

PART B

UNIT-5, 6 & 7

ELECTRIC TRACTION

Introduction: By electric traction is meant locomotion in which the driving (or tractive) force is obtained from electric motors. It is used in electric trains, tramcars, trolley buses and diesel-electric vehicles etc.

Electric traction has many advantages as compared to other non-electrical systems of traction including steam traction.

Traction Systems

Broadly speaking, all traction systems may be classified into two categories :

(a) Non-electric traction systems

They do not involve the use of electrical energy at *any stage*. Examples are : steam engine drive used in railways and internal-combustion-engine drive used for road transport.

(b) Electric traction systems

They involve the use of electric energy at some stage or the other. They may be further subdivided into two groups :

1. First group consists of self-contained vehicles or locomotives. Examples are : battery-electric drive and diesel-electric drive etc.
2. Second group consists of vehicles which receive electric power from a distribution network fed at suitable points from either central power stations or suitably-spaced sub-stations.

Examples are : railway electric locomotive fed from overhead ac supply and tramways and trolley buses supplied with dc supply.

Direct Steam Engine Drive

Though losing ground gradually due to various reasons, steam locomotive is still the most widely adopted means of propulsion for railway work. Invariably, the reciprocating engine is employed because

1. it is inherently simple.
2. connection between its cylinders and the driving wheels is simple.
3. its speed can be controlled very easily.

However, the steam locomotive suffers from the following disadvantages :

1. since it is difficult to install a condenser on a locomotive, the steam engine runs non-condensing and, therefore, has a very low thermal efficiency of about 6-8 percent.
2. it has strictly limited overload capacity.
3. it is available for hauling work for about 60% of its working days, the remaining 40% being spent in preparing for service, in maintenance and overhaul.

Diesel-electric Drive

It is a self-contained motive power unit which employs a diesel engine for direct drive of a dc generator. This generator supplies current to traction motors which are geared to the driving axles. In India, diesel locomotives were introduced in 1945 for shunting service on broad gauge (BG) sections and in 1956 for high-speed main-line operations on metre-gauge (MG) sections. It was only in 1958 that Indian Railways went in for extensive main-line dieselisation.* Diesel-electric traction has the following advantages :

1. no modification of existing tracks is required while converting from steam to diesel-electric traction.
2. it provides greater tractive effort as compared to steam engine which results in higher starting acceleration.
3. it is available for hauling for about 90% of its working days.
4. diesel-electric locomotive is more efficient than a steam locomotive (though less efficient than an electric locomotive). **Disadvantages**

1. for same power, diesel-electric locomotive is costlier than either the steam or electric locomotive.
2. overload capacity is limited because diesel engine is a constant-kW output prime mover.
3. life of a diesel engine is comparatively shorter.

4. diesel-electric locomotive is heavier than plain electric locomotive because it carries the main engine, generator and traction motors etc.
5. regenerative braking cannot be employed though rheostatic braking can be.

Battery-electric Drive

In this case, the vehicle carries secondary batteries which supply current to dc motors used for driving the vehicle. Such a drive is well-suited for shunting in railway yards, for traction in mines, for local delivery of goods in large towns and large industrial plants. They have low maintenance cost and are free from smoke. However, the scope of such vehicles is limited because of the small capacity of the batteries and the necessity of charging them frequently.

Advantages of Electric Traction

As compared to steam traction, electric traction has the following advantages :

1. Cleanliness. Since it does not produce any smoke or corrosive fumes, electric traction is most suited for underground and tube railways. Also, it causes no damage to the buildings and other apparatus due to the absence of smoke and flue gases.

2. Maintenance Cost. The maintenance cost of an electric locomotive is nearly 50% of that for a steam locomotive. Moreover, the maintenance time is also much less.

3. Starting Time. An electric locomotive can be started at a moment's notice whereas a steam locomotive requires about two hours to heat up.

4. High Starting Torque. The motors used in electric traction have a very high starting torque. Hence, it is possible to achieve higher accelerations of 1.5 to 2.5 km/h/s as against 0.6 to 0.8 km/h/s in steam traction. As a result, we are able to get the following additional advantages:

(i) high schedule speed

(ii) increased traffic handling capacity

(iii) because of (i) and (ii) above, less terminal space is required—a factor of great importance in urban areas.

5. Braking. It is possible to use regenerative braking in electric traction system. It leads to the following advantages :

- (i) about 80% of the energy taken from the supply during ascent is returned to it during descent.
- (ii) goods traffic on gradients becomes safer and speedier.
- (iii) since mechanical brakes are used to a very small extent, maintenance of brake shoes, wheels, tyres and track rails is considerably reduced because of less wear and tear.

6. Saving in High Grade Coal. Steam locomotives use costly high-grade coal which is not so abundant. But electric locomotives can be fed either from hydroelectric stations or pit-head thermal power stations which use cheap low-grade coal. In this way, high-grade coal can be saved for metallurgical purposes.

7. Lower Centre of Gravity. Since height of an electric locomotive is much less than that of a steam locomotive, its centre of gravity is comparatively low. This fact enables an electric locomotive to negotiate curves at higher speeds quite safely.

8. Absence of Unbalanced Forces. Electric traction has higher coefficient of adhesion since there are no unbalanced forces produced by reciprocating masses as is the case in steam traction. It not only reduces the weight/kW ratio of an electric locomotive but also improves its riding quality in addition to reducing the wear and tear of the track rails.

Disadvantages of Electric Traction

1. The most vital factor against electric traction is the initial high cost of laying out overhead electric supply system. Unless the traffic to be handled is heavy, electric traction becomes uneconomical.
2. Power failure for few minutes can cause traffic dislocation for hours.
3. Communication lines which usually run parallel to the power supply lines suffer from electrical interference. Hence, these communication lines have either to be removed away from the rail track or else underground cables have to be used for the purpose which makes the entire system still more expensive.
4. Electric traction can be used only on those routes which have been electrified. Obviously, this restriction does not apply to steam traction.