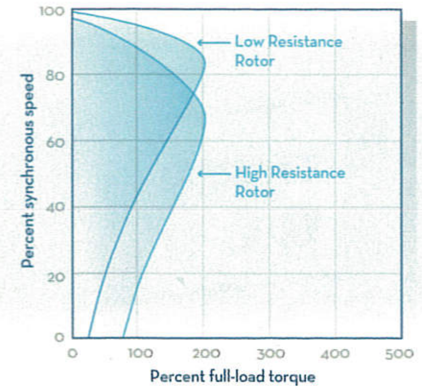
MOTORS

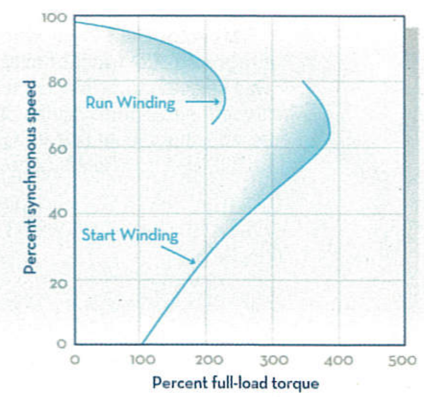
Shaded Pole Performance Characteristics



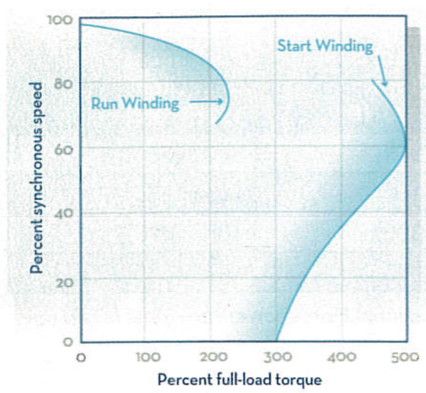
Permanent Split Capacitor Performance Characteristics



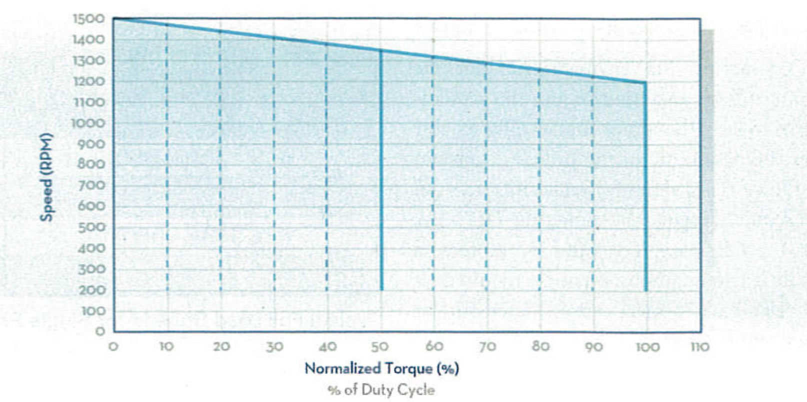
Split Phase Performance Characteristics



Capacitor Start Performance Characteristics



Variable Speed / ECM Motors Performance Characteristics



Select the Best Motor

A growing range of motors for specific applications provides a variety of benefits, limitations and price points.

by kamron wright

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Our society takes for granted that washers will agitate, dryers will spin and furnaces will circulate warm air, often not understanding the sophisticated motor technologies that make these products reliable, quiet and efficient.

As a design engineer, selecting motor and control technologies is not always an easy task. A growing range of motors for specific applications provides a variety of benefits, limitations and price points. So how can OEMs choose the best fit for an application?

The Basics

Normally, motor specifications begin with the fundamentals, including:

- Available power supply (voltage and current),
- Intended/projected use of the motor,
- Duty cycle,
- Horsepower,
- Space limitations,
- Ambient and operating temperatures,
- And environmental conditions.

Based on this information, it's ideal to select the simplest motor available to permit fast delivery and to eliminate the cost of special features but, if any application details are overlooked, the chosen motor may fail to perform to the standards of the job. In some cases even specially engineered designs may fail.

It's important to consider all of the following factors relating to a project, whether it be for a dishwashing, laundry, refrigeration or HVAC application:

- What is standard?
- What is readily available?
- What can be offered differently from the standard, but with a minimum penalty in time and expense?
- What are the required motor standards or regulatory requirements for the application?

Motor Horsepower and Operating Point(s)

Start by understanding the device the motor is driving, its load and speed, starting load and duty cycle. The horsepower needs to be determined at the intended operating speed(s). This can be calculated using machine handbook formulas and tables, or from the manufacturers of the driven devices such as fans and blowers, which provide graphs and charts as guides to the load requirements that will achieve a certain output.

OEMs also need to consider any efficiency losses of the unit being driven from bearings, belts, gears or friction. In addition, it's important to account for the worst case loading such as when the washing machine is full of wet clothes versus dry, or when an air handling system is operating at high external static pressures.

Motor Type

Engineers should pay attention to the types of motor that best meet load requirements and power supply specs for an individual application. Fractional and sub-fractional horsepower motors are classified by electrical types.

Shaded pole motors are simple in mechanical construction and are usually low in price. However, their low efficiency, power factor, dip torque and starting torque typically limit their application to direct drive fan and blower applications and submersible pumps where efficiency is not a concern and price is the main consideration.

Permanent split capacitor motors are widely used when starting torque requirements are not too high and moderate electrical efficiency is needed. They are typically used on fans, blowers, small pumps and gear motors. Like most AC induction motors, permanent split capacitor motors have a peak efficiency that occurs at a point 5 to 10% below synchronous speed that decreases dramatically as you move toward no load speed or locked rotor. They are typically designed for 1 to 5 speeds.

Split phase motors often are used in appliances such as washers and dryers. They have a start and a run winding. They can accommodate larger starting load requirements. Once a certain speed is reached, the start winding drops out by a mechanical switch or relay to run on the lower power run winding.

Capacitor start motors are typically used in compressors and pumps. They have a start and a run winding. However, the additional capacitor, in series with the auxiliary start winding, helps produce a higher starting torque per ampere than the split phase motor. As a result, a capacitor start motor can accommodate larger starting load requirements. Once a certain speed is reached, the start winding drops out, typically using a mechanical switch or relay to run on the lower power run winding.

Variable speed electronically controlled (including permanent magnet) motors include the category known as electronically commutated motors (ECM). The single phase AC power is converted to DC power using a rectifier and filter capacitor bank. The DC power is then converted back to AC power by using power transistors and a microprocessor control. This allows control of the current and frequency to the motor winding, allowing torque and speed control. Since both current and frequency can be controlled, the motor can operate up to the 80% efficiency range for larger fractional horsepower motors. While induction motors can be designed to run almost that efficient at a single speed, these motors maintain high efficiencies across wide speed ranges. The electronic control of the motor allows various input control methods such as 24 VAC, PWM (pulse width modulation or duty cycle control), and others from the user system control board.

HORSEPOWER FORMULA

A typical formula for determining power for fractional horsepower motors is:

horsepower = speed (RPM) X torque (oz. ft.) / 84032

Horsepower (1 HP = 746 watts). The shaft power may also be specified as "watts out" for very small motors. The efficiency of the motor is then determined by dividing "watts out" by the "input electrical watts" ("watts in"). For sub-fractional horsepower, the torque may be specified in ounce-inches; integral motors may be specified in pound-feet. The conversion constant must change accordingly.

WHAT MOTOR SPEED / RPM (ROTATIONS PER MINUTE) IS REQUIRED?

Most AC single phase induction motors will operate at their most efficient point at 5 to 10% below synchronous speed.

Synchronous Speed = 120 x Frequency (Hz) / # of Poles

For a six-pole motor operating at 60Hz, that would be 120 X 60/6 = 1200 RPM synchronous speed. A typical single speed motor's operating RPM at the motor's peak efficiency would then be from 1080 to 1140 RPM.