Example

A 460-V, 25-hp, 60-Hz, four-pole, Y-connected wound-rotor induction motor has the following impedances in ohms per phase referred to the stator circuit

$R_1 = 0.641\Omega$ $R_2 = 0.332\Omega$

$X_1 = 1.106\,\Omega$ $X_2 = 0.464\,\Omega$ $X_M = 26.3\,\Omega$

1. What is the maximum torque of this motor? At what speed and slip does it occur?
2. What is the starting torque of this motor?
3. If the rotor resistance is doubled, what is the speed at which the maximum torque now occur? What is the new starting torque of the motor?
4. Calculate and plot the *T*-*s* c/c for both cases.

4

Solution

$$V_{TH} = V_{\phi}\frac{X_M}{\sqrt{R_1^2 + (X_1 + X_M)^2}}$$

$$= \frac{\frac{460}{\sqrt{3}} \times 26.3}{\sqrt{(0.641)^2 + (1.106 + 26.3)^2}} = 255.2 \text{ V}$$

$$R_{TH} \approx R_1\left(\frac{X_M}{X_1 + X_M}\right)^2$$

$$\approx (0.641)\left(\frac{26.3}{1.106 + 26.3}\right)^2 = 0.590\Omega$$

$$X_{TH} \approx X_1 = 1.106\Omega$$

5

Solution

$$s_{T_{max}} = \frac{R_2}{\sqrt{R_{TH}^2 + (X_{TH} + X_2)^2}}$$

$$= \frac{0.332}{\sqrt{(0.590)^2 + (1.106 + 0.464)^2}} = 0.198$$

The corresponding speed is

$$n_m = (1 - s) n_{sync} = (1 - 0.198) \times 1800 = 1444 \text{ rpm}$$

6

Solution

The starting torque is now

$$\tau_{start} = \frac{3\times(255.2)^2\times(0.664)}{1800\times\frac{2\pi}{60}\times[(0.590+0.664)^2+(1.106+0.464)^2]}$$

$$= 170 \text{ N.m}$$

7