Understanding Fractional Horsepower Permanent Magnet Motors

Torque

The torque rating of an electric motor is described as the maximum turning movement the motor can produce at its output shaft without overheating.

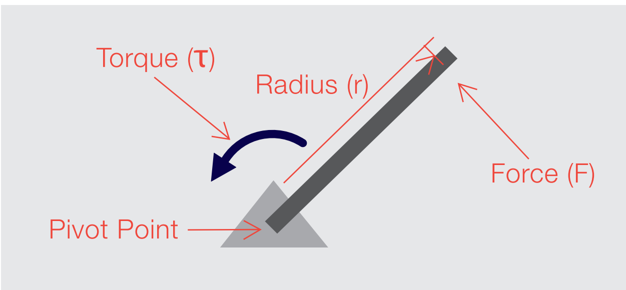

Figure 1 – Applying force to a lever produces torque

The force that produces the torque in a permanent magnet motor is proportional to:

- Total magnetic field strength
- Amount of current going into the motor
- Windings (number of turns affects motor torque and wire diameter affects heat and efficiency)

Torque is a major cost driver.

Increasing torque drives cost because it is driven by 3 of the most expensive parts of the motor:

1. Magnets
2. Frame size
3. Copper magnet wire

Power

The Concept of "Work":

In linear terms work is simply force times distance or W = Fd. In the rotating world of electric motors work is defined as torque acting through angular displacement, represented by the symbol θ. Therefore W = τθ.

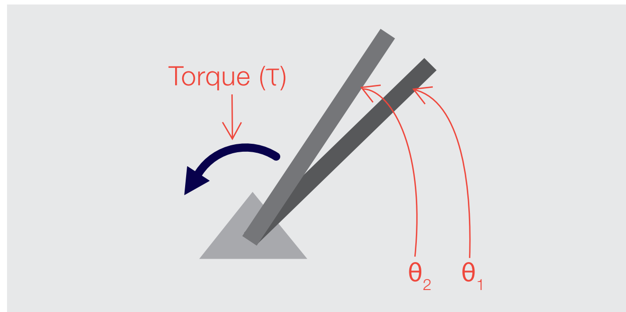

Figure 2 – Work is proportional to torque and displacement

Power = the rate at which work is done.

Helpful Hints:

- The ultimate performance of a motor depends on the load it must move, the distance it moves the load and the time over which it moves through the angular displacement.
- Power supply available will have a big impact on the ultimate motor design.

Simplifying Power Calculations:

Torque and rotational velocity are often expressed in different units that must be converted to a common basis. The conversion constants in the table below make the task of power calculation much easier:

Torque (τ) Units	K to Calculate Power in Watts (W)	K to Calculate Power in Horsepower (HP)
Oz-in	.0007395	9.913×10^{-7}
N-m	.1047	1.404×10^{-4}
Lb-in	.01183	1.586×10^{-5}
Lb-ft	.1420	1.903×10^{-4}

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Heat Dissipation

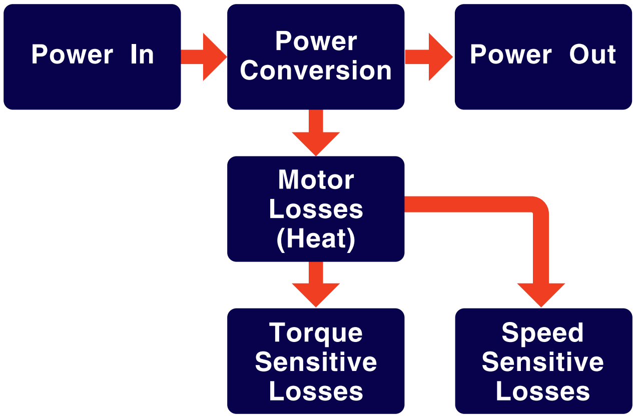

Figure 3 – Motor losses generate heat

Motor losses are a by product of the power conversion process. These losses are dissipated as heat in the motor and they come in two types:

1. **Proportional to torque** – caused by resistance of the motor

2. **Related to speed** – include such things as eddy currents, hysteresis, bearing friction and brush contacts.

The question is:

How much will the motor's environment or duty cycle help or hinder the heat dissipation process?

To illustrate:

A fan cooled motor will dissipate as much as four times the heat of a non-fan cooled motor which means a smaller motor can be used for the same application.

Other factors affecting heat dissipation:

- Heat sinking improves thermal efficiency
- Larger motors will radiate more heat
- High ambient temps will reduce motor thermal efficiency
- Motors mounted in enclosed spaces will be less efficient
- Intermittent duty will require a smaller motor
- Dirty motors radiate less heat

Let us help you design and build the right motor for your application.

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