Introduction

How to Choose the Right Motor for Your Electric drive?

A guide of how to choose the best motor for your application.

According to the structure and working principle, there are three types of electric propulsion drive motors:

These are:

1. Direct current motors have 2 types:
   a. Brushed, commonly referred to as DC motors, are the original traditional design dating back to the early 1900's. They have a wound rotor with a static magnet field grouped around the outside of the rotor. They need routine maintenance because the internal carbon brushes regularly wear out and have inherent sparking at the commutator when changing direction to further increase wear. Thus, DC motors are not recommended for electric vehicle drives and now usually confined to applications for sub-fractional powers.
   b. Brushless, commonly referred to as BLDC motors, were developed on a similar basis but with permanent magnets fixed to the rotor and the windings grouped outside the rotor. There are no brushes and commutation is achieved using a digital speed controller or servo drive. Care must be taken as demagnetization can occur if over-driven but with the advent of modern-day sophisticated controllers this can be avoided but which also limits the available peak torque. BLDC motors are typically used where power is less than 5 kW and used in e-bicycle or scooter.

2. Asynchronous AC motor (AC motor for short) are a more conventional AC induction motor design as used for high voltage motors powered by industrial/domestic mains electricity but wound for operation with low voltage battery power from 48 to 120 volts. Compared with BLDC motors the efficiency of an AC motor is slightly lower but the torque is higher for the same power which means that for vehicle drives they have a better climbing ability. After several years of development, the cost of AC motors is now less than a BLDC motor and is maintenance free. It is better to use BLDC motors for applications below about 3 kW while 3 kW to 30 kW is most suitable for an AC motor. Also, AC motors have an inherent higher speed capability over BLDC which, for example, results in a maximum vehicle speed of a 15 kW AC motor to typically reach 120 km/hr.

3. Synchronous permanent magnet AC motor, commonly referred to as PMSM. These are brushless AC motors with a permanent magnet rotor thus a cross between BLDC and AC but they also can be used as a generator. Because the structure of PMSM is more complicated the cost of the motor and controller is higher and there is also the possibility of de-magnetism. These are typically used for very high power where the power to weight ratio is advantageous to BLDC but the cost ratio is a disadvantage.

In summary, given that electric vehicles require climbing and overload ability which usually exceeds 5 kW with a high demand up to 30 kW and above, the AC motor has a distinct price advantage because magnets are not used in their construction.

PMSM have several disadvantages for powers <20 kW:

a. The motor and controller prices are much higher than AC motors and controllers.

b. The higher the power the more batteries are needed. At present, lithium batteries are expensive while the volume of lead acid Gel batteries is large so the application typically dictates the type of battery chosen.

To conclude, AC asynchronous motors are the best choice for electric vehicles in the 3 to 30 kW range.