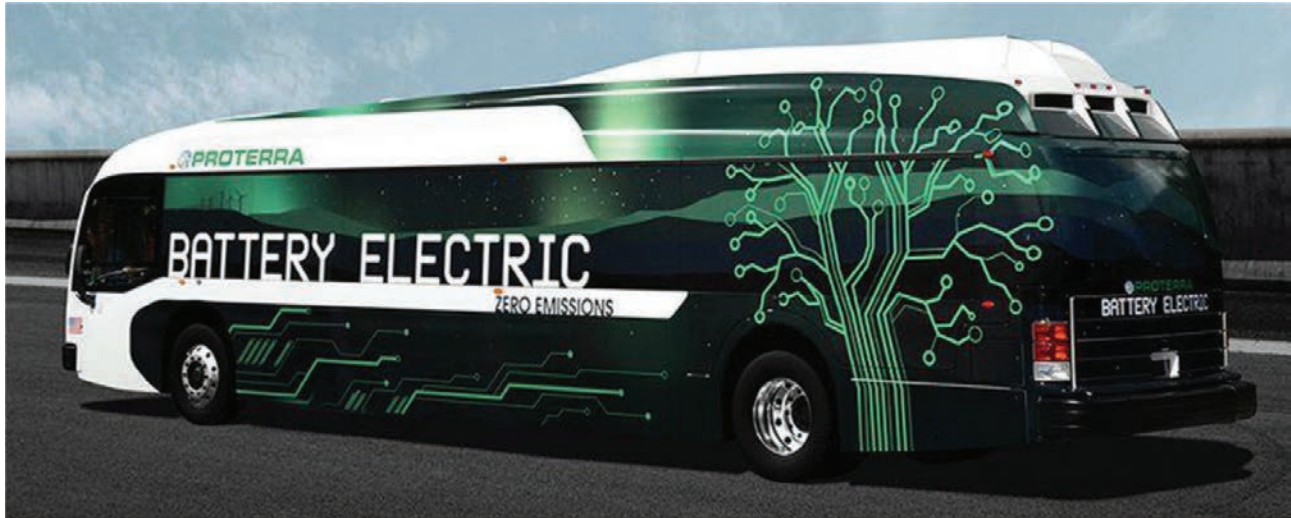


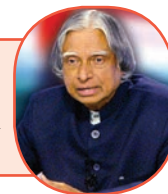


## Electric drives and its controls



We should not give up and we should not allow the problem to defeat us.

A. P. J. Abdul Kalam



### Learning Objectives

In this lesson, students have to learn about the electric drives needed for various requirements and its control systems.

### Table of Content

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| 5.1 Introduction             | 5.4 Controller        |
| 5.2 Types of electric drives | 5.5 Electric vehicles |
| 5.3 Selection of motors      | 5.6 Electric traction |



## 5.1 Introduction

Electric drive or electric motor is a device which converts electrical energy into mechanical energy to do a particular work connected to it.

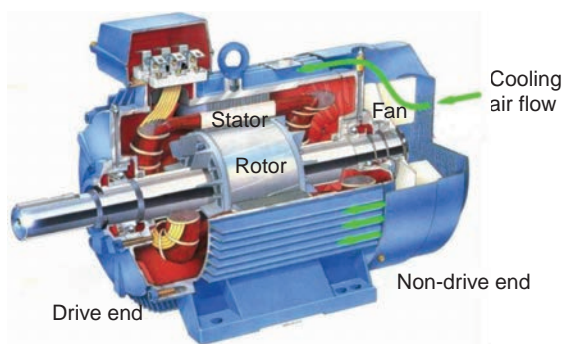
The electric drive designed electric train is shown in figure 5.1. It is operated by a high-torque electric DC series motor. The system used to control the speed is called power drive. While using this electric motor, its speed is controlled by the current, voltage and frequency.



**Fig. 5.1** Electric train



## 5.2 Types of electric drives



**Fig. 5.2** Electric motor

The internal construction of a motor is shown in figure 5.2. Depending on the applications, the motor can be divided

into different categories. According to the design, the drives are classified as

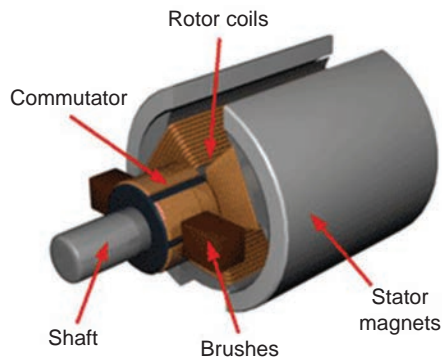
- i. Individual drive,
- ii. Group drive and
- iii. Multi-motor drive.

### 5.2.1 Classification of electrical drives

1. Depending on the power supply,
  - A. Direct Current electric drive
  - B. Alternating Current electric drive
2. According to the process of electric drives,
  - A. Continuous duty drive
  - B. Short-term duty drive
  - C. Intermediate duty drive
3. According to the control of Drives,
  - A. Manual
  - B. Semi automatic
  - C. Automatic
4. According to the number of machines,
  - A. Individual drive
  - B. Group drive
  - C. Multi-motor drive
5. Based on speed control
  - A. Reversible and non reversible speed control
  - B. Variable speed control

### 5.2.2 DC drive

The drive is nothing but one type of electric machine. This converts electrical energy into mechanical energy. Its structure is similar as in figure 5.3. The speed of the drive will depend on the amount of voltage given to it. Small type motor is used in sports equipment such as toys. Large size of electric motor is used in electrical vehicles such as Hoists and Steel rolling mills.



**Fig. 5.3** DC motor

### 5.2.3 AC drive

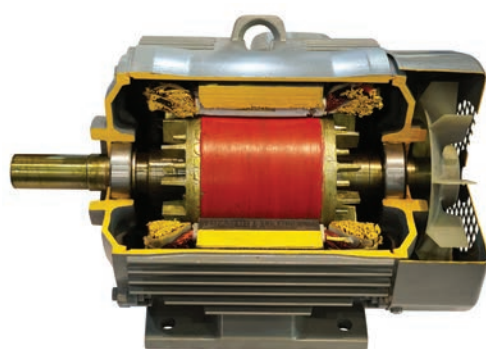
AC drive is a type of electric machine, and it is shown in figure 5.4. It changes the electrical energy into mechanical energy. The inner appearance of the AC Motor is shown in figure 5.5. AC motors are used in electric fan, electric pump, air compressor and automobile industries.

AC motors has two parts.

1. Stator.
2. Rotor.



**Fig. 5.4** AC motor



**Fig. 5.5** Internal structure of AC motor

### 5.2.4 Comparison of DC and AC drives

Sl. No.	DC drive	AC drive
1	Energy and method of control is simple	Energy and method of control is difficult
2	More maintenance is required.	Less maintenance is required.
3	Commutator is required	Commutator is not required
4	Rapid speed control	Gradual speed control
5	Speed and design ratings are less	Speed and design ratings are high

### 5.2.5 Advantages of electric drives

- i. It has flexible control characteristics.
- ii. Drives with fixed and dynamic characteristics changed according to load requirements.
- iii. Computers can be used to control the drive movements automatically by closed loop operation.
- iv. Available with wide range of torque, speed and power.
- v. It is applicable to function in the state such as explosion and radiation.
- vi. It can start immediately even at full load of the drive.
- vii. To control the speed and also simplest way to start and stop the drive.

### 5.2.6 Selection of drive

The choice of an electric drive depends on many factors. Some of the key factors are given below:

- i. Depending on the nature cycle of the speed, torque characteristics, speed control, speed limit, performance and obligation, the level of operation, speed of performance.
- ii. Uninterrupted operating requirements will depend on the acceleration and initial loss and performance change.
- iii. The source and the ability to meet the source will consist of voltage, voltage optimization, power factor compatibility and other loads, and restoration of power adaptability
- iv. Basic capital and running cost and maintenance is required.
- v. Space and weight should be less.
- vi. Environmental and area of the space be selected.
- vii. Reliability.

#### i. Individual drive

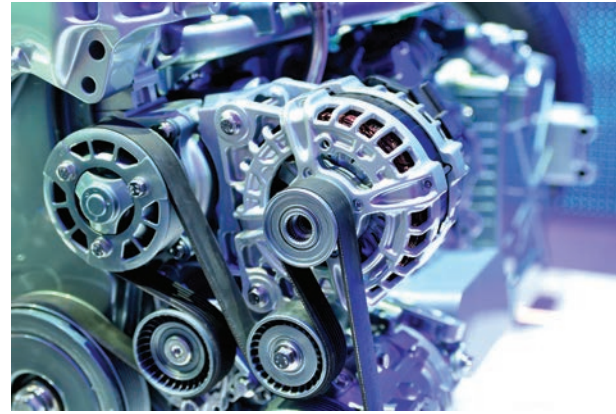
As shown in figure 5.6, this drive is driven by an electric machine with an individual machine. It provides movement to various areas and all the operations are done by the individual machine.

A separate machine will change the direction and size. It is applicable in automobile systems, molecular machines, computers, radios, and television.



**Fig. 5.6** Individual electric drive

#### ii. Group drive



**Fig. 5.7** Group electric drive

This drive has an electric motor. It is connected with one or more roller bearing and axis as shown in figure 5.7. This axis is fitted with belts or gears. With this, a group of electrical machines are operated.



**Fig. 5.8** Block diagram of group drive

#### a. Advantages

- i. A large size of motor can be used instead of using small number of motors
- ii. Low price.

#### b. Disadvantages

- i. If the motor is in fault, the entire operation will be stopped
- ii. The efficiency will be reduced due to losses by conduction of energy.



- iii. Less security measures.
- iv. No flexibility.
- v. There will be more noise in the working area.

### iii. Multi motor drive

Many electric drives combined with a single common controlled structure is known as multi motor drive system.

#### a. Advantages

- i. Each drive is powered by a single electric motor. It can only stop or use the required motor.
- ii. Individual drives can be controlled.
- iii. If any drive fails, it will not affect the other drives.

#### b. Applications

- i. Rolling mills
- ii. Paper mills
- iii. Escalators
- iv. Mixer metal works.



## 5.3 Selection of motors

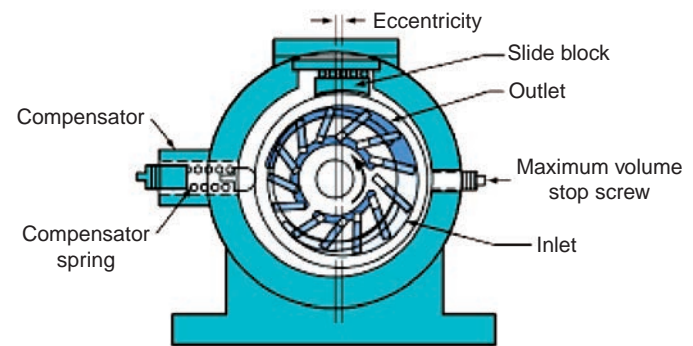
Based on its speed, torque and accuracy, an electric machine should be chosen. It should be similar for the speed-torque characteristics of the machine loads.

Types of mechanical loads can be classified as follows:

### 5.3.1. Fixed speed loads

As shown in figure 5.9, some loads require steady speed when load varies. These are called fixed speed loads.

- i. Mechanical Tools
- ii. Hydraulic pumps
- iii. Paper industries



**Fig. 5.9**

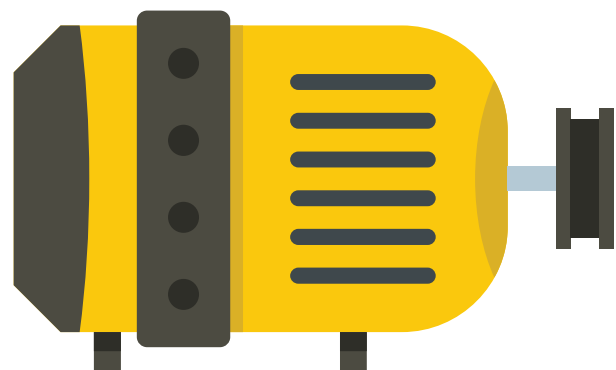
### 5.3.2 Different speed loads

Some of the specific mechanical devices that has the same advantage are low speed, and torque requirement. These are in figure 5.10. Some drives require more speed limits.



**Fig. 5.10**

- I. Crane
- II. Hoist



**Fig. 5.11**



**Fig. 5.12**



## 5.4 Controller

Controller is used to control the torque and speed of the electrical drives.

### a. AC - DC controller

AC / DC controllers are of electronic system. A steady state speed and voltage of the device can be used to convert it to the desired limit. This allows to control the speed, rotation, horse power, and direction of rotation. It is used more effectively because of the energy savings of the drive.

### b. DC - DC controller

The control of the DC - DC driver is used for heavy load traction. The speed control and rotation direction is essentially modified based on the voltage level normally connected to a fixed power voltage supply.



## 5.5 Electric vehicles

### 5.5.1 Two wheeler electric vehicle

The UK-based Humming bird company discovered weight less a two-wheeler

as shown in figure 5.13 on the lowest electric bike in the world. This bike will ride at a speed of 25 km, and can drive up to 30 km for single charge. This vehicle, like a bicycle is also used as a smart bike. The weight of the smart bike is 10.3 kg.



**Fig. 5.13** Two wheeler electric vehicle

### 5.5.2 Electric vehicle



**Fig. 5.14** Electric vehicle

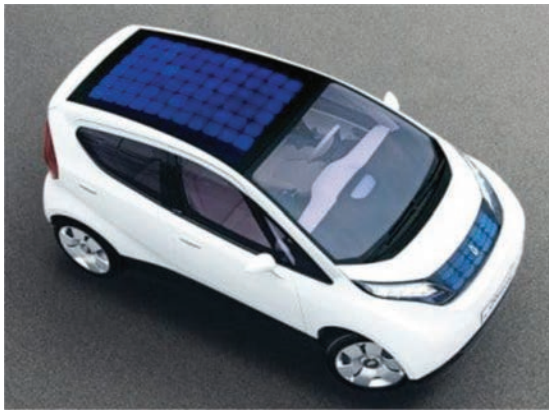
Increasing air pollution in India, there are a number of attempts were going on to run vehicle with electricity as source instead of petrol or diesel. The hyper car type in figure 5.14 is enhanced by the power of the turbine power that does not affect the environment. Such a system is a rare use in electric vehicles. The top of the cover is made of very light metal. The hyper car has been developed with all the features of beautiful design and smooth running.

### 5.5.3 Solar vehicle

As shown in figure 5.15, the solar vehicle is a vehicle that runs with solar

power as input to drive. The electric current required for this vehicle is obtained from sunlight through light voltage cells. These batteries convert solar power into electricity.

It has been incorporated into alternative energy and vehicle technologies. Most solar vehicles are used for car races. Nowadays, solar car systems are designed for the use on roads.



**Fig. 5.15 Solar vehicle**

When sunlight falls on photo voltaic cell, it induces electrons and converts it as electrical energy. Photo voltaic cells consist of silicon and alloys such as indium, gallium and nitrogen, with huge quantity of silicon.



**Fig. 5.16 Solar vehicle**

#### 5.5.4 Battery

Storage battery packs in a solar system carries 250 miles (400 km) without the rays of sun. More cars have enough power to allow them to travel at a speed upto 60 miles (97 km/h).



### 5.6 Electric traction

The electric traction is divided into two types.

1. The Urban train and
2. The Sub-urban train.



#### 1. Urban train

In this way the drives are given necessary power for two ways, as shown in figure 5.17.

1. Getting power from the overhead lines.
2. Getting power from the diesel drive.

The collector is mounted and the current passes through the overhead transmission line.



**Fig. 5.17 Electric train**

#### 2. Sub-urban train

Sub-urban trains are used to travel short distances. The train is called the local train. The sub-urban train can be used to stop and park to a distance of 2 to 5 km intervals.



The main features of electric drives are given below

- i. During starting the drive needs more torque.
- ii. For economic reasons, AC traction requires single phase supply.
- iii. For AC and DC, it causes interference in telephone lines and signals.
- iv. Traction machines are mainly used for dynamic braking.
- v. Mechanical brake is used where the engine need to stop at exact place.



### Do you Know?



### Very high speed trains (Bullet trains)

There is no engine in most high-speed trains. It runs to a speed of 600 km/hour. These trains operate in magnetic levitation mode. If attraction and repulsion forces are in equal, the train will be above the track. When the speed of the force increases, connecting trains will also run at high speed.



## Activities



1. Create a small toy for children with an electric motor.
2. See the types of electric motor used in home appliances.
3. Take a car with a drive used in electric vehicle.

## Glossary



Squirrel cage motor	- அணில் கூடு மின்னோடி
Synchronous motor	- ஒத்தியங்கு மின்னோடி
Induction motor	- தூண்டு மின்னோடி
Stepper motor	- படிநிலை மின்னோடி
Variable motor	- மாறு வேக மின்னோடி
Motor shaft	- மின்னோடி அச்சத்தண்டு



## Evaluation



### PART - A

#### Choose the correct answer

(1 Marks)

1. Elements of electric drive
  - a) Electric motor and control system
  - b) Electric motor
  - c) Control system
  - d) Voltage
2. In electric drive the energy conversion is \_\_\_\_\_
  - a) mechanical energy converted into electrical energy
  - b) electrical energy converted into Mechanical energy
  - c) electrical energy converted into chemical energy
  - d) mechanical energy converted into sound energy
3. The individual drive is used in \_\_\_\_\_
  - a) computers
  - b) vacuum cleaner
  - c) cranes
  - d) jet pump

4. The speed of the DC drive depends on \_\_\_\_\_
  - a) current
  - b) voltage
  - c) frequency
  - d) Power
5. Depending upon the load current the power \_\_\_\_\_ in the motor gets changed.
  - a) voltage
  - b) current
  - c) speed
  - d) Power
6. Low and medium electric motors are
  - a) 400-440V
  - b) 200-230V
  - c) 150-180V
  - d) Above 11KV
7. Some electric drive run through
  - a) capacitor
  - b) resistance
  - c) battery
  - d) inductance
8. \_\_\_\_\_ type of energy is used in electric trains.
  - a) wireless
  - b) Direct coupling exchange
  - c) with wire
  - d) remote control

### Part-B

**Answer the questions in brief**

**(3 Marks)**

1. What is an electric drive?
2. Define speed control methods.
3. What is called multi motor drive?
4. Define DC electric drive.
5. Define AC electric drive.
6. What are the characteristics of mechanical loads?
7. What is meant by different voltage controller?

### Part-C

**Answer the questions in one page**

**(5 Marks)**

1. Explain individual electric drive functions.
2. What is electric group drive?
3. Compare the DC and AC electric drives.
4. What are the types of electric drives?

### Part–D

Answer the questions in two page

(10 Marks)

1. What are the advantages of electric drives, and how are they selected?
2. Explain with diagram about electric vehicles.



### Reference Book

1. A text book of 'Electrical Technology' Volume-III B.L.Theraja and A.K.Theraja, S.Chand & Company Ltd.



### Reference Internet Source

1. <http://www.wikipedia.org>
2. <https://www.electrical4u.com>