EEEN313/ECEN405

Motor Parameters 2 – An example

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So what do we do?

- When we select a motor for a given load, we should select a motor that matches that load while using the motor at its full rating.
- If a load requires 500 N-m of torque, select a motor that is designed to deliver 500 N-m as its full load.
- But what if I can't find such a motor? Should I go high or low?
- Many motors have a service factor of 1.15, so a motor that can deliver at full load 440 N-m won't be overloaded by a load of 500 N-m (440 × 1.15 = 506).
- So the proper choice would be a 440 N-m motor.

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Motor Selection based on matching Load

- To select a motor (normally) –
  - choose a motor whose rated torque equals load torque
  - Or whose HP rating is equal to load's HP
- Not that easy and leads to wrong decision
- Our example: centrifugal fan that requires a torque of 70 N-m at 1,800 rpm and 100 N-m at start.
- We are to select a motor to properly drive this load. The only other thing we know about the fan is that the power required is proportional to the cube of the shaft speed.
- Our solution – finding the HP required by the fan and pick some from catalogue

HP for fan

- Simple solution – Find HP of the motor and find the next larger motor.

$$\omega_f = \frac{1800}{60} 2\pi = 188.5 \text{ radians/second}$$

$$P_f = 70\omega_f = 13.20 \text{ kW} = 17.7 \text{ hp}$$

- From a catalogue, we can choose a 15 HP one but tempted to get a 20 HP motor.
- 15 HP with service factor (1.15) is 17.3 which is less than 17.7.
- Lets see if 15 HP can do our job.

Motor Constants

- Motor constant k_m relates torque to shaft speed (slope of the torque slip curve)

$$T_m = k_m s_m$$

- 15 HP catalogue says full load torque of 61 N-m at 1750rpm. So km would be

$$61 = k_m \frac{1800-1750}{1800}, \;\; k_m = 2.20\times10^3 \;\; \text{N-m}$$

K for fan

- k value for fan would depend on required power-speed relationship that we can choose (by design)
- For our example, lets say power for this fan is proportional to the cube of the speed
- So torque is square of the speed (Torque is power divided by speed)

$$T_f = k_f n_f^2$$

$$70 = 1800^2 k_f, \;\; k_f = 2.16\times10^{-5} \;\; \text{N-m/rpm}^2$$

Two torque equations

- Since torque for fan must be produced by the motor

$$T_f = k_f n_f^2 = T_m = k_m s_m$$

- Changing slip to rpm

$$2.16\times10^{-5} n_f^2 = 2.20\times10^{3}\frac{1800-n_f}{1800}$$

$$n_f^2 + 5.658\times10^{4} n_f - 1.019\times10^{8} = 0,$$

$$n_f = 1,747 \text{ rpm}$$

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How all this relates

- Motor's speed of 1747 is close to full-load speed of motor 1750

$$T_m = 2.20\times10^{3}\frac{1800-1747}{1800} = 64.8 \text{ N-m}$$

$$P_m = \left(\frac{1747}{60}2\pi\right)64.8 = 11.85 \text{ kW} = 15.9 \text{ hp}$$

- Since this is well below 17.3 HP limit of 15 HP motor, 15 HP is fine.
- So no point in over-sizing the motor.

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