SPEED CONTROL FROM STATOR SIDE

1. **V / f control or frequency control -** Whenever three phase supply is given to three phase induction motor rotating magnetic field is produced which rotates at synchronous speed given by

$$N_s = \frac{120f}{P}$$

In three phase induction motor emf is induced by induction similar to that of transformer which is given by

$$E \text{ or } V = 4.44\phi K.T.f \text{ or } \phi = \frac{V}{4.44KTf}$$

Where K is the winding constant, T is the number of turns per phase and f is frequency. Now if we change frequency synchronous speed changes but with decrease in frequency flux will increase and this change in value of flux causes saturation of rotor and stator cores which will further cause increase in no load current of the motor . So, its important to maintain flux , φ constant and it is only possible if we change voltage. i.e if we decrease frequency flux increases but at the same time if we decrease voltage flux will also decease causing no change in flux and hence it remains constant. So, here we are keeping the ratio of V/ f as constant. Hence its name is V/ f method. For controlling the speed of three phase induction motor by V/ f method we have to supply variable voltage and frequency which is easily obtained by using converter and inverter set.

2. **Controlling supply voltage:** The torque produced by running three phase induction motor is given by

Since rotor resistance, R_2 is constant so the equation of torque further reduces to

$$T \propto sE_2^2$$

We know that rotor induced emf $E_2 \propto V$. So, $T \propto sV^2$. From the equation above it is clear that if we decrease supply voltage torque will also decrease. But for supplying the same load, the torque must remains the same and it is only possible if we increase the slip and if the slip increases the motor will run at reduced speed . This method of speed control is rarely used because small change in speed requires large reduction in voltage, and hence the current drawn by motor increases, which cause over heating of induction motor.

3. **Changing the number of stator poles :** The stator poles can be changed by two methods

4. **Adding rheostat in the stator circuit -** In this method of speed control of three phase induction motor rheostat is added in the stator circuit due to this voltage gets dropped .In case of three phase induction motor torque produced is given by $T \propto sV_2^2$. If we decrease supply voltage torque will also decrease. But for supplying the same load, the torque must remains the same and it is only possible if we increase the slip and if the slip increase motor will run reduced speed.

Disadvantage:

the demerit of this method is that with the resistance in circuit there is considerable loss of power

Speed Control from Rotor Side

1. **Adding external resistance on rotor side -** In this method of speed control of three phase induction motor external resistance are added on rotor side. The equation of torque for three phase induction motor is

$$T \propto \frac{sE_2^2 R_2}{R_2^2 + (sX_2)^2}$$

The three phase induction motor operates in low slip region. In low slip region term $(sX)^2$becomes very very small as compared to R_2. So, it can be neglected . and also E_2 is constant. So the equation of torque after simplification becomes,

$$T \propto \frac{s}{R_2}$$

Now if we increase rotor resistance, R_2 torque decreases but to supply the same load torque must remains constant. So, we increase slip, which will further results in decrease in rotor speed. Thus by adding additional resistance in rotor circuit we can decrease the speed of three phase induction motor. The main advantage of this method is that with addition of external resistance starting torque increases but this method of speed control of three phase induction motor also suffers from some disadvantages :

1. The speed above the normal value is not possible.
2. Large speed change requires large value of resistance and if such large value of resistance is added in the circuit it will cause large copper loss and hence reduction in efficiency.
3. Presence of resistance causes more losses.
4. This method cannot be used for squirrel cage induction motor.

✓ In practice this method is adopted when speed control is needed for a short duration. This method is shown in figure (4.18)

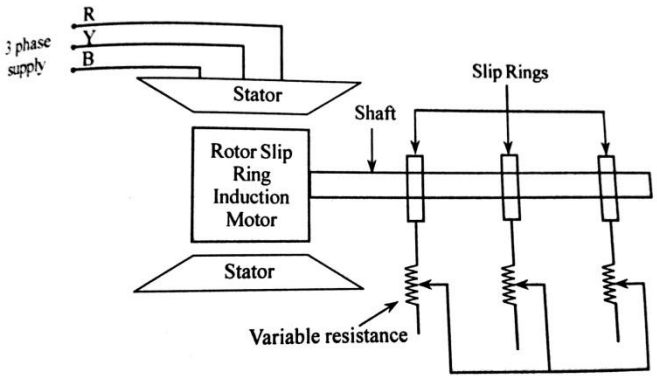

Figure (4.18) Rotor Resistance Method (or) Additional Resistance Method of speed control