

# LOCOMOTIVE TRANSPORT

## Applicability

- Where the way is gradient of the roadway is mild. Nearly flat gradient is preferred. A gradient of 1 in 15 against the loads is considered to be limit though locos are generally employed on gradient milder than 1 in 25.
- Where the loco track is in settled ground not subjected to movement by mining operations.
- Where a high standard of track can maintained.
- Large output has to be handled.

- In the intake air-ways, where air velocity is adequate to keep fire damp percentage appreciably low. If diesel locos are used the exhaust gases of the loco should be diluted by the air current sufficiently well so as to be harmful to workers.
- Where roads are reasonably wide and high.
- Where the transport of mine cars involves long haul distances.
  
- Compare to belt conveyor and haulage system

## Major part of locomotive

- A chassis which is a rigid frame work of rolled steel sections
- Driving wheels on axles springs and brake block mounted underneath the chassis
- A power unit. Diesel/electric/compressed air.
- Operator cabin
- Light at both ends
- A hand screw break for emergency.

- **Frame:** Locomotive frames are unique structurally sound welded frames and quality steel which is carefully inspected and specified.
- On completion of fabrication all frames are blasted in a large chamber which removes stains.

- **Wheels:** All wheels are cast from a high grade of abrasion resistant steel to MTI specifications.
- Wheels are mounted via fasteners to wheel hubs.
- The wheel hubs are spline fitted to the axles to ensure the highest integrity of fit.

- **Axles:** Axles are designed for maximum loads and are carefully manufactured from high quality alloy steel with high factors of safety. Axles are press fit and keyed to main drive worm wheels.
- **Suspension:** The standard suspension used by Locomotives is a chevron suspension designed around parameters well known to the locomotive industry and proven in countless mine and tunnel rail haulage applications

- **Motors:** The DC drive motors supplied are series wound and built to exacting standards with a standard base load speed of 1400 RPM.
- The motors utilized in the trolley application are designed for operation on nominal 250 volts DC input power.

- Controlled reverse braking
- Electric braking
- Neutral braking
- Unique programmable coded keys
- Overspeed governor
- Stall protection
- “Thermal” overload protection
- Operator interface with fault indication
- Watchdog safety circuit
- Isolated power supply
- Modular construction
- Vigilance control
- Auto shut down

## Main Haulage Locomotives

- Locomotives of this type are the heaviest of those used anywhere in the mine.
- The type of work they perform requires high traction effort and a speed rating of six to eight miles per hour.
- Such locomotives range in size from 6 to 8 tons minimum to 25 tons maximum.
- The majority of the locomotives are of the electrically driven type receiving their power from an overhead trolley wire carrying either 250 or 500 volts DC.

## Gathering Locomotives

- Gathering haulage involves the collection of individual cars at the faces of rooms or entries, or at other points where loading is done. Then bringing them to suitable sidings where they are made into trains for the main haulage locomotives.

## Types of locomotives

- Diesel locomotives
- Electric locomotives
- Battery locomotives
- Reel locomotives
- Compressed Air locomotives

## Diesel locomotive

- The diesel engine locomotive having greater safety, higher efficiency, lower fuel consumption.
- It is based on mechanical power generated by fuel combustion and running the piston.

## About Engine

Diesel locomotive

- The compression –ignition engines used on underground locos are of the 4-stroke/cycle type, the air being drawn in during the first forward stroke of the cycle and compressed on the first stroke to a pressure of about 35 MPa.
- The compression of the air is adiabatic and when fuel from a fuel pump is injected as a spray either into the cylinder or into a pre-combustion chamber at the end of this stroke ignition occurs spontaneously owing to the temp of air 1000.

Diesel locomotive

- The piston is driven forward by the expanding products of combustion through the exhaust ports during the second back and last stroke of the cycle.
- The maximum speeds of the engines which have from 2 to 6 cylinder, vary from 1,100 to 1700 rpm.
- The air for the engine passes through an air filter which should be cleaned twice weekly as engine wear is fairly rapid it would appear that the efficiency of filters in the dusty atmosphere of mines might be improved.

Diesel locomotive

## Specificaitons

- Weigh range from 3 – 15 te and power from 15 – 75 kW.
- The power unit is a diesel engine with 2,3 or 4 cylinders of 4-stroke cycle compression-ignition type.
- Locos used in underground coal mines have the power unit in a flameproof enclosure as a safeguard against ignition of fire damp.



Diesel locomotive

## Safety and regulations

- No locos may be used in a mine unless constructed as far as possible of non inflammable material and where inflammable material has to be used it must be protected by a metallic shroud
- For diesel locomotives the air entering the engine must be cleaned the exhaust gases cooled and diluted and the emission of sparks prevented.

Diesel locomotive

## Maintenance

- Careful maintenance and servicing and meticulous cleanliness are particularly necessary for the safe and efficient operation of diesel locos.
- Daily maintenance should include the cleaning of exhaust flame traps, replenishing conditioners, checking and replenishing oil in the sump, oiling and greasing all working parts, checking and replenishing radiator water and fuel tanks and sand boxes.

## Diesel locomotive

- Weekly break must be tested, intake flame traps and filters cleaned conditioner box flushed out.
- Monthly the fuel atomizers should be cleaned engine sump and radiator drained and refilled valve clear checked and oil gear boxes.
- Quarterly and half-yearly the exhaust gases are analysis the engine decarbonized and valves re-ground inlet and exhaust manifolds
- yearly the fuel tank and the radiator and all connecting pipes should be stripped and cleaned

## Diesel locomotive

- About Engine
- Specifications
- Safety and regulations
- Maintenance
  - Daily, weekly, monthly and yearly
- Advantages / disadvantages

## Battery locomotive

- The power unit of an electric battery locomotive is a DC electric motor receiving its currents from a storage battery carried in a casing on the upper parts of the chassis.
- These are locomotives designed to operate entirely on storage battery power and thus eliminate the use of trolley wires/diesel engine in working sections.

- Storage battery locomotives may vary in size from four to eight tons with a speed rating of three and a half miles per hour.
- The framework and suspension gears are stronger and heavier than the trolley wire locos.
- Part of every storage battery in which the battery is carried must be designed and construction to resist rough usage and to be proper ventilated.

## Specifications

- Capacity 1.5 – 25 tonnes
- Speed 4.5 to 15 km/h
- Battery types: lead acid or alkaline.
- Number of cells of either type in any one battery should be sufficient to give an average of 80 volts.

## Charging

- Charging station must be constructed of non-inflamable material.
- Charging stations are necessary to charge the battery at the end of a shift.
- Extra batteries and facilities for changing battery boxes are necessary where locomotives are double shifted.
- The battery charging plant can be located in the underground substation which houses the generators for the trolley locomotive system.

## Latest developments

- Latest developments in battery locomotives stressing large batteries assure the operator of sure, steady power throughout the shift without loss of time due to power failure.
- This type of locomotive can equal or exceed the production of the cable reel locomotive in the same territory due to the gain in time from no necessity of handling the cable and is more economical of power due to its lower speed rating and other features of this design.

## Applications

Battery locomotive

- This types of locomotive has universal application being used for main line. It can be used for all kinds of mines wherever locomotive are employed.
- These locomotives can be used with safety in any part of any gassy mine since even the hazard of a cable reel has been eliminated.

## Advantages

- It is independent of an outside source of fuel and thus can travel anywhere where tracks are laid.
- It can also work where ventilation problem.
- They are easy to inspect and repair.

## Disadvantage

- Low power to weight ratio
- Spare batteries must be provided and replaced every 3-5 year.

## Battery locomotive

- Introduction
- Charging
- Development
- Applications
- Advantages
- Disadvantages

## Overhead wire locomotive

- The trolley wire locomotive is equipped with electric motor fed with current from overhead electric wire through a pantograph or through a long pole.

## Electric locomotives

Electric locomotives

- Direct current electric trolley locos are widely used
- It is simple and rugged in design and will stand rough handling.
- They are suitable for the heaviest kind of work as they will operate over long distance and fairly steep grades.
- The problem may be due to hanging of bare trolley wire introduce fire and explosion hazard in a gassy mines.

Electric locomotives

- The trolley locos driving unit usually consist of two or four electric motors driving the axles through suitable gearing.
- Size range from 8 to 25 tonnes,
- Hauling speed 9 to 15 km/h and up to 40 km/h
- Horse powers 60 to 375



- Power from electric traction may be obtained from an overhead conductor or from an insulated extra rail.

## Compressed air locomotive

- The use of these types of locos are very rare.
- The high cost of installation and auxiliary equipment.
- They are safe and reliable and working cost are fairly low and in hot and deep mines they may be only types which will prove suitable.
- Their total working costs are higher than other types however and their efficiency is lower.

## Compressed air

- High pressure compressed air is usually produce on the surface by multistage reciprocating compressors and conveyed very often considerable distances under ground in special pipes of solid drawn steel.
- The air is store in special containers carried on the locomotive.
- High pressure air passes through a reducing valve on the locomotive where it is reduced to about 12-15 atm.

## Compressed air

- The amount of compressed air required per locomotive depends on several variable factors which are largely indeterminate.
- Some factor are fairly stable and may be utilized in determining size and number of bottles on each locomotive for a given journey.

## Advantages

Compressed air

- Probable safest of all types of locos.
- Very reliable and easy to maintain
- The cost per ton is very little.
- The compressed air has cooling effect.

## Disadvantage

Compressed air

- Its own compressor that required daily inspection and maintenance.
- It requires armored plated pipe lines receiver and special valves
- A filling station is required on each main or section
- Efficiency is less
- Driving cost is high

## Cable reels

- Cable reels are used to enable a trolley loco to operate over a short distance beyond the terminal point of overhead conductor.
- In case of battery locomotive for use at point where there is a lot of starting, stopping shunting and collection of load. The cable reel is carried on the loco and the cable end is brought in contact with overhead wires by a long insulated hook or alternatively the cable end is plugged into a special socket of mains supply.

### Cable reels

- These are light weight locomotives that get their power from the trolley wire either by the use of a trolley pole and wheel or with the cable. They may be of the single or double motor type.
- They range in size from 4 up to as much as 10 tons in places where the cars are of high capacity. The cable is held on a reel which may be of the Long Horizontal Type or the Flat Vertical Type.
- The reel may be either operated by a motor or by a mechanical friction drive.

- Selection of cable reel locomotives is based on car sizes, grades, radius of room curves, rail size and seam height.
- Control and speed are also important with many locomotives designed with a speed rating of four miles per hour.
- Room travel is usually over uncertain track and the low speed locomotive can negotiate such track with safety and enjoy the following advantages over locomotives rated at six miles per hour.

## Advantage

- Lower man power
- Flexibility and ease of extension
- Supply and men may be taken in bye and debris outbuy.
- Economic efficiency
- Higher speed
- Bend and curves can more easily negotiated
- Man power can be save at pit bottom
- Elimination of pulleys ropes etc results in reduction in accidents
- Less cable maintenance due to lower current consumption and less liability to being over run.
- Less need of brakes and better control of locomotive and loads on critical grades.

## Disadvantage

- Limitation of small gradient
- Digging and ripping of ground
- Additional risk to safety; explosion, fire, shock,

## Tractive forces

- Tractive force or tractive effort is force required to cause movement and the tractive effort depends on the weight of the loco and also on the frictional adhesion between the locomotive's driving wheels and the rail track.
- The coefficient of adhesion is the coefficient of static friction  $\mu$  between the wheels of a loco and the rails.
- If  $W$  is the total weight of the loco bearing on the driving on the driving wheel,  $\mu W$  is the total tractive effort exerted at the driving wheel treads. ( $\mu = 0.15 - 0.25$ )

