FACTORS AFFECTING SIZE OF MOTOR – PART 2

Motor output power:

$$P_{out} = \mathrm{K} B_{av} \mathrm{ac} D^2 \mathrm{L} N_s$$

where,
P_{out} = Output power (W)
K = Constant
B_{av} = Average airgap flux density (T)
ac = Electrical loading (amp – turn/m)
D = Rotor diameter (m), L= Length of rotor (m)
N_s = Motor speed (rpm)

For the same output power, the size of the motor can be reduced by:

1. Increase in magnetics/magnetic loading (i.e. Increase in magnet B_r and hence the B_{av})
2. Increase in motor speed (N_s)
3. Increase in winding current or no. of turns/coil (i.e. Increase in ac)

Increase In Motor Speed

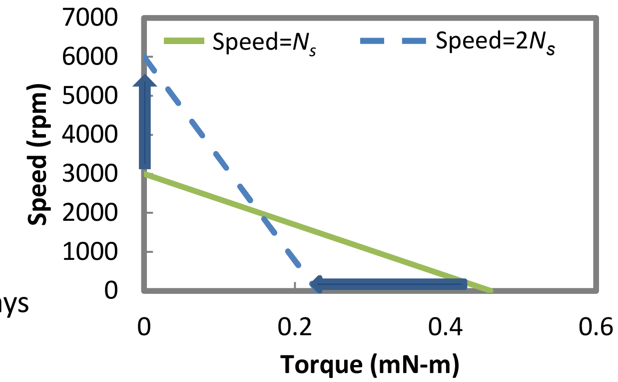
- For a given output power, if the motor is designed to operate at double the operational speed, only half the torque is required.

$$P_{out1} = T_1\omega_1,\ P_{out2} = T_2\omega_2,$$

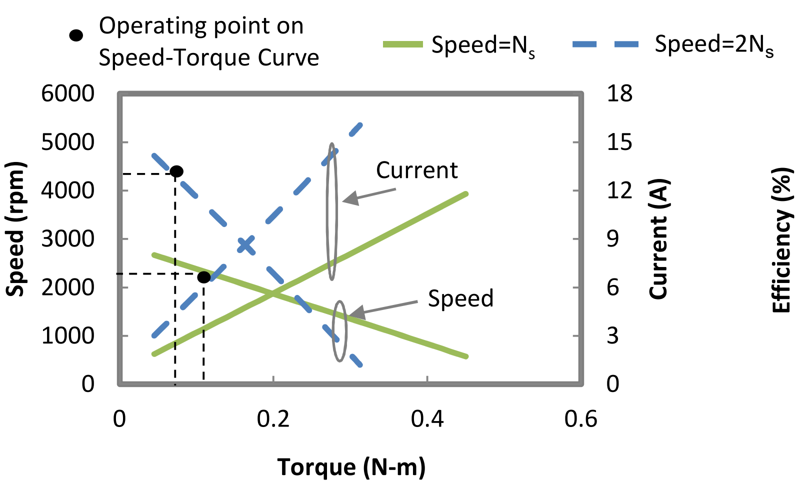
if $P_{out1} = P_{out2}$, $\omega_2 = 2\omega_1$, $T_2 = 0.5T_1$

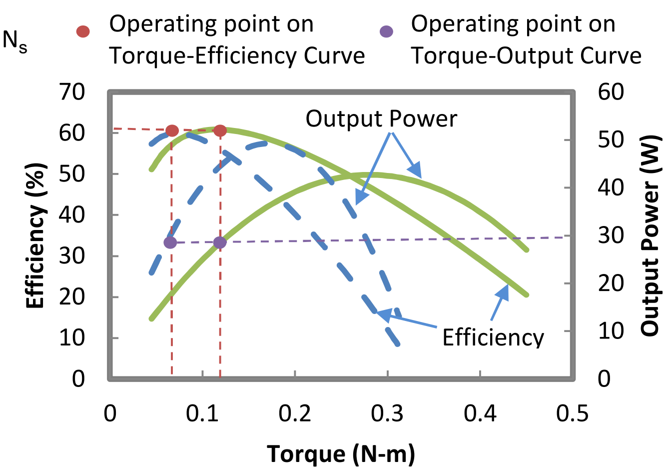
where, T=Torque and $\omega = {}^{2\pi Ns}/_{60}$

This equation dictates that a higher speed motor is always smaller (and lighter) for any given P_{out} and T.



Speed	N_s	$2N_s$
Volume ratio	1	0.5
Magnet weight (g)	34.6	17.3
Total motor weight (g)	283.0	151.7





Following considerations should be made while deciding the motor speed:

- Influence on gear system: e.g. Gear system with higher gear ratio may become mechanically weak
- Influence on noise and vibration: e.g. Higher motor speed may lead to higher noise and vibration
- Influence on core losses: e.g. Higher motor speed may lead to higher core losses
- Influence on brushes: e.g. Higher speed may lead to sparking at brush and commutator surface

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