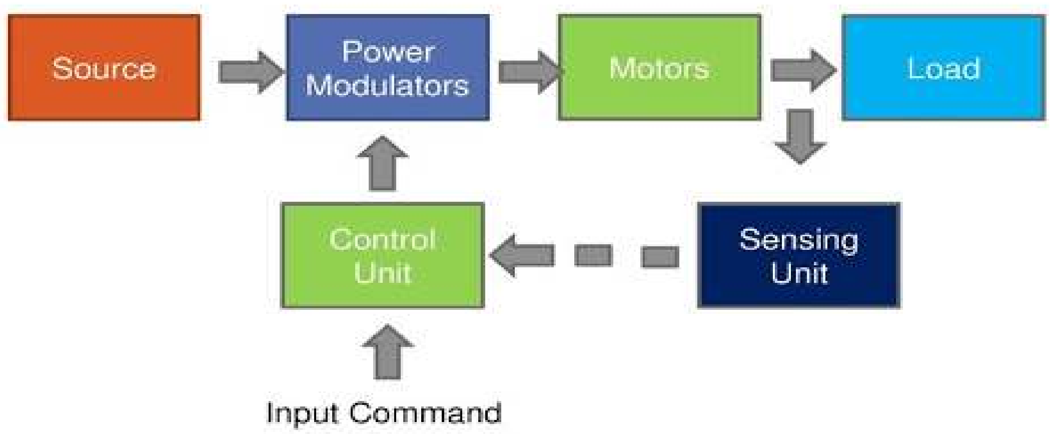
THYRISTORISED CONTROL OF ELETRIC DRIVES

Electric Drives : Electrical Drive is an Electromechanical Device which converts Electrical Energy into mechanical energy and provide electrical control on the processes.

This system (Electric Drives) are used for motion control of electrical Machine .

Block Diagram of Electrical Drive

The block diagram of the electrical drive is shown in the figure below:



The main parts of the electrical drives are power modulator, motor, controlling unit and sensing units. These parts are explained below in details:

i. **Source**: The Power Source in the above Block Diagram provide the necessary Energy for the System and can be AC or DC. Single Phase or Three Phase (50 Hz) AC Sources are mostly used in the drive system. Lower power drives are generally fed from the single phase supply and high power drives are generally fed from the 3 phase supply. Some of the drives are also fed from the battery source.

ii. **Power Modulator** – The Power Modulator converts the Energy according to the requirement of the Motor e.g. if the Source is DC and an Induction Motor is used then Power Modulator convert DC into AC. The Power Modulator also regulates the Output Power of the Source. It controls the Power from the Source to the Motor in such a manner that motor transmits the speed-torque characteristic required by the Load.

During the transient operations like starting, braking and speed reversing the excessive current drawn from the source. This excessive current drawn from the source may overload it or may cause a voltage drop. Hence the Power Modulator controls the Source and Motor Current.

It also selects the mode of operation of the Motor, i.e., Motoring or Braking.

iii. **Motor:** Motors are generally used in the System to convert Electrical of Energy into Mechanical Energy. Motors used in electric drives may be Induction Motors. Synchronous Motors, DC Motors, Stepper Motors and also Reluctance Motors.

iv. **Load:** Load can be any machinery, such as fans, blowers, pumps, robots and machines which consumes Power and performs a given task.

v. **Control Unit** – The Control Unit generates commands for the protection of Power Modulator and Motor as per input command signal received to the control unit.

vi. **Sensing Unit** – It senses the certain Drive Parameter like Motor Current and Speed of Motor and the information will be provided to Control Unit for issuing necessary command . It mainly required either for protection or for closed loop operation.

Advantages of electrical drives

1. The electric drive are available in wide range of Torque, Speed and Power.
2. Working of Electric Drive is independent of the environmental conditions.
3. Electric Drives have a longer life than other Drives Systems.
4. Electric Drives are Air Pollution Free as there are no flue gases.
5. Electric Drives are more economical and reliable source of Power.
6. No need of any fuel storage and transportation.
7. Electric Drive has High efficiency.
8. Electric Drives have various speed control methods.
9. Electric Drive require less Space.
10. Electric Drives can be remotely controlled.
11. Available in wide range of various parameters like speed, torque, and power.

Disadvantages of Electrical Drive

1. The Application of the Drive is limited because it cannot use in a place where the Power Supply is not available.
2. It can cause noise Pollution.
3. On the failure of Electrical Supply, the Electrical Drive System cannot work.
4. The initial Cost of the System is high.
5. It has a Poor dynamic Response.
6. The Output Power obtained from the Drive is low.
7. During the breakdown of Conductors are short circuit, the System may get damaged due to which several problems occur.

Application of Electric Drive

Electric Drives are used in a large number of industrial and domestic applications as below:

1. Electric drives are used in boats.
2. Electric Drive are used in lifts.
3. Electric Drive are used in cranes.
4. Electric Drive are used in electric car.
5. Electric Drive are used in traction systems.
6. Electric Drive are used in transportation systems.
7. Electric Drive are used in rolling mills.
8. Electric Drive are used in paper machines.
9. Electric Drive are used in textile mills.
10. Electric Drive are used in fans, pumps, robots and washing etc.

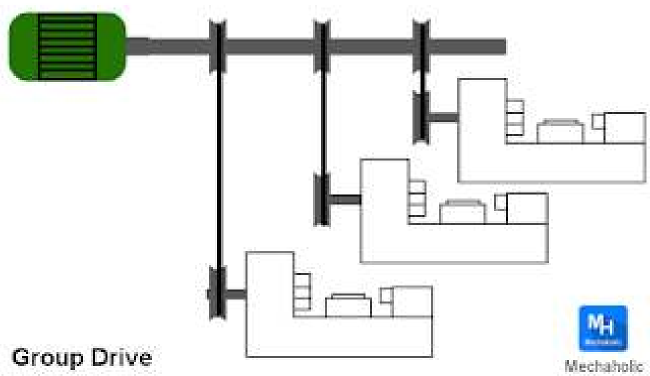
CLASSIFICATION OF ELECTRIC DRIVES WITH BASED ON DEVELOPEMENT FACTOR

There are three Type of Electric Drives

1. Group Electric Drive
2. Individual Electric Drive
3. Multi-motor Electric Drive

THYRISTORISED CONTROL OF ELETRIC DRIVES

1. **Group Electric Drive:** Group Electric Drive are those Electric Drives in which One motor is used as a drive for two or more than two motors are used as machines. The motor is connected to a long shaft. All the other machines are connected to this shaft through belt and pulleys and shaft of the driven machine, serves to vary their speed. Hence Group Electric Drive is also called "line shaft drive"



Group drive is economical in consideration for the Cost of Motor and Control Gear. A Single Motor of large capacity Costs less than that of the Total Cost of number of small Motors for same Total capacity namely, a Single Motor of 100KW costs less than that of ten Motors of 10KW each. Since all the Motors may not operate on full load at the same time, the KW rating of motor of group drive is often less than the aggregate KW output rating of the individual Motor and further cause reduction in Cost.

Advantages:

i. Group Electric Drive are most economical.
ii. Group Electric Drive reduces the initial Cost of installing a particular Industry.
iii. Group Electric Drive Cost is less because of investment in one Motor which is lesser in HP rating.

Disadvantages:

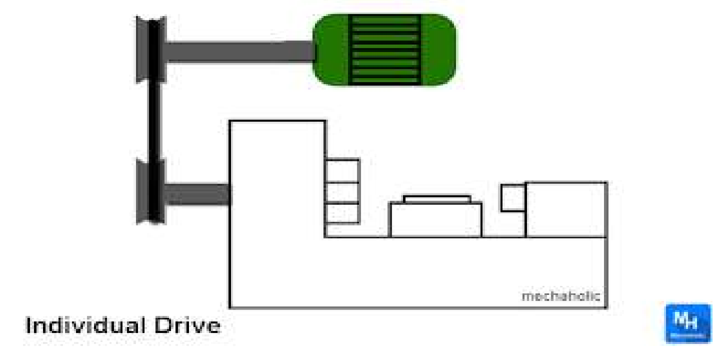
i. It is not possible to install any machine as per our requirement. so, flexibility of lay out is lost.
ii. The possibility of installation of additional machines in an existing Industry is limited.

iii. In case of any fault to the main driving Motor, all the other Motors will be stopped immediately.

iv. Level of noise produced at the Site is high.

v. Since all the motors has to be connected through belts and pulleys, large amount of energy is wasted in transmitting mechanisms. Therefore, Power loss is high.

2. **Individual Electric Drive** Individual Electric Drive are those Electric Drives in which there will be a separate driving motor for each process (Machine) equipment**.** One motor is used for transmitting motion to various parts or mechanisms belonging to signal (Machine) equipment.



In individual Electric Drive, the Energy is transmitted to different parts of same mechanism by means of mechanical parts like Gear, Pulley, etc. hence occurs some power loss

Advantages:

i. Machines can be located at convenient places.

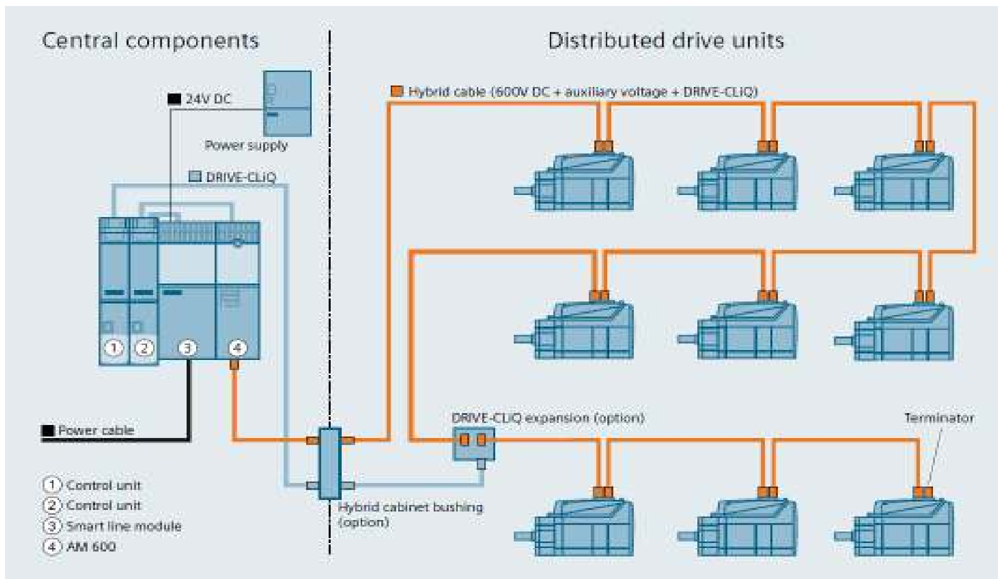
ii. Continuity in the production of the processing Industry is ensured to a high level of reliability.

iii. If there is a fault in one Motor, the effect on the production or output of the industry will not be appreciable.

Disadvantages:

i. Initial cost of Individual Electric Drive is very high.

3. **Multi-motor Electric Drive:** Multi-Motor Electric Drives are those Electric Drives in which separate motors are provided for actuating different parts of the driven (Machine) mechanism.



The Multi-Motor Electric Drive consist of several individual Motors which serve to one of many motions or mechanism (Machine) in some Production Unit.

For example, in Travelling Crane, there are three Motors used. One for hoisting, other for long travel motion and third for cross travel motion. Such Drives are used in Metal cutting Machine, Paper making Machine, Rolling Mills, Rotary Printing Machine, etc.

The use of multi-motor electric drive is expanding in modern industries due to their advantage outweighs increase in capital cost compared to the group drive.

Advantages :

1. In Multi-Motor Electric Drives, Automatic control methods can be employed.
2. In Multi-Motor Electric Drives, each operation can be executed under optimum conditions.

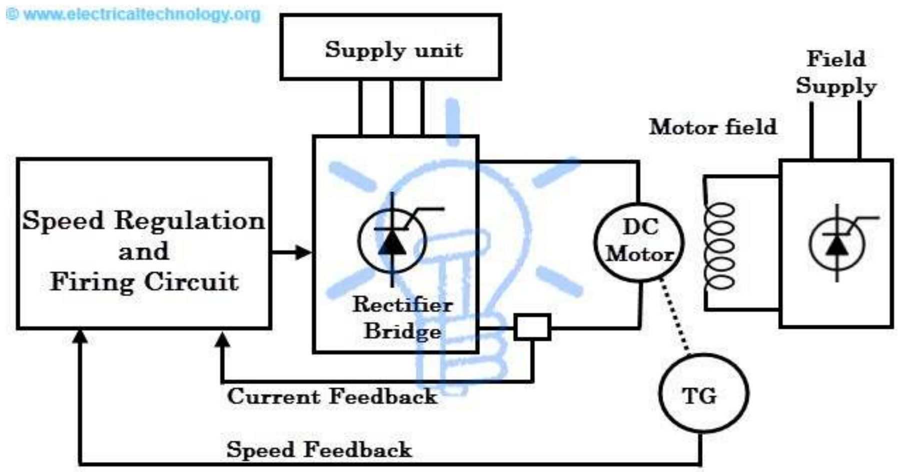
CLASSIFICATION OF ELECTRICAL DRIVES AS PER SOURCE OF POWER AVAILABLE & LOAD REQUIREMENT

Basically, there are two types of Electric Drives:

1. D. C. Electric Drives
2. A. C. Electric Drive

1. **D. C. Electric Drive**: DC Electric Drive is basically a DC Motor Speed Control System that supplies the D. C. Voltage to the Motor to operate for desired speed. Nowadays, the thyristor family of devices are used widely to control the speed of the DC Motor.

The main components of a DC drive system are shown in figure below:



COMPONENTS OF A DC DRIVE SYSTEM

i. **DC Drive Input (Supply Unit) :** Mostly Available Supply Unit is Single Phase AC Supply for DC Drives. This Supply to be converted into Controlled DC through Full Wave Fully Controlled Rectifier.

ii. **Rectifier Bridge:** The Power Component of a Controlled DC drive is a Full Wave Bridge Rectifier which can be driven by AC Power Supply. The Thyristors Controlled Full Wave Bridge Rectifier convert incoming AC Supply into Controlled DC Supply and supply to the motor armature. By changing the Firing angle of these Thyristors, the Voltage varies to the Motor.

iii. **Field Supply Unit:** A Separate Thyristor Bridge or Diode Rectifier is used for supplying the Power to the Field Winding of the Motor. The function of the Field Supply Unit is to provide a Constant Voltage to the Field Winding to create a constant field or flux in the Motor.

In some cases, this Unit with Thyristors reduce the voltage applied to the field so as to Control the Speed of the Motor above the base Speed.

In case of permanent magnet DC Motors, the Field Supply Unit is not included in the Drive.

iv. **Speed Regulation unit**: It compares the desired Speed with feedback Signals and sends appropriate Signals to the Firing Circuit. This Unit consists of both Voltage and Current Regulators. The Voltage Regulator accepts the Speed error as Input and produces the Voltage Output which is then applied to the Current Regulator.

The Current Regulator then produces required Firing Current to the Firing Circuit. If more Speed is required, additional Current is called from the Voltage Regulator and hence thyristors conducts for more periods. The Field Current Regulator is also provided where Speed greater than the Base Speed is required.

v. **Firing Circuit**: It supplies the Gate Pulses to Thyristors so that they turned ON for particular periods to produce Variable Armature Voltage.

Advantages of DC Drives over AC Drives:

i) DC Drive technology is efficient.
ii) DC Drives are more reliable.
iii) This cost of DC Drives is less.
iv) The DC Drive have regenerative and high power applications.
v) DC drives are widely used in industrial drive applications in order to offer very precise control.

Speed Control of DC Motor By D. C. Drives :

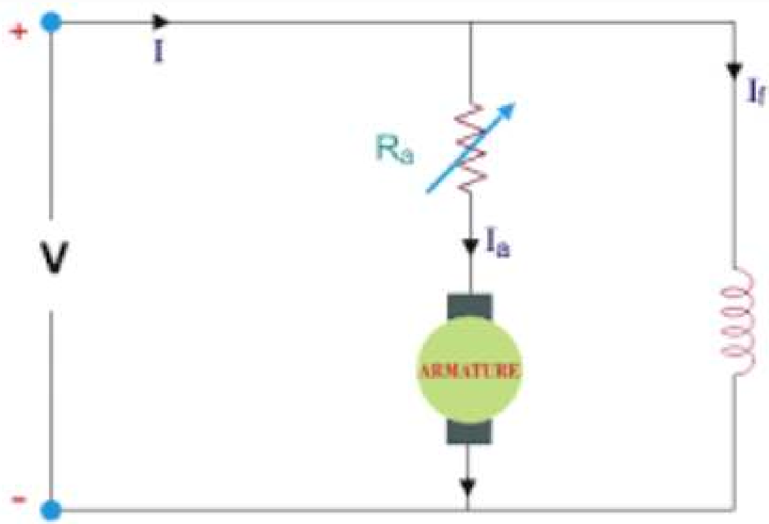
In DC motors, the speed is proportional to the Armature Voltage and inversely proportional to the Field Current. And also, the Armature Current is proportional to the Motor Torque. Therefore, by increasing or reducing the applied Voltage, the Speed of the Motor is varied. However, it is possible up to the Rated Voltage. If the speed greater than the Base Speed is required, the Field Current of the Motor has to be reduced. By reducing the Field Current, the flux in the Motor reduces. The reduction of Field Current reduces the Armature counter EMF. The more Armature Current flows if there is less counter armature EMF. Further, this Armature Current increases the Motor Torque and hence the Speed.

THYRISTORISED CONTROL OF ELETRIC DRIVES

There are the two basic DC drives to control the speed of the motor.

1. Armature Controlled DC Drive:
2. Field Controlled DC Drive:

1) **Armature Controlled DC Drive:** In Armature Controlled DC Drive, the Voltage is varied using Armature Resistance. In this method, a Variable Resistance is connected in series to the Armature. Once resistance increased, the current flow through this circuit is reduced and the Armature Voltage drop is less than the Line Voltage. This will reduces the Motor Speed in proportion to the Voltage that's being applied.



The armature resistance control method is used in applications that require Speed variation for shorter periods of time, not continuously.

In the Armature Control Method, the Speed of the DC motor is directly proportional to the back EMF (Eb)

And $E_b = V - I_a . R_a$.

When Supply Voltage (V) and Armature Resistance Ra are kept Constant, then the speed is directly proportional to Armature Current I_a. Thus, if we add resistance in series with the Armature, I_a decreases and, hence, the speed also decreases. Greater the resistance in series with the armature, greater the decrease in Speed.

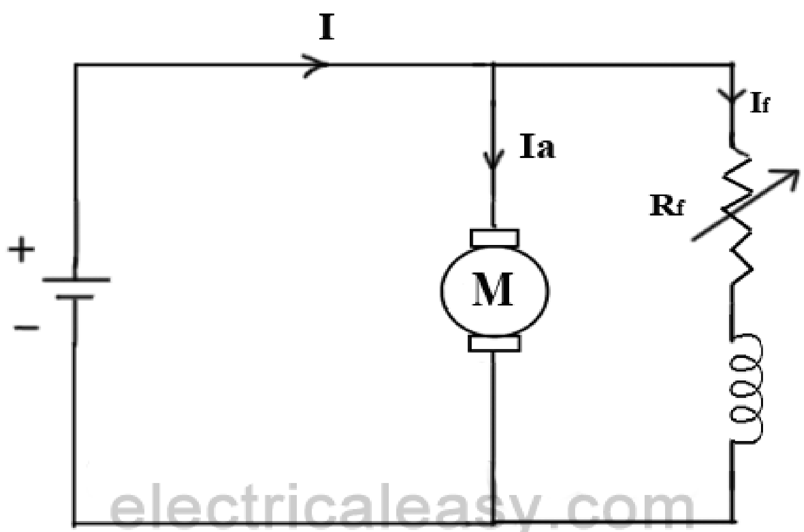
Advantages of Armature Controlled of DC Motor

i. In Armature Controlled DC Motor, Very fine Speed Control over Whole range in both directions.
ii. In Armature Controlled DC Motor, Uniform acceleration is obtained
iii. In Armature Controlled DC Motor, Speed Regulation is Good.
iv. It has regenerative braking capacity.

Disadvantages of Armature Controlled of DC Motor

i. Armature Controlled DC Motor arrangement is Costly
ii. It require more floor space.
iii. It has Low efficiency at light loads
iv. This Drive produce more noise.

2) **Field Controlled DC Drive:** In Field Controlled DC Drive, the speed of a DC Motor controlled by the Flux in the Field of the Poles. The Speed of Motor is inversely proportional to the Flux per Pole. Thus by decreasing the Flux, Speed can be increased and vice versa.



For controlling the flux, a rheostat (Variable resistance) is connected in series with the Field Winding, as shown in the above Circuit Diagram.

By increase the resistance in series with the Field Winding, it will increase the Speed as it decreases the Flux. In Shunt Motors, as Field Current is relatively very small, I_{sh}^2R loss is Small. Therefore, this method is quite efficient.

Though speed can be increased above the rated value by reducing Flux with this method, it puts a limit to maximum Speed as weakening of Field Flux beyond a limit will adversely affect the commutation.

Advantages of Field Controlled of DC Motor:

i. This method of speed control is independent of Load on the Motor.
ii. In this method, Power wasted in controlling resistance is very less as Field Current is a small value.

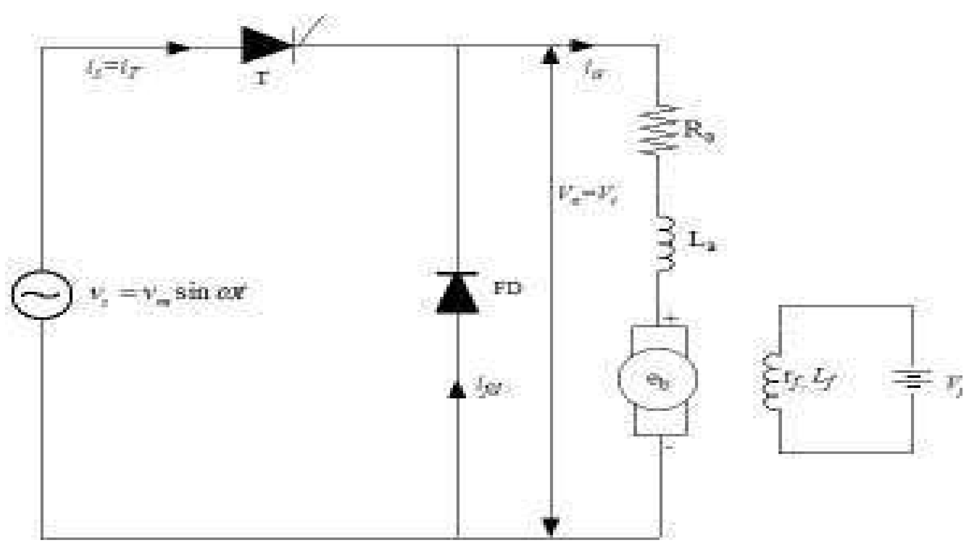
Disadvantages of Field Controlled of DC Motor

i. Creeping (Constant / Continues) speeds cannot be obtained.
ii. Top speeds only obtained at reduced torque.

Depending Upon Source of Power Supply is available for DC Load, DC Electric Drive are classified as under:

I) Single Phase Half-Wave DC Drive Control:

Figure shows a single phase half-wave DC Drive for controlling a separately excited dc motor.



It needs a Single Thyristor (T) and a Freewheeling Diode (D_{FD}). The Freewheeling Diode is also known as Bypass Diode, which is used to improve the wave-shape of Load Current and Power Factor. Freewheeling diode is connected across the Motor terminals to allow for dissipation of Energy stored in the Motor Inductance and to provide for continuity of Motor Current when the Thyristors are blocked. It also provides protection against transient over-voltages.

UNIT-IV

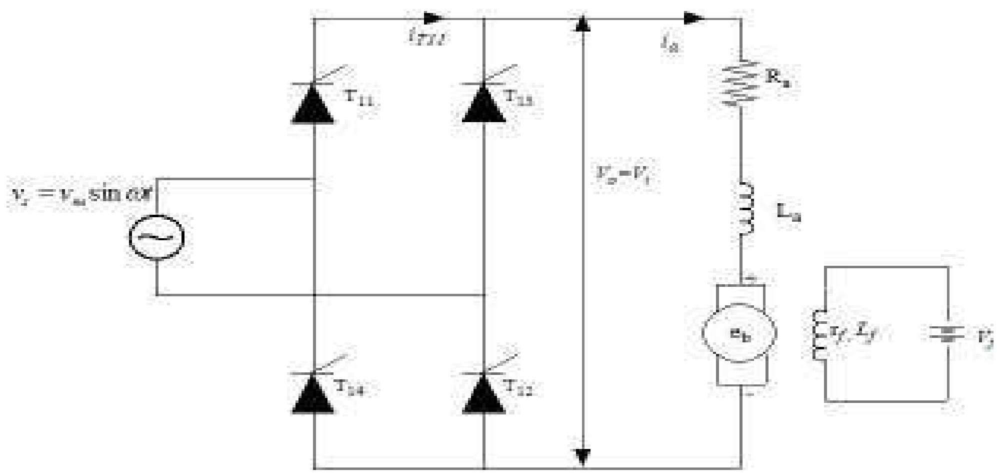
THYRISTORISED CONTROL OF ELETRIC DRIVES

The Half Wave Rectifier is used for Supply to Field Circuit of the DC Motor. Because of inductance of the Field and Armature, the Thyristor would not turn OFF at $\omega t = \pi$. Therefore it is desirable to have Freewheeling Diode (D_{FD}) in the circuit.

In Half Wave Rectifier / DC Drives, the Load Current is always discontinuous, resulting in poor performance. This type of drive is used only for small DC Motors of rating up to 500 W.

II) Single Phase Full-Wave DC Drives Control:

Figure shows a Single Phase Full-Wave DC Drive for controlling a separately excited DC Motor. A full-DC Drive / Rectifier needs four Thyristors. In Full Wave Rectification, Two quadrants operation is possible as the rectifier in the armature circuit provides + V_a or – V_a,. Thus allowing operation in first and fourth quadrants.



Current remains unidirectional because of the unidirectional thyristors. When operating in the fourth quadrant regenerative braking is possible and motor feeds back energy to the source. This drive is also employed for motors of rating up to 15 kW.

III) Chopper Control of Separately Excited DC Motor Drive:

The chopper converts the fixed DC voltage to variable DC voltage. Self-commutated devices are used for making choppers because they can be commutated by low power control signal and do not need commutation circuit.

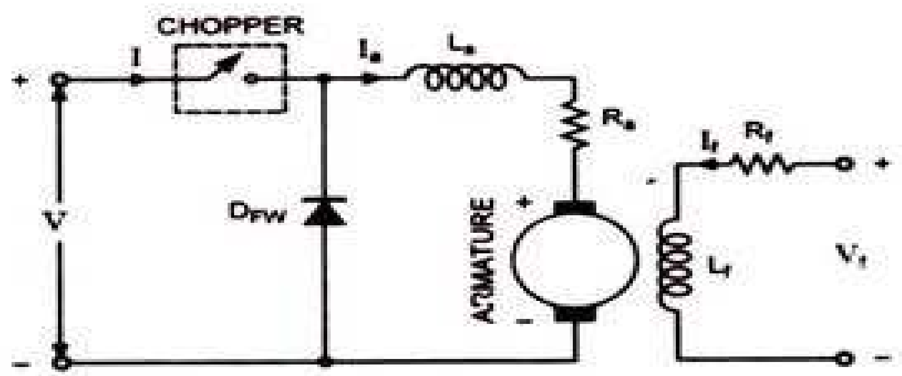
The chopper was operated at high frequency due to which it upgrade the motor performances by decreasing the ripple and removing the discontinuous conduction. The most important feature of chopper control is that the regenerative braking is carried out at very low generating speed when the drive is fed from a fixed voltage to low DC voltage.

Chopper drives can be operated in the following modes:

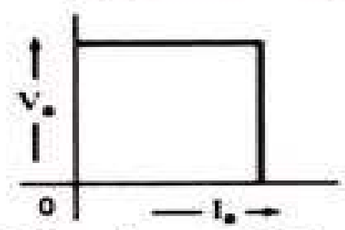
1. Motoring mode.
2. Regenerative braking mode.

1. Motoring Mode:

Figure (a) Shows Motoring Mode of the Chopper, this mode of operation with a one quadrant Chopper feeding the Motor from DC Supply of Voltage V, the Field being excited from a separate Source. Figure (b) shows the quadrant of operation.



(a) Circuit Diagram



(b) Quadrant of Operation

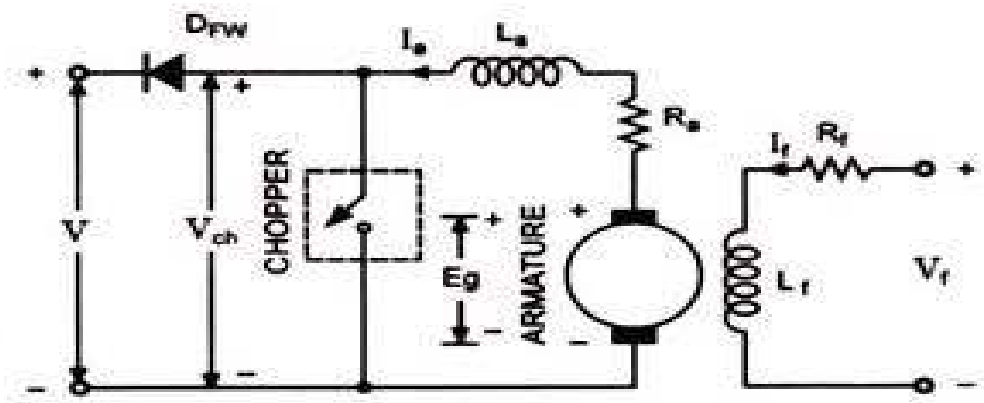
Fig. 3.24. *Separately Excited DC Motor Supplied by a Chopper*

When the Chopper conducts, Coltage across the Motor Armature is Supply voltage V, and when it blocks, Voltage across the Motor Armature is zero. Therefore, both average voltage and current are Positive and Power can flow from Supply Source to the Load, and thus, represents Motoring operation.

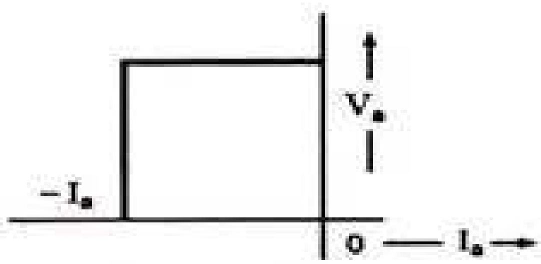
Freewheeling diode D_{FW} is necessary so that the Armature Current may flow when the Chopper is OFF. By varying the Duty cycle α, the Speed of the Motor can be controlled.

2. Regenerative Braking Mode:

When the Motor is to be stopped, brakes are to be applied. In Regenerative braking the Motor is made to operate as a generator and the kinetic energy of the Motor is converted into electrical energy and returned to the Supply.



(a) Circuit Diagram



(b) Quadrant of Operation

Fig. 3.25. Regenerative Braking of Separately Excited DC Motor

Fig. (a) shows the Circuit Diagram for this mode of operation. During Regenerative braking mode, When the Chopper is Triggered so that the Motor Armature is short circuited through the Chopper. Kinetic energy of the Motor is partly dissipated in Armature Resistance R_a and partly stored in Inductance L_a. When chopper is turned OFF, Freewheeling Diode D_{FW}, is turned ON and the energy stored in Inductance L_a is returned to the Supply Source. The operation is in Second quadrant, as shown in Fig. (b).

D. C. Drive are further classified into two types:

i. **Non-Regenerative D. C. Motors C Drives**: Non-regenerative DC Drives are those Drives that rotates only in one direction and hence also called single quadrant drive. The non-regenerative DC motor drive does not have any braking capability. The motor is terminated only by removing the supply. Such type of drive is used in a placed where high friction load or strong natural brake requires. In their most basic form, they are able to control motor speed and torque in one direction.

ii. **Regenerative DC drives**: Regenerative D. C. Drive are those Drives which are capable to control the speed of DC Motors as well as direction of motor rotations. Regenerative DC Drive are used as adjustable speed and direction drives, also known as four-quadrant drives.

2. A. C. Electric Drive: An AC Drive is a drive which Control the Speed of an AC electric Motor. In this Drive, the speed of the Motor is controlled by changing the Frequency and Voltage of the Electrical Supply to the AC Motor.

The speed of the AC (induction) motor can be controlled by ;

I. By changing frequency. (VFD)
II. By Changing Voltage (VVD) / Phase Control AC Drive
III. By Changing the slip of the motor (only possible in slip ring motors)
IV. By Changing number of poles

Classification of AC Drives

AC Drive are Basically of Two Types:

i. Variable Frequency Drive (VFD)
ii. Variable Voltage Drive (VVD)

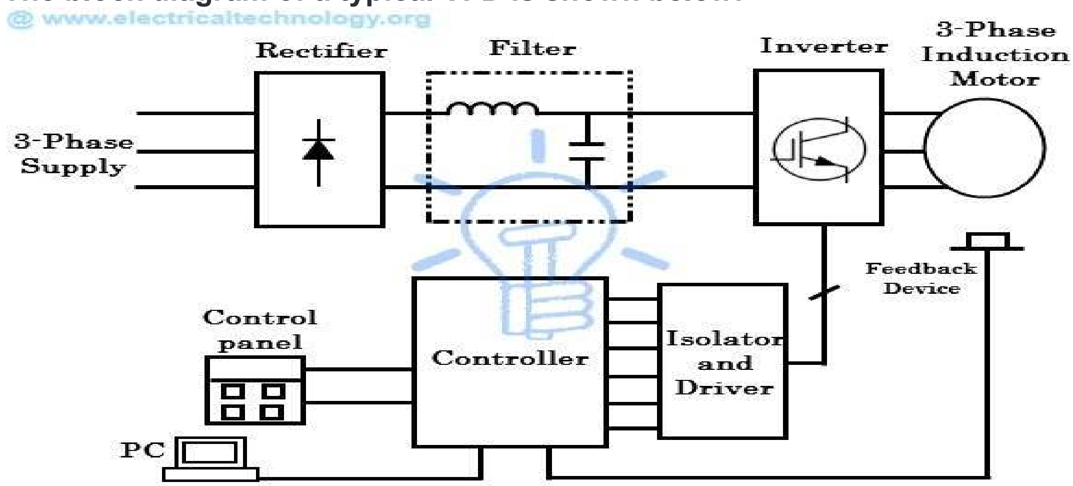
i. **Variable Frequency Drive (VFD)** A variable-frequency drive (VFD) is an adjustable-Speed Drive which used in electro-mechanical drive systems to control Speed & Torque of AC Motor by varying Motor Input Signal Frequency.

We know that the **speed of an Induction Motor is proportional to the frequency** of the supply (**N = 120 f / p**)

Where N is Speed of Induction Motor, f is the Frequency of the Power Supply and p are the numbers of Magnetic Poles

By varying the Frequency we can obtain the Variable Speed. When the Frequency of Power Supply is decreased, the Speed of Induction Motor also decreased and vice versa.

The block diagram of a typical VFD is shown below:



BLOCK DIAGRAM OF TYPICAL VFD (AC DRIVE)

i. **Rectifier**: The Rectifier is made with diodes that Converts AC in to Pulsating DC output with negligible Ripples .

ii. **Filter**: The Filter Section removes Ripples and produces the fixed DC from pulsating DC and gives the pure DC at the Output.

iii. **Inverter:** The **inverter** takes the DC power from the rectifier / Filter section and then converts back to the AC Power of Variable Frequency under the control of microprocessor or microcontroller. This section is turned ON/OFF by the Signals from the Controller.

iv. **Controller:** The controller is made with microprocessor or microcontroller and it takes the input from Sensor (as speed reference) and Speed reference from the user and accordingly Triggers the Power electronic components in order to vary the Frequency of the Supply.

It also performs Overvoltage and Under voltage Trip, Power Factor Correction, Temperature Control and PC connectivity for real time monitoring.

v. **AC motor:** The AC Motor converts AC Electrical Energy into Mechanical Rotations which drive the Load.

The AC electric Motor used in a Variable Frequency Drive System is usually a Three-Phase Induction Motor. Some types of Single-Phase Motors or Synchronous Motors can be advantageous in some situations, but generally Three-Phase Induction Motors are preferred as the most economical.

ii) Variable Voltage Drive (VVD): A variable-Voltage Drive (VVD) is a type of adjustable-Speed Drive used in electro-mechanical drive systems to control AC motor Speed and Torque by varying Motor Input Signal Voltage through Thyristors by controlling of Firing Angle..

Voltage Control is a method used to control the speed of an Induction Motor. The Speed of a Induction Motor can be varied by varying the Supply Voltage. When Supply Voltage decreases, the Speed of Induction Motor also decreased and vice versa.

This method gives a speed control below the normal rated speed and suitable for the Fan and Pump Drives. As in Fan and Pump, the Load Torque Varies as the square of the speed. These types of drives required Low Torque at Lower Speeds. This condition can be obtained by applying Lower Voltage without exceeding the Motor Current.

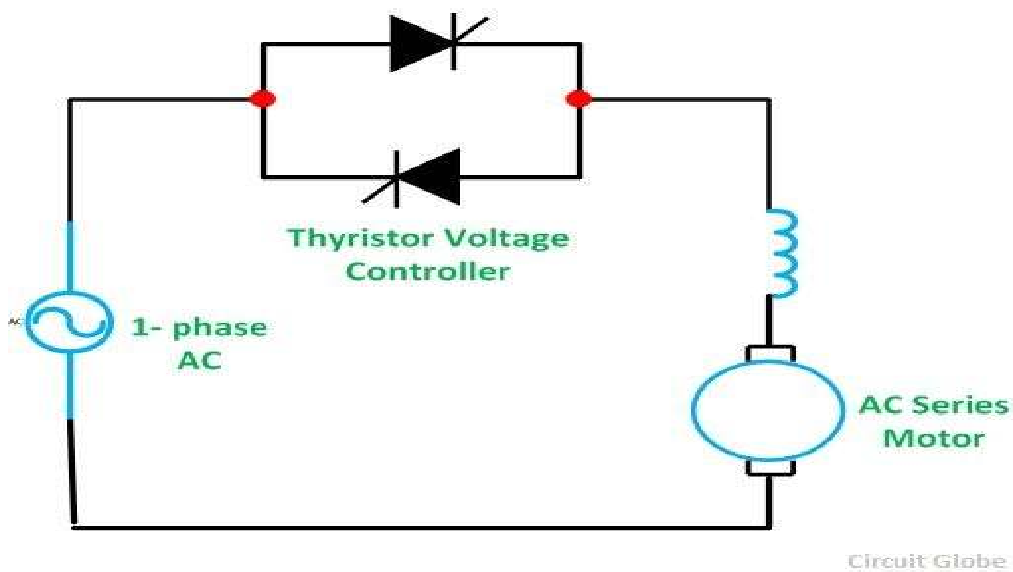
The Variable Voltage for Speed control of Small Size Motors mainly for Single Phase can be obtained by using a Thyristor (SCRs / TRIAC) voltage controller.

THYRISTORISED CONTROL OF ELETRIC DRIVES

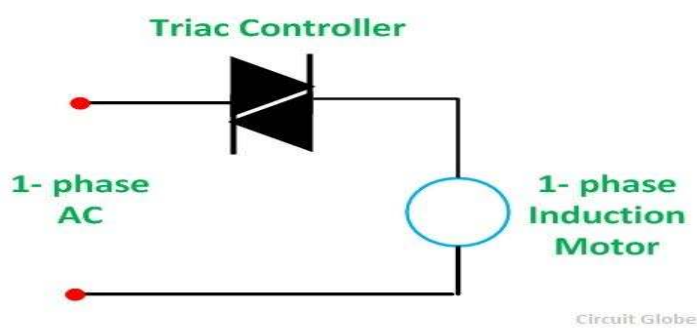
Single Phase Variable Voltage AC Drives:

For a single phase supply, Two SCRs are connected back to back Voltage Controller as shown in the figure below.

The Upper Thyristor will provide the controlled output during Positive half Cycle and Lower Thyristor will provide the controlled output during Negative Half Cycle.



For a Single Phase AC Supply, Two SCRs can be replaced by a Single Phase TRIAC Voltage Controller / DRIVE as shown in the figure below.

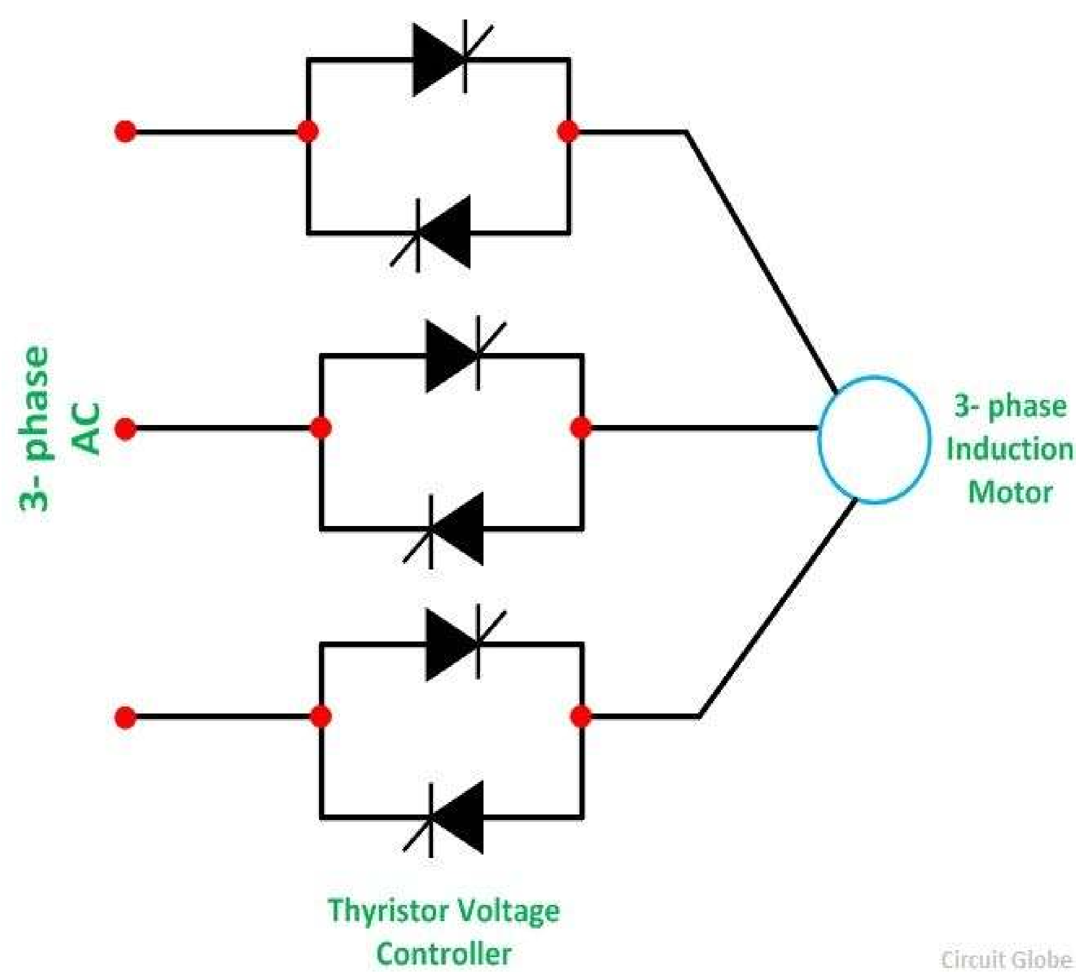


Speed control can obtained by varying the Firing Angle of the SCRs / TRIAC. These controllers are known as Solid State Fan Regulators. As the solid state Regulators are more compact and efficient as compared to the conventional variable Regulator. Thus, This controller is preferred over the normal regulator.

Three Phase Variable Voltage AC Drives

In case of a Three Phase Induction Motor, Three Pairs of Thyristors are required which are connected back to back. Each pair consists of Two Thyristor. The diagram below shows the Stator Voltage Control of the three phase induction motors by Thyristor Voltage Controller.

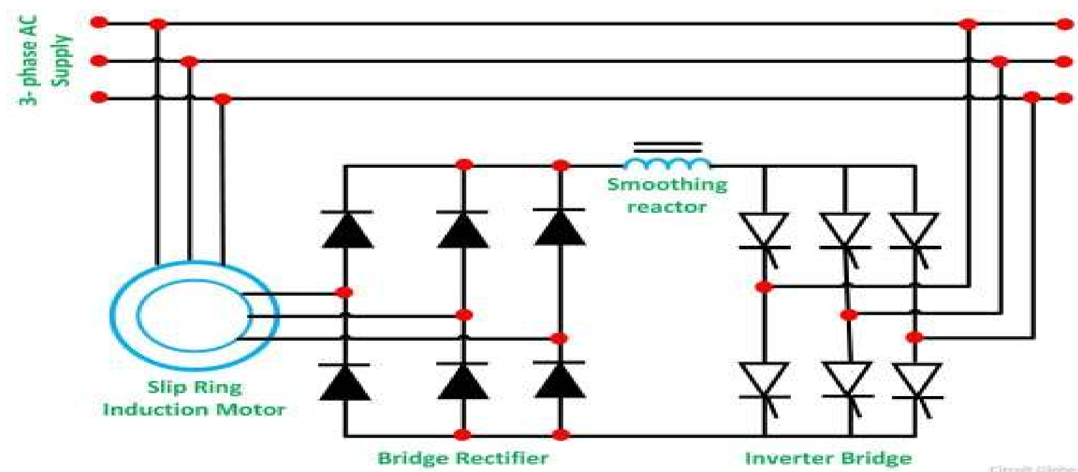
The Upper Set of Thyristors will provide the controlled output during Positive half Cycle and Lower Set of Thyristors will provide the controlled output during Negative Half Cycle.



Each pair of the Thyristor controls the Voltage of the Phase to which it is connected. Speed control is obtained by varying the Conduction Period of the Thyristor. For lower power ratings, the back to back Thyristor pairs connected in each phase is replaced by TRIAC.

iii) **Slip Energy Recovery of an Induction (Slip Ring) Motor:** Slip Energy Recovery is one of the methods of controlling the Speed of an Induction (Slip Ring) motor. In the Rotor Circuit, the Slip Power is wasted as I^2R losses during the Low-Speed operation. The efficiency is also reduced. The Slip Power from the Rotor Circuit can be recovered and fed back to the AC Source so as to utilize it outside the Motor. Thus, the Overall Efficiency of the Drive System can be increased and control can be obtained on the Speed also.

The figure below shows the connection and method for recovering the Slip Energy and Power recovery of an Induction Motor.



The Basic Principle of the Slip Power recovery is to connect an external Source of the EMF of the Slip frequency of the Rotor Circuit. The Slip Energy recovery method provides the Speed control of a Slip Ring Induction Motor below its Synchronous Speed.

A portion of Rotor AC Power (Slip Power) is converted into DC by a diode bridge.The smoothing reactor is provided to smoothen the rectified current. The output of the rectifier is then connected to the DC terminals of the Inverter. The Inverter converts the DC Power to the AC Power and feeds it back to the AC Source.

This method of Speed control is used in large Power applications where the variation of Speed over a wide range involves a large amount of Slip Power.

iv) Pole Changing Method to Control Speed of Induction Motor: In Pole Changing Method for controlling the Speed of Induction Motor, The of Induction is inversely proportional to the number of Magnetic Poles.

Therefore, Motor Speed can be changed by changing the number of Poles. Provision for changing the number of Poles has to be incorporated at the manufacturing Stage and such machines are called, '**Pole Changing Motors**' or '**Multi-Speed Motors**'.

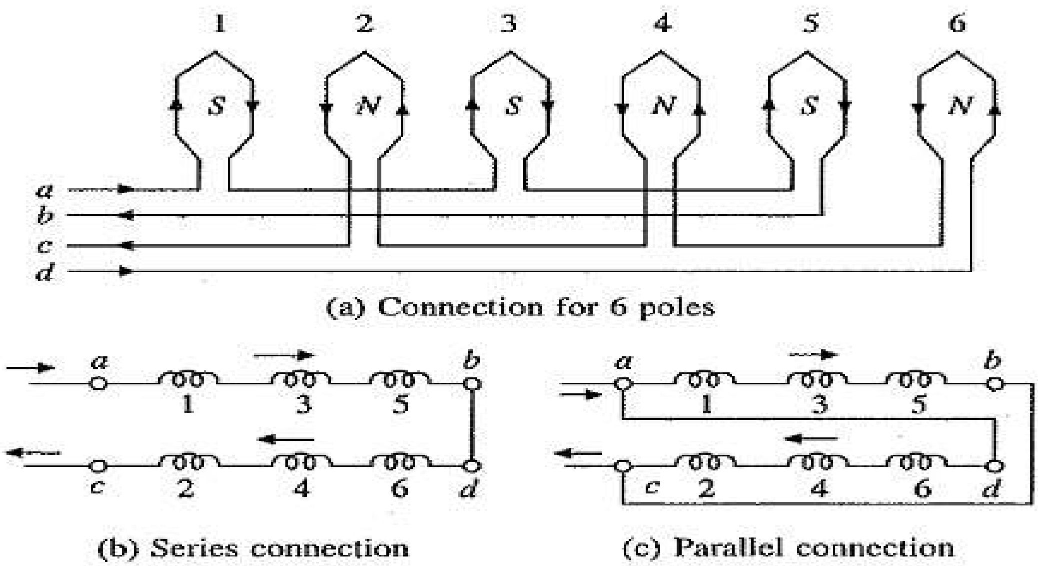


Fig. 6.24 Stator phase connection for 6-poles

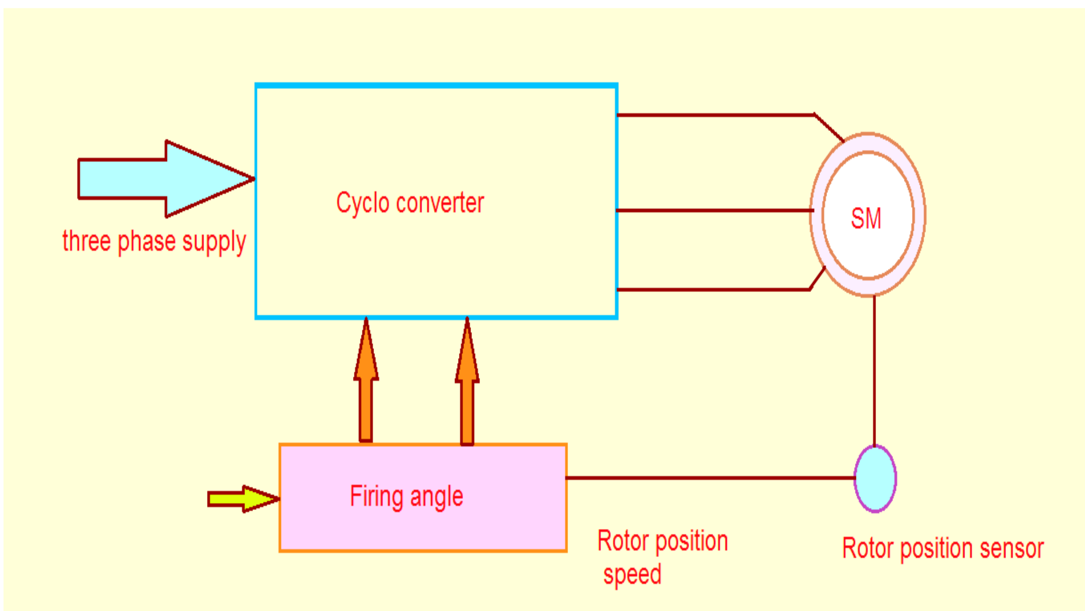
Squirrel-Cage Rotor is not wound for any specific number of poles. It produces the same number of poles as stator winding has. Therefore, in a Squirrel-Cage Motor, an arrangement is required only for changing the number of poles in stator. In wound-rotor motor, arrangement for changing the number of Poles in Rotor is also required, which complicates the machine. Therefore, this Pole Changing of Induction Motor method of Speed Control is only used with Squirrel-Cage Motors.

A simple but expensive arrangement for changing the number of Stator Poles is to use Two separate Stator winding which are wound for two different Pole numbers. An economical and common alternative is to use a Single Stator winding divided into few Coil Groups.

Number of poles is changed by changing the connections of these coil groups. Theoretically by dividing winding into a number of coil groups and bringing out terminals of all these groups, a number of pole numbers can be obtained by reconnecting these groups. In practice, for simplicity, winding is divided only in two coil groups. This allows the change in pole number by a factor 2.

v) **Cyclo-Converter AC Drive**: In this Drive, A Cyclo-Converter is used to control the speed of a single phase induction motor.

A Cyclo-Converter is a Frequency Changer that converts AC (alternating current) Power of a certain frequency to AC Power of another frequency without the help of any intermediate DC (direct current) link.



Cyclo-Converter control has the advantages of smooth Low Speed operation, four-quadrant operation with regenerative braking and good dynamic response. But it has low speed range.

These Drives are used in Low Speed gearless Drives for Ball Mills in cement Plants, Mine hoists, Reversing Rolling mills requiring fast dynamic response and in ships equipped with diesel generator etc.

Advantages of AC drives:

i. AC drives have the lowest starting current of any starter type.
ii. AC drives reduce Thermal and Mechanical stresses on Motors and Belts.
iii. AC drives installation is Simple as connecting the power supply to the AC Drive.
iv. AC Drives save large Energy at Lower Speed.
v. AC Drives increase the life of rotating components, as operating speed of rotating components is Slower.
vi. AC Drives reduce the Noise and vibration level.
vii. AC Drives provide High Power Factor.
viii. AC Drives provide lower KVA, helping to reduce voltage sags and power outages.

Difference between AC Drives and DC Drives

CHARACTERISTICS	AC DRIVES	DC DRIVES
Maintenance	Requires less maintenance.	Requires comparatively more and frequent maintenance.
Use/ Application	Are generally used for AC motors.	Are used for DC motors normally.
Locational use	Are used in almost all the locations.	are used in very few locations
Breaking Mechanism	Breaking and accelerating when supply frequency (F s) changes	Breaking occurs when resistance is applied at rotor.
Power & Control Circuitry	Power and control circuits are difficult and quite complex in design.	Power and control circuits are simple to design and less expensive as compared to their counter-parts.

UNIT-IV

THYRISTORISED CONTROL OF ELETRIC DRIVES

CHARACTERISTICS	AC DRIVES	DC DRIVES
Size in terms of Power Rating	Power to Weight ratio is very large.	Power to Weight ratio is considerably small.
Commutation	There is no commutation which makes AC Drives less bulky and inexpensive.	Because of commutation, they are more heavy and costly.
Rectifier	There is no need of rectifier circuit	Rectifying circuit is necessary
Speed Control	Sped control is achieved by changing the frequency	Speed control is achieved by armature and field control
Cost	In AC Drives, motors are less expensive especially squirrel cage motors.	In DC Drives, motors are significantly expensive.
Speed limit	There is no upper limit for speed.	Speed is limited because of commutation process.
Harmonics	Converters produce harmonics in supply as well as in load	Converters do not produce harmonics
Motor speed	Can reach up to 10000 RPM	Can reach up to 2500 RPM
Starting torque	Do not produce high starting torque	Produces high starting torque
Noise	Operation is noisy which is highly unfavorable in certain applications	They are not noisy as compared to AC Drives
Power consumption	Consume less power	Consume more power
Circuit complexity	More complex as it involves inverter (DC → AC) and converter (AC → DC)	Less complex because of single power conversion process from AC to DC

POWER ELECTRONICS **UNIT-IV**

THYRISTORISED CONTROL OF ELETRIC DRIVES

FILL IN THE BLANKS:

1. Speed of Motor ……………………………… with the increase in firing angle of Thyristor Bridge.
2. DC Motors provide ……………………starting torque.
3. Speed of AC Motor can be controlled by AC Drive by changing of ………………of Input signal.
4. For wide range speed control, ……………..drives are used.
5. Power conversion efficiency of AC to DC converter is ……………….
6. The speed of Motor increases with the increase in armature…………..
7. Cyclo-Converter is used for ……………. Drives.
8. The Drive in which a single thyristor is used to control input power is called ………….drive.
9. AC Motors are better suited for ………speed of operation.
10. For DC Motors, Dual Converter is used to obtain …………… speed control.
11. For Controlling speed of 3 phase Induction Motor, the scheme generally used is variable voltage and variable…………….. scheme.
12. Armature control method is used in DC Motors to get the speeds………..Normal speed.
13. Field control method is used in DC Motors to get the speeds………..Normal speed.
14. DC Chopper Drive controls the voltage across DC Motor by continuously switching ON and OFF the Motor for …………….. duration of T_{ON} and T_{OFF}.
15. Cyclo-Converters Drives can be used for speed control of ………………. Motors.
16. Single Phase DC Drive converts AC signal in to ………………….. Signal.
17. Chopper drive are used for controlling the speed of ……….Motor.
18. …………. Control method is used to control the speed above normal speed.
19. …………. Control method is used to control the speed above normal speed.
20. Power Modulator controls the ………… of power from source to Motor.

Answers:

1) Decrease	**2) High**	**3) Frequency**	**4) AC**
5) High	**6) Voltage**	**7) AC**	**8) Half Wave**
9) High	**10) Reversible**	**11) Frequency**	**12) Below**
13) Above	**14) Fixed**	**15) AC**	**16) DC**
17) DC	**18) Field**	**19) Armature**	**20) Flow**

POWER ELECTRONICS **UNIT-IV**

THYRISTORISED CONTROL OF ELETRIC DRIVES

TRUE / FALSE Statements:

1. DC Motors provide High starting torque.
2. Armature control method is used in DC Motors to get the speeds above Normal speed.
3. For wide range speed control, AC drives are used.
4. Cyclo-Converters Drives can be used for speed control of DC Motors.
5. Speed of Motor increasees with the increase in firing angle of Thyristor Bridge.
6. Field control method is used in DC Motors to get the speeds above Normal speed.
7. Chopper drive can be used in regenerative breaking mode.
8. Output frequency of Cyclo-Converter Drive can be 1/3rd of input frequency.
9. Chopper drive are used for controlling the speed of AC Motor.
10. Cyclo-Converter Drive can be used for speed control of three phase Induction Motors.
11. The Drive in which a single thyristor is used to control input power is called Full Wave drive.
12. Chopper drive cannot be used in regenerative breaking mode.
13. Power Modulator controls the flow of power from source to Motor.
14. DC Chopper Drive controls the voltage across DC Motor by continuously switching ON and OFF the Motor for Fixed duration of T_{ON} and T_{OFF}.
15. DC Motors provide very low starting torque.

Answers:

1) TRUE	**2) FALSE**	**3) TRUE**	**4) FALSE**
5) FALSE	**6) FALSE**	**7) TRUE**	**8) TRUE**
9) FALSE	**10) TRUE**	**11) FALSE**	**12) FALSE**
13) TRUE	**14) TRUE**	**15) FALSE**	