Speed control of Induction motor

A 3φ induction motor is practically a constant speed motor just like a dc shunt motor. The speed of a d.c shunt motor can be adjusted between wide range with good efficiency and speed regulation by shunt field regulator, but in induction motors speed ~~control~~ cannot be changed without loosing efficiency and good speed regulation.

The speed of an induction motor is given by the expression. rotor speed = N_r

$$N_r = \frac{120f}{P}(1-S) \quad \text{and} \quad N_s = \frac{120f}{P} \left[N_s \Rightarrow \text{stator speed} \right]$$

$N_r = (1-S)N_s$

Thus there are three factors

(1) supply freq f

(2) number of poles P and

(3) slip S

on which speed of an induction motor depends.

Hence to change the speed of an induction motor it is essential to change at least one of the three factors.

1. Frequency control :- Though this method provides wide ~~range~~ speed control range with gradual variation in speed throughout the range but the difficulty is that how to get the variable supply frequency. That is why this method is not used for general purpose speed control applications.

The synchronous speed of an induction motor is given by $N_s = \frac{120f}{P}$

The synchronous speed and therefore the speed of the motor can be controlled by varying the supply frequency

The emf induced in the stator of the induction motor is given by

$$E_1 = 4.44 \cdot K_f \Phi T_1$$

Therefore if supply frequency is changed E_1 will also change to maintain the same air gap flux. If the stator voltage drop neglected, the terminal voltage V_1 is equal to E_1. In order to avoid saturation and to minimise losses motor is ~~generated~~ operated at rated air gap flux by varying terminal voltage with freq. Thus the speed control of induction motor using variable freq supply requires a variable voltage power source,

2 By changing the no of poles :- The no. of stator poles can be changed by

1. multiple stator winding
2. method of consequent poles and
3. pole amplitude modulation

The method of speed control by pole changing are suitable for cage motors only because the cage motors automatically develops no of poles equal to the poles of stator windings.

3. slip control : The various methods of slip control are.

1. Line voltage control
2. Rotor Resistence control
3. Secondary Foreign voltage control.

x ——— x

Que. A 10Hp, 230V, 3 phase 50Hz, 6 pole Squirrel Cage induction motor operates at a full load slip of 4% when rated voltage and rated frequency are applied. Determine (i) full load speed

(ii) full load torque in newton - meter

(iii) frequency of rotor current under this condition

(iv) Speed of rotation of the stator mmf.

Soln. Supply frequency = 50Hz.

Number of poles P = 6

(i) Full load speed $N = N_s(1-s)$

$= 1000(1-0.04) = 960$ rpm.

(ii) Full load torque in N-m $= \frac{\text{output in watts}}{2\pi N/60}$

$= \frac{10 \times 735.5}{2\pi \times 960/60}$

$= \frac{7.355}{32\pi} = 73.16$ Nm

(iii) frequency of rotor current $f' = sf$

$= 0.04 \times 50 = 2$ Hz.

(iv) Speed of rotation of the stator mmf

$= N_s = \frac{120f}{P} = \frac{120 \times 50}{6} = 1000$ rpm.