16/EN604/017 EEF 326 (TEST) 1 EMEKA Nwoqu
17/06/2020

Question 1:

ABUAD mango Juice factory is serviced by a 415V, 3-phase, 4-wire 50Hz. This supply powers the main drive motor having an output of 74.6 KW and running on full Load at a power factor of 0.7 Lagging with an efficiency of 85%

Identify the drive motor type and sketch the motor-supply circuit with a direct-online starter.

Determine the capacitance per Phase of a mesh-connected capacitor necessary to raise the power factor to
(i) Unity
(ii) 0.9 Lagging.

Answers

NOTE: V = 415v, f = 50Hz, P.F = 0.7,
3-Φ, 4-wire, P = 74.6, %ef = 85%.

① Unity => 1

$$C = \frac{KVAR}{2\pi f V^2}$$

$\therefore$ KVAR = P (tan actual P.F − tan target P.F)

$\therefore$ actual P.F => $\cos\theta = 0.7$

$\theta = \cos^{-1} 0.7$

$\therefore = 45.57$

$\tan 45.57 = 1.0201$,,

target p.F => $\cos\theta = 1$

$\theta = \cos^{-1} 1 = 0$

$\tan 0 = 0$

$\therefore$ KVAR = 74.6 x (1.0201 − 8)

= 76.0995

$\therefore \approx$ 76.10,,

$$C = \frac{76.10}{2 \times \pi \times 50 \times 415^2}$$

$$= 0.000004$$

$$\therefore \simeq 1.4 \times 10^{-6} C \text{ //}$$

ii 0.9 Lagging

when actual p.f = 1.0201

target P.F = $\cos\theta = -0.9$

$\theta = \cos^{-1}(-0.9)$

$= 154.16$

$\therefore \tan\theta = -0.48.$

$KVAR = 74.6 \times (1.0201 - (-0.48))$

$= 111.90.$

$\simeq 112.$

$$C = \frac{KVAR}{2\pi FV}$$

$$= \frac{112}{2 \times \pi \times 50 \times 415^2}$$

$= 0.00086.$

$\simeq 8.6 \times 10^{-4} C$ //

3

QUESTION 3

A 50Hz, 1/4hp motor runs at 2000rpm and takes 0.7A when connected to a 220V DC source if the resistance and inductance of the machine are given at 15Ω and 0.25H respectively, Determine the following when the motor is connected to a 220V. 50Hz AC supply and is loaded to take 0.7A of current

i Speed of the motor

ii The power factor of the motor

iii Torque developed by the motor

iv What type of motor could be used for this application

Answers

NOTE:

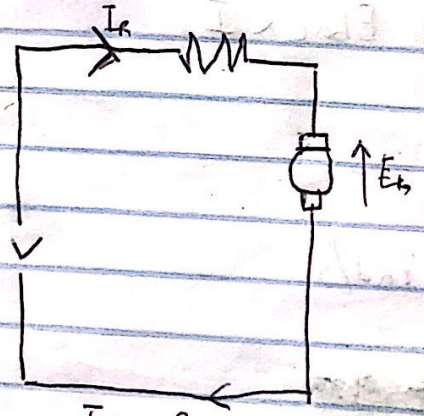
$F = 50Hz$, $1/4 hp$, $N_f = 2000 rpm$,

$V = 220V$, $R = 15ohms$, $L = 0.25H$

On a DC Supply

Voltage = 220V

Current I = 0.7A



$\therefore V - E_b = I_L \times R$

$V - [I_L \times R] = E_b$

$\therefore E_b = 220 - [0.7 \times 15]$

$= 209.5V$

Speed on DC, = 2000rpm

On Ac Supply

Supply voltage (V) = 220V

Current drawn, $I_L = 0.7A$

Reactance drop: $I_L \times R = 0.7 \times 15$

$\therefore = 10.5V$ //

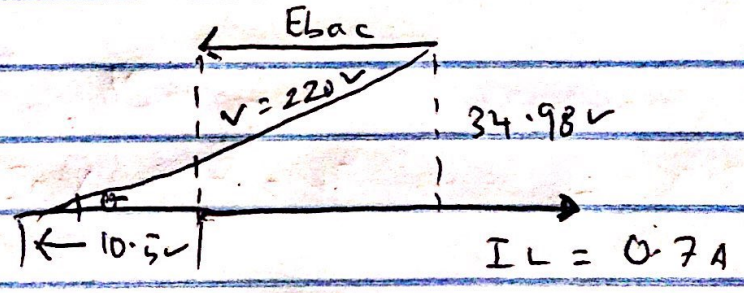
Reactance voltage drop = $I_L \times X_L$

$= 0.7 \times 2\pi FL$

Where $X_L = j\omega L = 2\pi FL$

$= 0.7 \times 2\pi \times 30 \times 0.25$

$= 54.98V$ //



$Ebac = \sqrt{V^2 - (X_L)^2} - IR$

$\therefore = \sqrt{(220)^2 - (54.98)^2} - 10.5V$

$= 202.32V$ //

i Speed Constant equation:

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}$$

$$\therefore \frac{E_{bac}}{E_{bdc}} = \frac{N_{ac}}{N_{dc}}$$

$$\therefore N_{ac} = N_{dc} \times \frac{E_{bac}}{E_{bdc}}$$

$$= 2000 \times \frac{202.52\,V}{209.5\,V}$$

$$\therefore N_{ac} = 1933.37\,rpm$$

ii Power factor $(\cos\theta) = \frac{E_{bac} + IR}{V}$

$$\therefore = \frac{202.52 + 10.5}{220}$$

$$\therefore = 0.968 \text{ Lagging}$$

Torque developed $(T_w) = E_{bac} \times I$

$$\therefore T_{ac} = \frac{E_{bac} \times I}{w}$$

Where (w) is speed in rad/s

$$\therefore W = 2\pi n$$

$$\therefore T_{ac} = \frac{E_{bac} \times I_L}{2\pi \times \frac{N_{ac}}{60}}$$

$$\therefore = \frac{202.52 \times 0.7 \times 60}{2\pi \times 1933.37}$$

$$\therefore = 0.700\,Nm$$