Electrical Machines, Drives and Power Systems | (6th Edition)

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Chapter 13, Problem 24QP | Bookmark | Show all steps: ON

Problem

Intermediate level

If we slightly increase the rotor resistance of an induction motor, what effect does have (increase or decrease) upon

a. Starting torque

b. Starting current

c. Full-load speed

e. Power factor

f. Temperature rise of the motor at its power output

Step-by-step solution

Step 1 of 6

a.

The rotor resistance is directly relative to the initial torque of the three phase induction motor. So, high rotor resistance tends to increase starting torque.

Hence, the starting torque is increased if the rotor resistance is increased.

Comment

Step 2 of 6

b.

Refer to Figure 13.18 in the text book.

From different cases of current vs. speed characteristics, it concludes that the initial current of the motor is directly relative to the rotor resistance. So, starting current decreases when rotor resistance increases.

Hence, the starting current is decreased by increasing the rotor resistance.

Comment

Step 3 of 6

c.

Increasing of rotor resistance reduces the rotor current and it tends to reduce the torque. So, it is essential to decrease the motor speed (full-load speed) to develop an equivalent torque which was available at earlier.

Hence, the full-load speed of the motor is $\boxed{\text{slightly decreased}}$ by increasing the rotor resistance.

Comment

Step 4 of 6

d.

Write an expression to find I^2R losses in the rotor.

$$P_{jr} = I^2R$$

Here,

I is the current [A], and

R is the rotor resistance $[\Omega]$.

This I^2R loss is directly relative to the rotor resistance. So, losses increases by increasing the rotor resistance. The equation of efficiency of the motor is mentioned as follows:

$$\eta = \frac{\text{output power}}{\text{input power}}$$
$$= \frac{\text{output power}}{\text{output power} + \text{losses}}$$

So, increasing of losses tends to decrease the efficiency of the motor.

Hence, the efficiency is $\boxed{\text{decreased}}$ by increasing the rotor resistance.

Comment

Step 5 of 6

e.

Consider the expression of power factor.

$$\text{pf} = \frac{\text{real power}}{\text{apparent power}}$$

From this expression, power factor is directly relative to the real power. Increasing of rotor resistance increases the real power of the motor. So, this increasing of real power increases the power factor.

Hence, the power factor is $\boxed{\text{increased}}$ by increasing the rotor resistance.

Comment

Step 6 of 6

f.

Consider the expression of I^2R losses in the rotor.

$$P_{jr} = I^2R$$

Here,

R is the rotor resistance $[\Omega]$.

This I^2R loss is directly relative to the rotor resistance. The motor will get more heat whenever the losses or power dissipation increases.

So, the heat dissipation in the rotor winding is increased by increasing the rotor resistance value.

Hence, the temperature rise at the full-load is $\boxed{\text{slightly higher}}$ when the rotor resistance is increased.

Comment

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Recommended solutions for you in Chapter 13

Chapter 13, Problem 16QP

Intermediate levelA 3-phase, 6-pole induction motor is connected to a 60 Hz supply. The voltage induced in the rotor bars is 4 V when the rotor is locked. If the motor turns in the same direction as the flux, calculate the approximate voltage...

See solution

Chapter 13, Problem 14QP

Practical levelHow can we change the direction of rotation of a 3-phase induction motor?

See solution