* It converts the input mechanical Energy to an Electrical Energy which is given back to supply. It delivers active power to the 3ϕ line.

* The Power Flow Reverses hence rotor induced EMF and Rotor current also reverse. So Rotor Produces torque in opposite direction to achieve the braking.

* Electrical Energy is given back to the lines while braking, it's called regenerative braking.

* It's very seldom used for braking but it's application is very useful to lifts and hoists for holding decending loads at a speed only slightly above the synchronous speed.

Advantages:

* Generated Power can be used for useful Purpose.

Disadvantages:

* Fixed frequency supply it can be used only for speeds above synchronous speed.

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1. A 4 pole, 3 phase, 50HZ, star connected induction motor has a full load slip of 4%. calculate full load speed of the motor.

Given:

No of Poles, $P = 4$

$f = 50HZ$

% of slip, $S_{FL} = 4\% \Rightarrow 0.04$

To fi

* Full load speed = ?

Sol:

$$N_s = \frac{120f}{P} \Rightarrow \frac{120 * 50}{4} \Rightarrow 1500 \text{ rpm}$$

$$S_{FL} = \frac{N_s - N_{FL}}{N_s}$$

$$0.04 = \frac{1500 - N_{FL}}{1500}$$

$$N_{FL} = 1440 \text{ rpm}$$

Result:

The full load speed of motor is, $N_{FL} = 1440$ rpm.

2. A 6 pole, 3 phase induction motor operating on a 50 Hz supply has rotor emf frequency as 2 Hz. Determine (a) slip and (b) the rotor speed

Given:

$P = 6$,
$f = 50$ Hz
$f_r = 2$ Hz

To find:

(a) slip, $s = ?$
(b) rotor speed, $N = ?$

$s = \frac{N_s - N_r}{N_s}$

~~$N_r = s \cdot N_s$~~

Sol:

(a)

$$f_r = s \cdot f$$

$$2 = s * 50$$

$$s = 0.04$$

$$s = 4\%$$

(b)

$$N_s = \frac{120f}{P} \Rightarrow \frac{120 * 50}{6} \Rightarrow 1000 \text{ rpm}$$

$$S = \frac{N_s - N}{N_s} \Rightarrow S \cdot N_s = N_s - N$$

$$N_s - SN_s = N$$

$N = N_s(1-s)$

$= 1000(1-0.04)$

$N = 960$ rpm

3. A 220V shunt motor has an armature resistance of 0.062Ω and with full fields has an emf of 215V at a speed of 960 rpm, the motor is driving an overhauling load with a torque of 172 Nm. calculate the minimum speed at which the motor can hold the load by means of regenerative braking.

given:

$V = 220V$

$R_a = 0.062\Omega$

$E = 215V$

$N = 960$ rpm

$T = 172$ N-m.

To Find:

speed = ?

$P_i = P_m$ W

$VI_a = \frac{2\pi N T}{60}$

$VI_a = \frac{\omega \cdot T}{E}$

Sol:

$\omega = \frac{2\pi N}{60}$

* $I_a = \frac{T \cdot \omega}{E} \Rightarrow \frac{172 * 2\pi * 960}{60 * 215} \Rightarrow 80.38$ A

I_a

Emf induced during regenerative braking.

$E_g = V + I_a R_a$

$E > V$

$= 220V + (80.38 * 0.062)$

$E_g = 225V$

$N \propto \frac{E_b}{\phi}$

E is directly proportional to speed, being a shunt machine.

Hence, speed $= \frac{N}{E} \times E_g = \frac{960}{215} * 225 \Rightarrow 1004.65$ rpm

(Q2)

1. A 3ϕ induction motor has a ratio of maximum torque to full load torque as 2.5 : 1. Determine the ratio of starting torque to full load torque if star-delta starter is used. The rotor resistance and standstill reactance per phase are $0.4\,\Omega$ and $4\,\Omega$ respectively.

Sol:

Given ratio is, $\frac{T_m}{T_{fl}} = 2.5$

The rotor values, $R_2 = 0.4\,\Omega$

$X_2 = 4\,\Omega$

$$\therefore \quad T_m = \frac{K E_2^2}{2 X_2}$$

$$\therefore \quad T_{FL} = \frac{T_m}{2.5} \Rightarrow \frac{K E_2^2}{5 X_2}$$

$$T_{FL} = \frac{K E_2^2}{20} \rightarrow (1)$$

Now $$T_{st} = \frac{K E_2^2 R_2}{R_2^2 + X_2^2}$$

with star-delta starter

$$E_2 = \frac{E_2}{\sqrt{3}}$$

$$T_{st} = \frac{K\left(\frac{E_2}{\sqrt{3}}\right)^2 \cdot R_2}{R_2^2 + X_2^2} \times \text{~~}\frac{20}{KE_2^2}\text{~~} \rightarrow (2)$$

$\therefore$ ratio of (2) & (1) is

$$\frac{T_{st}}{T_{FL}} = \frac{K\left(\frac{E_2}{\sqrt{3}}\right)^2 R_2}{R_2^2 + X_2^2} \times \frac{20}{K E_2^2}$$

$$\frac{T_{st}}{T_{FL}} = \frac{20 \times 0.4}{3\left[(0.4)^2 + (4)^2\right]}$$

$$\frac{T_{st}}{T_{FL}} = 0.165$$