INTRODUCTION

Speed control means intentional change of the drive speed to a desired value for performing the specific work process. The speed of A.C motors are not achieved exactly by changing the supply voltage, frequency, number of poles etc..,

The rapid development of thyristors and its handling capacities. The thyristors are using speed control of A.C and D.C motors.

Advantages:

1. High accuracy
2. Greater reliability
3. Higher efficiency
4. Ease of maintenance.
5. Low installation cost.
6. Lower floor space is required.
7. Energy saving is more.

Disadvantages:

1. It requires harmonic filters
2. The heat produced is more.

AC VOLTAGE CONTROLLER: (REGULATORS)

A.C. Voltage controllers are thyristors based devices which converts fixed A.C voltage into variable A.C. voltage without a change in frequency.

Advantages:

1. Flexibility in control
2. High Efficiency.
3. Compact in size.
4. Less maintenance.

Disadvantages:

1. Harmonics development.
2. Interference effects.

SINGLE PHASE A.C. VOLTAGE CONTROLLERS:

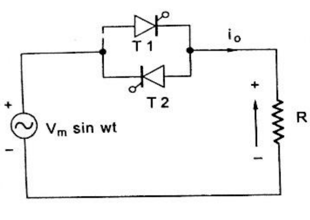
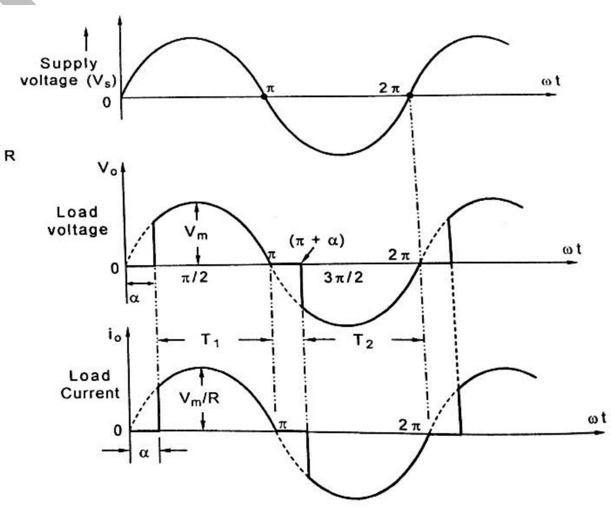


Fig 3.13 : (a) Power-Circuit diagram



(b) Voltage and Current Waveforms.

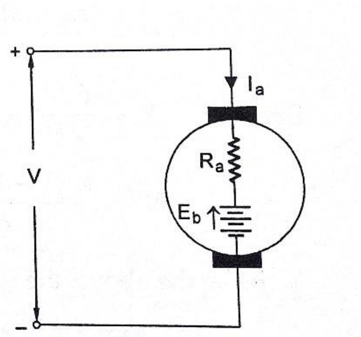
As shown in the figure single – phase full wave A.C. voltage controller with resistance load. It consists of two transistors T_1 and T_2 are connected in antiparallel.

During Positive half cycle: T_1 – is triggered at fixing angle α. T_1 starts conducting and source voltage is applied to load from α to π. At ωt = π, both V_o and i_o falls to zero. Just after π, T_1 – is subjected to reverse biased and hence it is naturally commutated.

During negative half cycle: T_2 – is triggered at fixing angle ωt = π + α. T_2 starts conducting from π + α to 2 π, T_2 is subjected to a reverse bias and hence it is turned-off. The output voltage and current waveforms during the positive and negative half cycles is identical.

<u>FACTORS AFFECTING THE SPEED OF DC MOTORS:</u>

The equivalent circuit for a separately excited dc motor is shown in fig 4.3



The speed of a D.C. Motor,

$$N = \frac{E_b \times 60.A}{\phi ZP} = \frac{(V - I_a R_a)}{\phi} \times \frac{60A}{ZP}$$

Because $k = \frac{60A}{ZP}$ is constant for a given motor

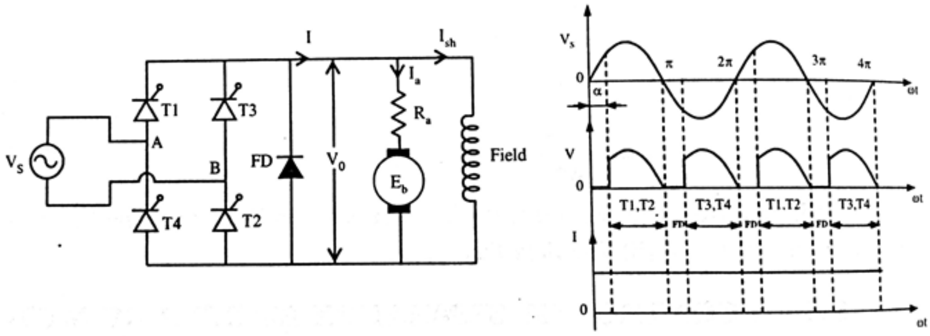
$$\therefore \quad N = \frac{K \cdot (V - I_a R_a)}{\phi}$$

From the above, the speed of D.C motor is mainly depends on the following factors, namely

1. **Armature resistance.**
2. **Applied voltage.**
3. **Flux, (Φ)**

SPEED CONTROL OF DC SHUNT MOTOR BY USING CONVERTER:

Full Wave converter feeding DC shunt motor is shown in below fig.



(a) Circuit diagram (b) Waveforms

Fig. Full wave converter feeding DC shunt motor drive

When supply voltage V_s is positive, terminal A is positive with respect to B, thyristors T_1 and T_2 are forward biased. If firing pulses are given at $\omega t = \alpha$, T_1 and T_2 will be turned ON and the shunt motor terminals are connected to supply V_s. The motor takes a current of I amps.

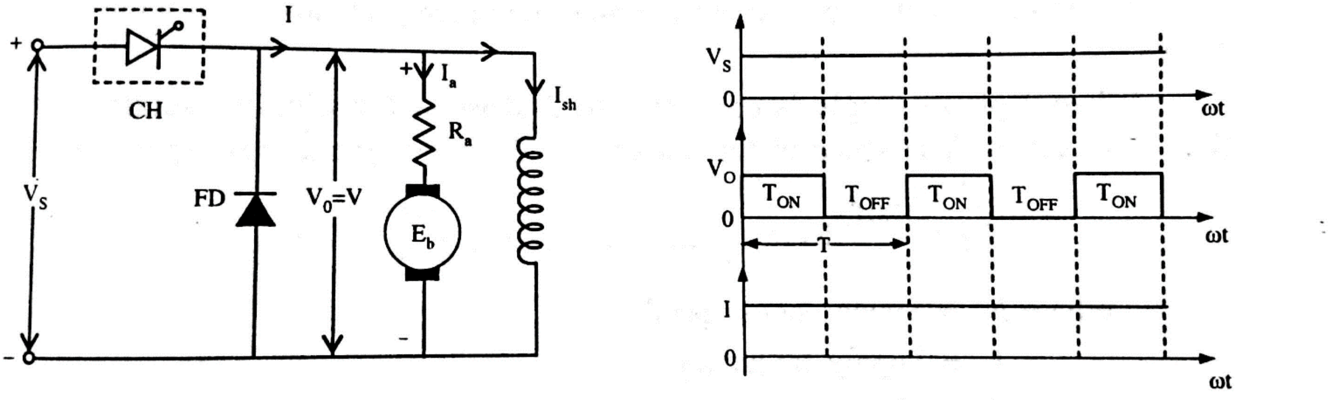
At $\omega t = \pi$, supply voltage V_S becomes zero and thyristors T_1 and T_2 are forced commutation.

At $\omega t = \pi$, the motor terminal voltage V will be zero but motor current I, due to stored energy in armature winding is bypassed through freewheeling diode FD.

At $\omega t = \pi + \alpha$ triggering pulse are given to the thyristors T_3 and T_4 as they are forward biased. The motor terminals again connected to supply voltage V_S and this process continues.

SPEED CONTROL OF DC SHUNT MOTOR USING CHOPPER:

Shows the basic arrangement of a DC chopper feeding power to a DC shunt motor. The chopper shown consists of a force commutated thyristor. Armature current is assumed continuous and ripple free.



(a) Circuit diagram (b) Waveforms

Fig. Chopper controlled DC shunt motor

When chopper 'CH' is on the DC shunt motor terminals are connected supply V_S. Through chopper. The terminal voltage V is equal to output voltage of chopper. During turn OFF of the chopper motor current I is bypassed through freewheel diode. FD. When chopper is OFF the output voltage of chopper or the terminal voltage of motor is zero. By turning ON and OFF of chopper the average output voltage is changed.

Average motor voltage, $V_o = V = \frac{T_{on}}{T}.V_S$

$$V = \alpha V_S \quad \text{............. (1)}$$

Where α = duty cycle = $\frac{T_{on}}{T}$

$$f = \frac{1}{T}$$

$$\therefore V = f \cdot T_{on} \cdot V_s \quad \text{........... (2)}$$

$$\therefore \text{ Speed, } N = \frac{V - I_a R_a}{K\phi}$$

$$\therefore N = \frac{\alpha V_S - I_a R_a}{K\phi} \quad \text{.............. (3)}$$

It is seen from eq (3) that by varying the duty cycle 'α' of the chopper, motor terminal voltage can be controlled and thus speed of the DC motor can be regulated.

THE FACTORS AFFECTING SPEED OF INDUCTION MOTOR:

Each motor consists of stator and rotor and its speed can be varied in different ways, either by changing the stator inputs or by changing rotor inputs.

The speed of induction motor is given by,

$N_S = 120f/p$ *and % slip* $S = \frac{Ns-N}{Ns} * 100$

$N = N_s (1\text{-}S)$.

Where N_s – is the synchronous speed of the motor

N – is the speed of the motor

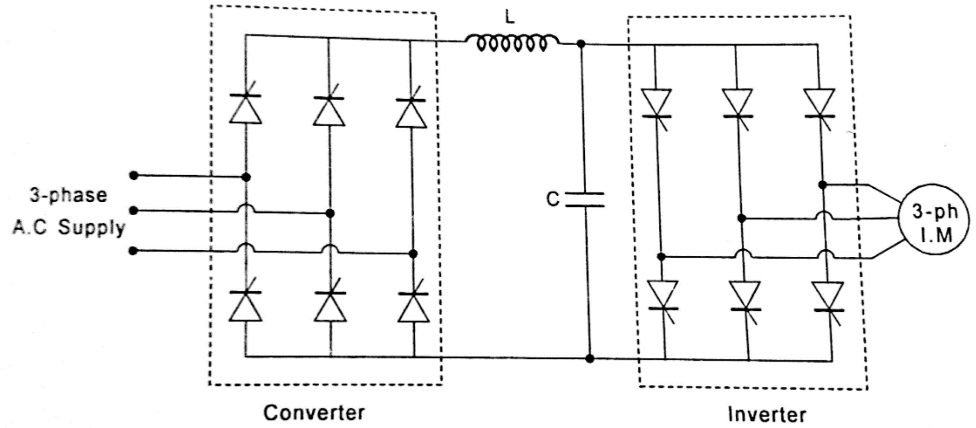
f – is the supply frequency

P – is the number of poles.

The following are various factors which affects the speed of induction motors,

1. By changing the applied voltage to the stator.
2. By changing the frequency of the stator.
3. By changing the number of stator poles
4. By rotor rheostat control.
5. By injecting an emf in the rotor circuit.
6. By operating two motors in cascade.

SPEED CONTROL OF INDUCTION MOTOR USING VOLTAGE – FREQUENCY CONTROL USING CONVERTER AND INVERTOR:



The speed of induction motors may be controlled by operating them from a variable voltage, fixed frequency supply.

Variable voltage fixed – frequency supply can be obtained by converter and inverter circuit. The 3- phase converter will convert a.c voltage into controlled variable contents, then the filtered D.C is fed to the 3- phase inverter as input. By varying the firing angle of the inverter bridge thyristors, a variable three phase a.c output voltage is obtained from the inverter bridge which is fed to the 3-phase induction motor for its speed control.

Simplified circuit of three phase induction motor: