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CORRECTLY INTERPRETING THE DC MOTOR NAMEPLATE

If you have ever tried to figure out the field resistance from the information on a DC motor nameplate, you probably wondered what the manufacturer was thinking. You know Ohm's Law (R=E/I or I=E/R or E=IR), but the nameplate information just doesn't seem to follow it.
(Where: R = resistance, E = voltage, I = current)

For those accustomed to the format of the AC motor nameplate, DC nameplate information can seem confusing–even misleading. Misinterpret the field voltage/field current/rpm information, and a technician is liable to conclude that something is wrong with the motor. You may even question whether a repair was done correctly. The most confusing case is the DC motor with dual voltage fields and field-weakening capabilities. An example should help illustrate the problem:

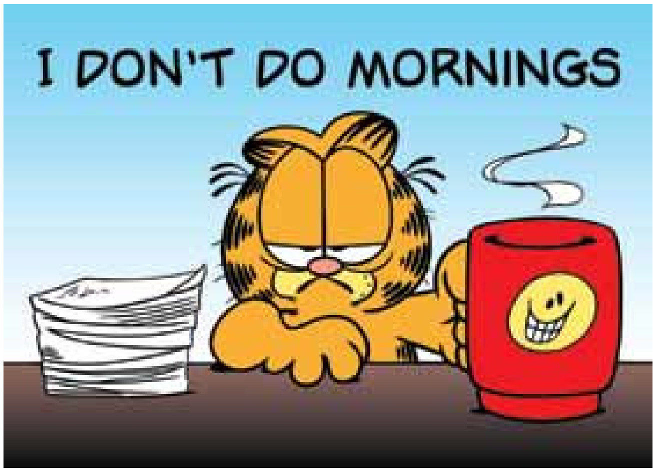
Field voltage: 150/300
Field amps: 3.2/1.2
Rpm: 1750/2500
Field Ohms @ 25 C

It would be natural to assume that the 150 volt, 3.2 amps and 1750 rpm ratings go together, with the 300 volts, 1.2 amps and 2500 rpm ratings also related (just like an AC nameplate). That assumption is wrong, unfortunately. With the DC nameplate, the first field current rating and the first rpm (base speed) correspond to the high field voltage rating (at operating temperature and rated load).

DC FIELD STRENGTH

DC coil strength is reported in ampere-turns (field current multiplied by the turns per field). Field weakening, by reducing the voltage applied to the fields, also reduces the current carried by the field conductors (I = E/R). Since the turns remain constant, a change in field current causes a corresponding change in field strength. As the shunt fields are weakened, the motor speed increases.
The first rpm listed on the nameplate is the base speed at full load. The second number, if two speeds are given, is the field-weakened speed or the maximum safe speed. This may be limited by the construction of the armature, or it could represent the limit for stable speed control. It provides a warning to the end user to limit the speed. DC motors are constant horsepower from base speed and higher.

Attempting to run a DC motor beyond that speed limit could result in the rapid acceleration associated with field loss–the motor "runs away" or accelerates so quickly that catastrophic failure is almost certain. Those who have seen the aftermath know how important it is not to exceed the maximum safe speed.
In the example above, 3.2 field amps should produce the rated base speed (1750 rpm) at full load. The second field current rating (1.2 amps) is the lowest safe current when field-weakening is used, and should result in a speed increase to 2500 rpm at rated load. That 2500 rpm is the maximum safe speed for this motor (the highest rpm at which it should be run).



FIELD CURRENT (AMPS)

The field current on the nameplate is based on the field being at full operating temperature, typically under full load conditions. In other words, the fields are “hot.” Conversely, the nameplate field ohms are typically given for ambient conditions with the machine not yet operating (i.e., “cold”). The temperature used is typically 25° C (68° F).

Since the nameplate field current refers to “hot amps,” and the resistance we are after is “cold” resistance, it is necessary to adjust the resistance in order to apply Ohm’s Law. The example below indicates accurate multipliers for each insulation class if the fields operate at the listed temperature.
Example:
Nameplate rating: 300 volts, 3.2 hot amps, Class A rise
3.2 x 1.2 = 3.90 cold amps
300 / 3.90 = 76.9 ohms “cold” estimate
The estimate of 76.9 ohms is very close to the nameplate cold resistance of 75.6 ohms.

Insulation class/Hot-cold resistance multiplier
A/1.22, B/1.33, F/1.53, H/1.63

CURRENT FOR LOW FIELD VOLTAGE

What about the field current for the low voltage rating? Consider the field coils as basic circuits. The dual voltage field circuit is comprised of 2 circuits that can be connected in series or parallel.
Using Ohm’s Law:
300 volts / 3.2 amps = 93.75 ohms
Since the high voltage connection is series, 93.75 ohms divided by 2 = 46.88 ohms per circuit.
Connecting those two resistors of 46.88 ohms in parallel, the resulting resistance = 23.44 ohms. If 150 volts (the low voltage rating) is applied, the expected current is 6.4 amps. Note that the field current doubles when the applied voltage is halved. This information is also helpful when troubleshooting dual-voltage field connections. Not everyone marks their 4-lead shunts in the same way. A DC motor accidentally connected so that only half the fields are energized will operate, but half the fields will have a short thermal life. The clue, of course, is that two fields will look brand new while the other two fields will exhibit severe thermal damage. Confirming the customer’s drive parameters, especially the current, may prove the misconnection.
For DC machines, the nameplate format actually is very logical once you know what you are looking at. Understanding the reason behind the labeling will help you avoid costly mistakes, and provide an additional level of quality control.
Caution: With modern DC drive parameters set by field current, the manufacturers recognize the need to report hot amps so that installers don’t make a similar mistake in applying Ohm’s Law. When a nameplate is missing or defaced, the installer may calculate the field current from what he knows: the applied voltage (of the drive) and the resistance (which can be measured). The trouble is, the controller will hold the field current constant, and that may saturate the fields. So the example of multipliers for various temperature classes is critically important.

The information in this month’s Foxtracks is from EASA’s “Fundamentals of DC Operation and Repair Tips” publication.