Internship Project Report on

Study of Electronic Ecofriendly Engine System like ACERT Technology, CRDI Technologies

*A report submitted as a part of the Industrial Orientation Training in **FMD (Field Machinery Department)**, Visakhapatnam Steel Plant*

By

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RASHTRIYA ISPAT NIGAM LIMITED (RINL), Visakhapatnam

(Duration: 14 February 2022 to 13 March 2022)

Certificate

This is to certify the following students of **Sastra University, Thanjavur** are engaged in the project work titled **Study of Electronic Ecofriendly Engine System like ACERT Technology, CRDI Technologies** from 14th February 2022 to 13th March 2022.

Ravi Teja Eegalapati TR No: 100006302

In partial fulfillment of the degree BACHELORS OF TECHNOLOGY in Mechanical Engineering stream in Sastra University, Thanjavur is a record of bonafide work carried out by them under my guidance and supervision during the period from 14th February 2022 to 13th March 2022.

Date:

Place: Visakhapatnam

Mr. G. BABU RAO

Deputy. General Manager (DGM),

Field Machinery Department (FMD),

RINL-VSP

Acknowledgement

First of all, I thank God in words for his grace, who gave me the opportunity and strength to carry out this work. The success and outcome of this project required a lot of guidance and assistance from many people and we are incredibly privileged to have got this all along with the completion of our project.

I take this opportunity to thank **Mr. G. Babu Rao Sir, DGM, Field Machinery Department, Visakhapatnam Steel Plant** for guiding me with is immense knowledge and helping me complete this project successfully.

I sincerely thank **Mr. Y. V. Ramana Sir** for investing his time in giving us an overview of each and every Machinery present in the FMD which helped us in completing our project successfully.

I wish to express my sincere thanks to FMD Dept. employees of Visakhapatnam Steel Plant for their valuable guidance in completing this project.

Declaration

I hereby declare that this project work entitled Study of **Study of Electronic Ecofriendly Engine System like ACERT Technology, CRDI Technologies** is original and has not been submitted to any university or college before fulfillment of the requirements of any course of study or to the award of any degree. The opinion is given and the conclusions arrived at are of my own. The views expressed in the report does not represent the views of organization.

Contents

1. Abstract

As the number of automobiles are getting increased day by day there is an enormous increase in pollution too which in turn is harmful for human beings. The main aim of **Field Machinery Department** is to incorporate latest technologies in heavy vehicles such as dumpers, loaders, dozers used in the Vizag Steel plant and reduce the emissions as much as possible, so they have started using **Common Rail Direct Injection** (CRDI) & **Advanced Combustion Emission Reduction Technology** (ACERT) engines to increase efficiency and decrease pollution. In this project we have studied about the CRDI and ACERT engine technologies, documented clearly along with the overview of different works taking place in all departments of Steel Plant.

2. Introduction

Rastriya Ispat Nigam Limited, the corporate entity of Visakhapatnam, popularly known as Vizag Steel, is the most advanced Indian Govt. owned steel producer. It is an integrated steel plant and produces one of the best products in the world market. Most of its income comes from its exports of steel products to Japan, Germany, The United States, Singapore, Dubai, Australia, South American countries and many more. Vizag Steel plant has conferred 'Navaratnam' status on November 17, 2010. VSP is established in 1971 and is focusing on producing value added steel.

It is equipped with modern technologies, VSP has an installed capacity of 63 million tons of liquid steel and 2.656 million tons of saleable steel per annum. At VSP, there is an emphasis on total automation, seamless integration and efficient upgradation, which result in a wide range of long and structural products to meet the stringent demands of customers within India and abroad. It is the first Steel Plant to be certified ISO 9001:2008 (presently2015), ISO 14001:2004 (presently 2015), OHSAS 18001:2007 and ISO/IEC 27001:2013 standards. It is the first PSE to be certified ISO 50001:2011-Energy Management Systems and has acquired CMMI level 3 certification for S/W development.

VSP has many production facilities such as:

- 5 Coke Oven batteries of 67 ovens each having 41.6 cubic meters volume.
- 3 Sinter machines of approx. 350 square meters area.
- 3 Blast Furnaces of 3800 cubic meters helpful volume.
- 2 Steel Melt Shops with 3 LD converters of 150 tons capacity each, 6 four-strand continuous bloom casters.

- Light and Medium Merchant Mill of 0.88MT capacity per year.
- 2 Wire Rod Mills of 0.55MT capacity per year.
- Medium Merchant & Structural Mill of 1.070MT capacity per year.
- Special Bar Mill of 0.75MT capacity per annum. The enhanced production capacity is 0.90MT per annum.
- Structural Mills of 0.70MT capacity per annum. The enhanced production capacity is 0.85MT per annum.

MAJOR SOURCES OF RAW MATERIALS: Iron Ore, Lumps and Fines, Limestone, SMS Limestone, BF Dolomite, SMS Dolomite, Manganese Ore, Boiler Coal, Imported Boiler Coal, Imported Coking Coal, Medium Coking Coal, Imported LAM Coal, Quartzite Lump and Fines, Sand.

MAIN PRODUCTS OF RINL- VSP: Angles, Billets, Channels, Beams, Squares, Flats, Rounds, Rebars, Wire rods.

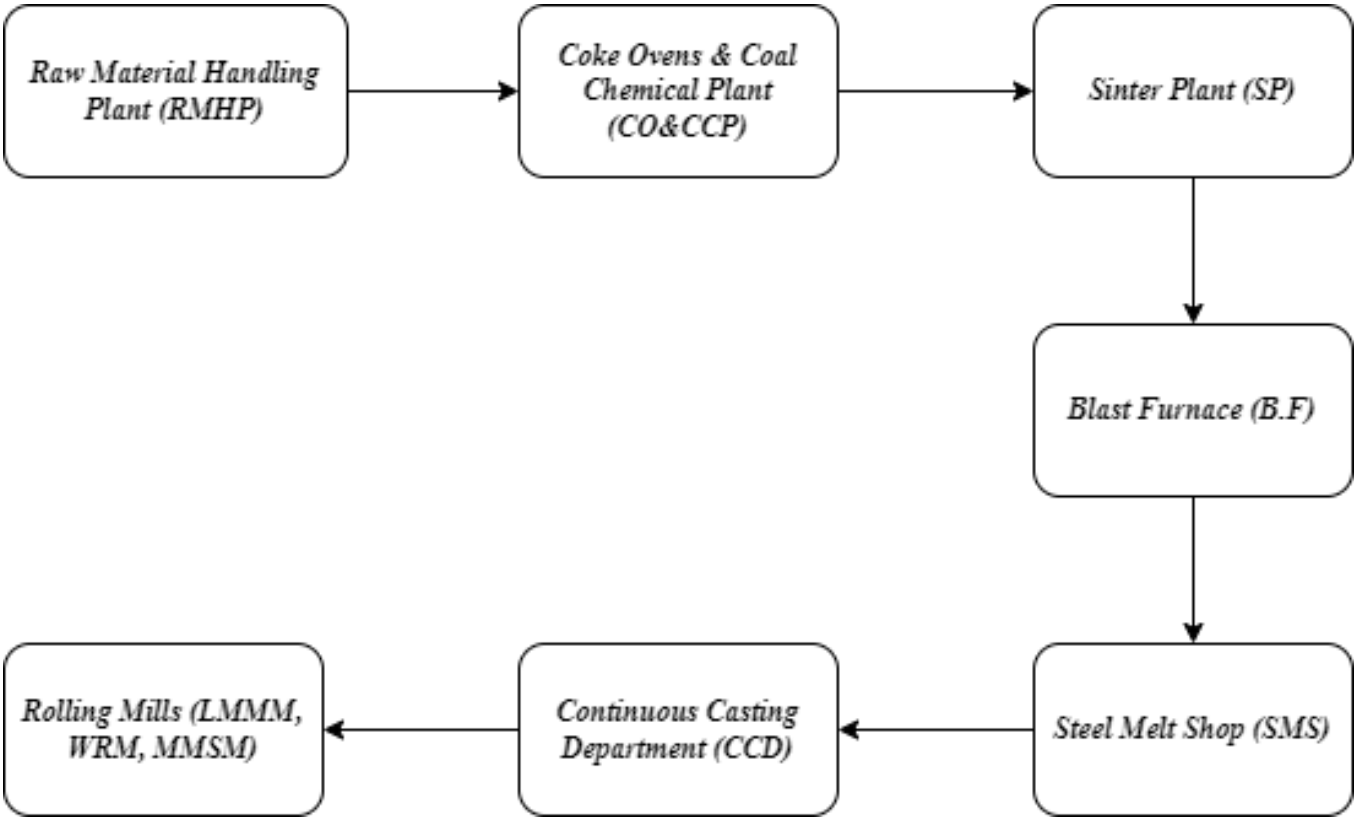
BYPRODUCTS: Coke dust, Coal tar, Anthracene, HP Naphthalene, Benzene, Toluene, Xylene, Wash oil, Granulated lag, Lime fines, Ammonium sulphate.

Extensive facilities have been provided for the repair and maintenance, and manufacture of spare parts. A Thermal Power Plant (TPP) and an Air Separation Plant also form part of the plant facilities. Modern technology has been adopted in many areas of production, some of them for the first time in the country. Among these are Selenide, Crushing of coal, Pneumatic Separation of Coal, 7-meter tall Coke Oven, Dry quenching of coke, the on-ground blending of Sinter base mix, conveyor charging and bell less top for blast furnace, cast house slag granulation for fast furnace, gas expansion turbine for power generation utilizing blast furnace top gas pressure, hot metal de-

sulphuration extensive treatment facilities of effluents for ensuring proper environmental protection, computerization for process control and sophistication in high speed and high production rolling mills.

2.1. Company Production Layout

For the production of steel and related shapes there are lot of steps involved, the flow of work from beginning to end of steel production in Vizag Steel Plant is depicted below.



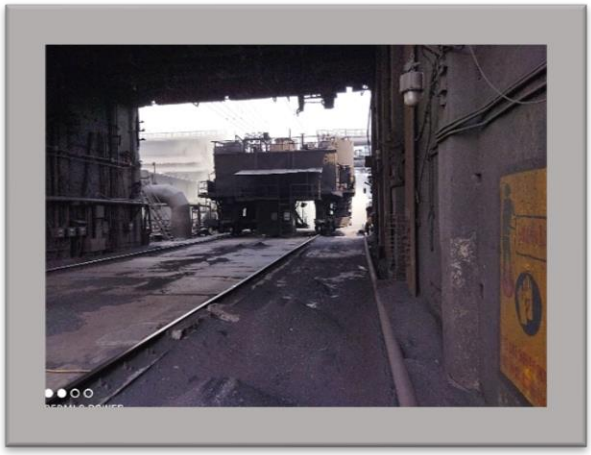
2.2. Raw Material Handling Plant

VSP annually requires quality raw materials viz. Iron Ore, Fluxes (Limestone, Dolomite), Coking and Non-Coking Coals etc. to tune of 12-13 MT of producing 3 MT of Liquid Steel. To handle such a large volume of incoming raw materials received from different sources and to ensure timely supply of consistent quality of feed materials to other VSP consumers, RMHP serves as vital function. This unit provided with elaborate unloading and blending, stacking& reclaiming facilities viz. Wagon Tipplers, Ground & Track Hoppers, Stockyards crushing plants, Vibrating screens, Single/twin boom stackers, wheel on boom and Blender reclaimers, Stacker cum - Reclaimer (SCR). In VSP, peripheral unloading has been adopted for the first time in the country. Coking coals are received through conveyors directly from M/s Gangavaram Port Limited to Coal Stock Yard

2.3. Coke Ovens & Coal Chemical Plant (CO & CCP)

We visited Coke Ovens & Coal Chemical Plant for an overview about its operation and application. In India we can't get pure coke for reduction of Iron from iron ores because iron ore is an oxide

ore, either we will be having pure coal (which is highly expensive) or coal with impurities. So first the coal with different types of impurities will be passed through different types of separators such as Foreign Object Separation etc. with the help of conveyor belts which are inter connected between different separators. Then the Coal which is separated from certain impurities is brought to the Coke Ovens with the help of conveyors.



A Coke Ovens are also called a battery because it has a series of ovens connected which are 7m high, 16m long and 0.4m wider. Here the coal is heated up to 1000 degrees Celsius for 16hrs continuously in the absence of air. There are totally 5 batteries in which each battery contains 67 ovens connected in series. The main machinery for coke oven functioning is Pusher Car, Door Extraction Unit, Charging car. The process starts from charging the ovens using a charging car and then the coal is heated for 16hrs and then using DE and Pusher car the hot coke is pushed into buckets. Then with the help of a wagon the hot coke is taken into the Coke Dry Cooling Plant for cooling the coke using nitrogen gas.

The main by-product is the coke oven gas which consists of different chemicals such as Ammonium Sulphate, Crude Thar, Crude Benzol etc. These are transferred to the Coal chemical

Plant using pipelines in which the by-products of Coke oven are separated and Ammonia, Benzol are extracted.

After cooling the Coke is transferred to a blast furnace using conveyors for extraction of iron from iron ore. The extruded chemicals are sold to the market.

The hot nitrogen from CDCP is passed through heat exchangers and the steam is used for rotating the turbines and power is generated, so everything is utilized without wasting.

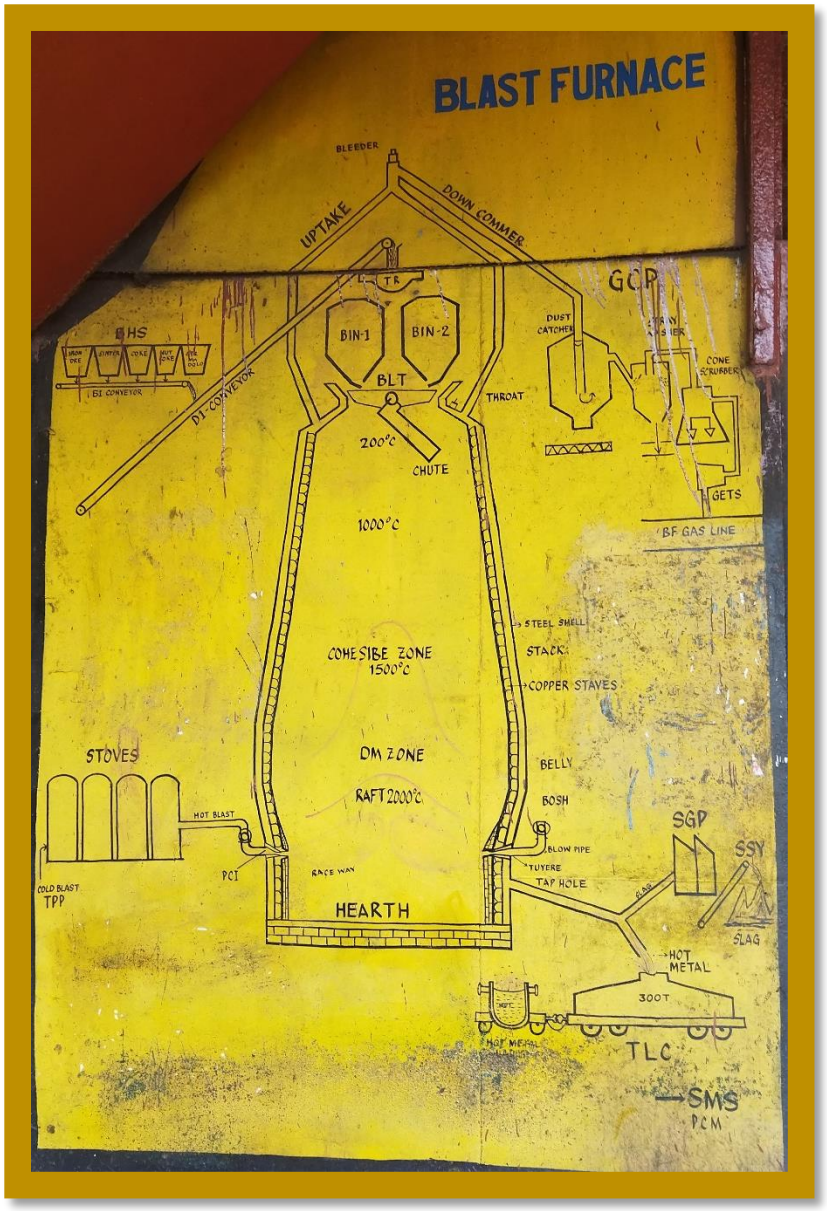
2.4. Sinter Plant (SP)

Sinter is a complex and porous ferrous material obtained by agglomeration of Iron Ore lines, Coke breeze, Limestone fines, Metallurgical wastes, viz. Flue dust, Mill scale, L.D. Slag etc. Sinter is a better feed material to Blast Furnace than Iron Ore lumps. It's usage in Blast furnaces helps in increasing productivity, decreasing the coke late and improve the quality of hot metal produced. Sintering is done in 2 number 312 m² Sinter machines of Dwight Lloyd heating the prepared feed on a continuous metallic belt made of pallets at 1200-1300 deg C. Hot sinter discharged from sintering machine is crushed to 5mm -50mm size and cooled before dispatching to Blast Furnaces.

2.5. Blast Furnace (BF)

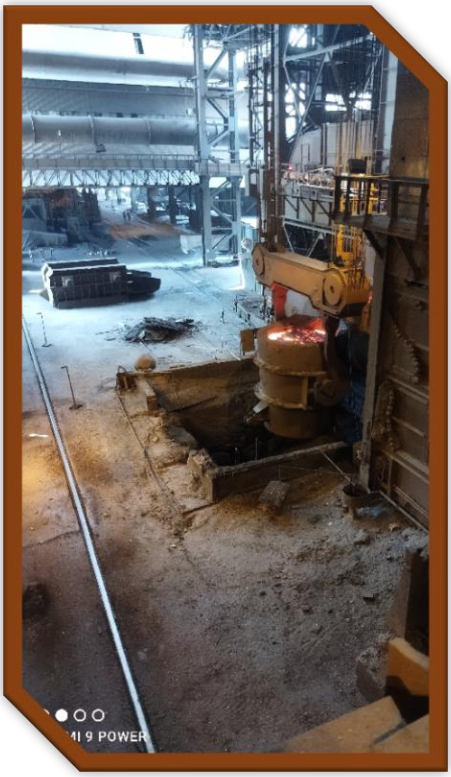
Hot Metal is produced in Blast Furnaces which are tall vertical furnaces. The furnace is named Blast Furnace it runs with the blast at high pressure and temperature. Raw materials such as sinter ore lumps, fluxes (limestone/dolomite) and coke are charged from the top, and hot Blast 1100 C-1300C and 5.745KSCH pressure is blown from the bottom. The furnaces are designed for 80% Sinter in the burden. RINL-VSP has three 3200 Cubic Meter blast furnaces (most prominent in India) equipped with Petworth Bell less top equipment with conveyor charging Rightly named as "Godavari" & "Krishna" after the two rivers of A.P and the other furnace hasn't named yet; the

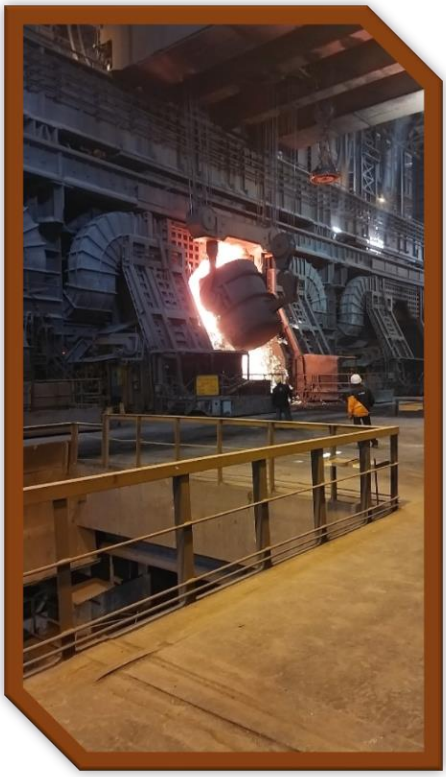
furnaces will help VSP in bringing prosperity to the state of Andhra Pradesh. Provision exists for granulation of 100% liquid slag at blast furnace cost house and utilization of blast furnace gas at maximum pressure (1.5 to 2.0 atmospheric pressure) to generate12 MV of power in each furnace turbines by employing gas expansion.



The two furnaces with their novel circular cast house and four tap holes each are capable of producing 9720 Tons of hot metal daily or 34MT of four hot Sulphur metal annually.

2.6. Steel Melt Shop (SMS)





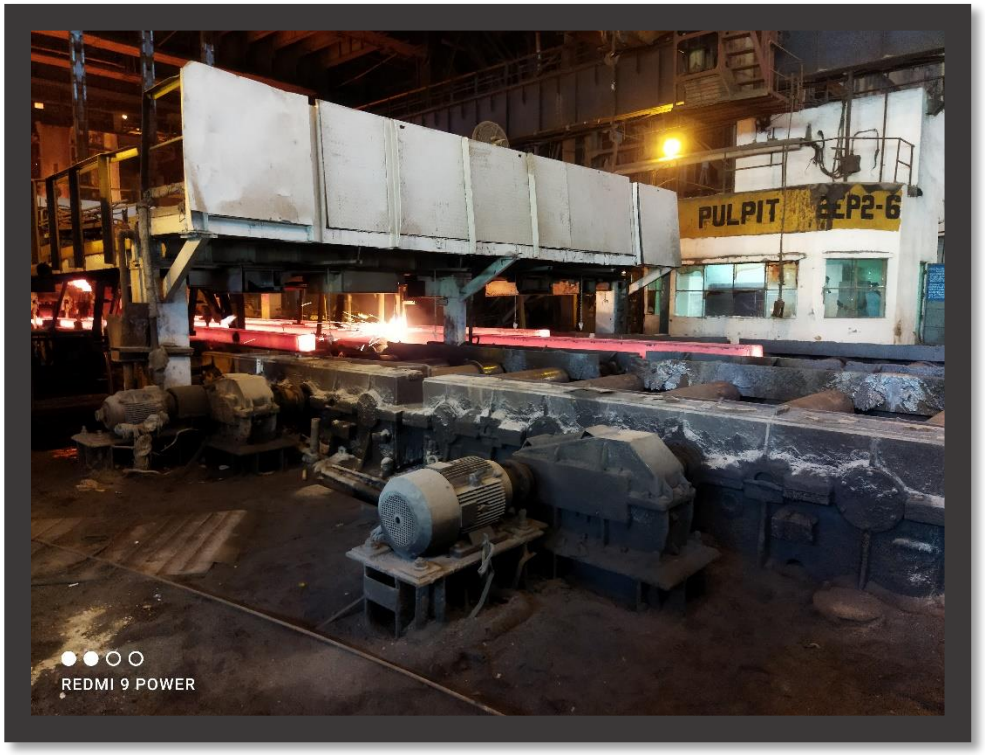
Steel is an alloy of iron with carbon un to 1.8% hot metal produced in Blast furnace contains impurities such as carbon (3.5-4.25 %), silicon (0.4-0.35%), manganese (0.3-0.4%), Sulphur (0.04%max), phosphorous (0 14% max) is not suitable as a material to improve the quality. The impurities are to be eliminated or decreased by the oxidation process. VSP produces steel using three numbers of top blown oxygen converters called E.D. convertors (L&D stand for Linz and Danowitz, two towns in Austria where this process was first adopted) or Basic oxygen furnaces/ convertors. Each converter has a 133 Cu Meter volume capable of producing 3 million tons of

liquid steel annually. Besides hot metal steel, scrap fluxes such as calcined dolomite form part of the charge to the convertors. 99 5% pure oxygen at 15-16 KSCG pressure is blown in the convertor through oxygen lance having convergent-divergent copper nozzles at the blowing end oxygen oxidizes the impurities present in the metal which are sag with elemental fluxes during process. That is generated by exothermic reactions of oxidation of metalloids viz Si-P and Carbon and temperature rise to 1700 deg. C enabling relining and stag formation.

2.7. Continuous Casting Department (CCD)

The continuous casting may be defined as teaming of liquid steel in a mold with a false bottom through which partially solidified ingot/bar is continuously withdrawn. At the same rate, steel is

teamed in the mold. Facilities at a continuous casting machine include a lift and turntable for laddels, copper mold, oscillating system tundish primary and secondary cooling arrangements to cool the steel bloom Gas cutting machines for cutting the blooms in required length (6 meters long). At VSP, we have six-4 strand continuous casting machines capable of producing 2.82 million tones/year blooms of 250 X 250 mm and 250 X 320 mm. The entire quantity of molten steel made (100%) is continuously cast in radial bloom casters.



Bloom produced in SMS, CCD do not find many applications as such and are required to be shaped into products such as billets rounds squares angles (equal and unequal) channels, IPE beams, HE beams, wire rods and reinforcements bars by cooling them.

2.8. Rolling Mills (LMMM, WRM, MMSM, RS&RS, STM)

Blooms produced in SMS-CCD do not find many applications as such and are required to be shaped into products such as billets, rounds, squares, angles (equal and unequal) channels-P.E. beams, HE beams, wire rods and reinforcements bars by rolling them in three sophisticated high-capacity high speed, fully automated rolling mills namely Light& Medium Merchant Mills (LMMM) Wire Rod Mill (WRM) and Medium Merchant and Structural Mill (MMSM)

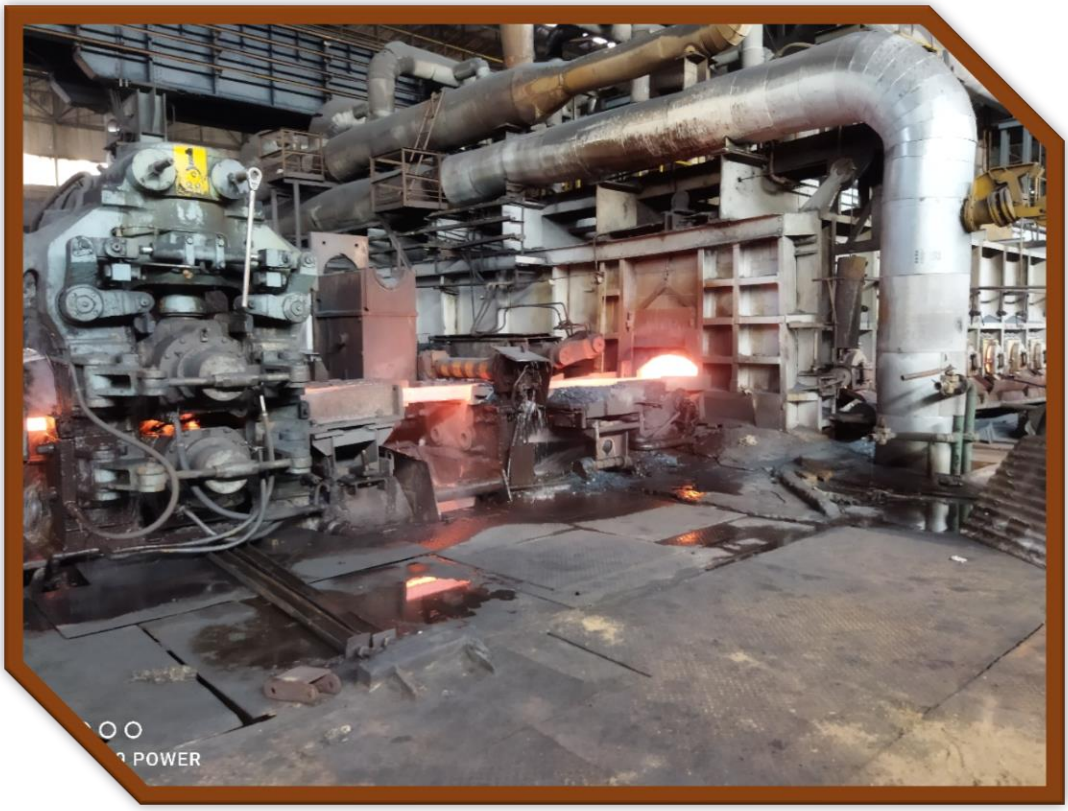
Light and Medium Merchant Mill: LMMM comprises two units in the billet/break down mill. 250 X 320 mm size blooms are rolled into billets of 125 X 125 mm size after heating them into two number of walking beam furnaces of 200 tons/hr. capacity each.

This unit comprises seven stands (2 horizontal 850 X 1200 mm) and five alternating vertical and horizontal stands (730 X 1000 mm X 630x 1000 mm). Billets are supplied from this to bar mill of LMMM and WRM. The billets for rolling in bar mill of LMMM are first heated in 2 strand roller hearth furnaces of 200 T/hr. capacity to the temperature of 1150 C-1200 C. The bar mill comprises 26 strands-8 strands double stand roughing train, 2 Nos of 5 strands double stand intermedial train

and two no's four single stand strand finishing trains. The Mill is facilitated with temp care heat treatment technology evaporative cooling system in walking beam furnaces automated pilling and bundling facilities, high degree of automation and computerization The Millis designed to produce 710,000 tons per annum of various finished products such as rounds, rebar, squares fats angles channels besides billets for sale.

Wire Rod Mill: Wire Rod Mill is a four- strand, 25 stands fully automated and sophisticated mill. The Mill has a four-zone combination type reheating damage (walking beam cum walking hearth) of 200 TPH capacity for heating the billets received from billet mill of LMMAM to rolling temperature of 1200 C.

The heated billets are rolled in 4strands, no-twist continuous Mill having a capacity of 8,50,000tonnes of wire rod coils.



The Mill has the following configuration: 7 Stand two high four strands horizontal roughing train, 6 Stand two high four strands horizontal intermediate mill, 2 Stand 4 strand per finishing mill, 10 Stand 4 strand, no-twisting finishing mill, the mill produces rounds in 5.5-12mm range and rebars in 8-12mm range. However, sizes up to 14mm are being rolled presently.

3. Field Machinery Department

Field Machinery Department (FMD) has a vital role in production of steel because it helps in transporting coal, coke etc. FMD provides maintenance and repair of the earth moving equipment at any time.

It uses latest technologies to stand up to the market requirements. It supplies with dumpers, dozers, loaders, cranes, trucks for the plant operations. The maintenance and repairs are done timely once they receive the vehicles to their repair shop.

It has three types of equipment:

1. **Earth moving equipment:** Dozers, Dumpers, Loaders, Excavators.
2. **Material handling equipment:** Track Mounted Cranes, Wheel Mounted Cranes, Fork Lifts.
3. **Vehicles:** Jeeps, Tippers, Trucks.

Jeeps

Jeeps are basically used for easy movement of technicians or supervisors to the field if there is an immediate assistance.

Dumpers

Dumpers are nothing but tipper truck with huge capacity trailer. The dumpers present in FMD are of 35T capacity. These help in transporting coal to RMHP if conveyers are in breakdown, also help in transporting coke to BF if there is a breakdown in conveyer belts. Bunkers help in moving the coke to stock yards if there is an excess amount near the Blast Furnace and from stock yards to BF when necessary.

Crawler Dozers

Dozers are mainly used for pushing purpose. These find their application in the plant near the RMHP for pushing the coal to a common place, so that excavators can do their work easily. FMD has BD 355 Crawler Dozer and also some small capacity dozers too which are used near coke ovens for clearing the track for pusher car movement. Most equipment used in FMD are Bharat Earth Movers Limited (BEML) make. It has a blade capacity of 11.6m^3.

Forklift

A forklift is powered industrial truck used to lift and transport materials. The modern forklift was developed in the 1920s by various companies including the transmission manufacturing company Clark and the hoist company Yale and town manufacturing. The fork lift has since become an indispensable piece of equipment in manufacturing and warehousing operations. In FMD it is used for lifting and moving wheels and other heavy components which cannot be lifted by workers.

Excavators

Excavator are heavy construction equipment consisting of a boom, bucket and cab on a rotating platform. The house sits atop an undercarriage with tracks or wheels. All movement and function fluid be with rams or motors. Their design is a natural progression from the steam shovel. It is used for loading the small amount of material into the small trucks when compared to loaders of huge capacity.

4. Engine and its Terminologies

Engine is nothing but a mechanical device which converts chemical energy into mechanical energy or useful work.

Engines are classified on basis of

1. **Internal combustion (IC) and External Combustion (EC)**
2. **Type of fuel:** Petrol, Diesel, Gas, Bio / Alternative Fuels
3. **Number of strokes –** Two stroke Petrol/ Two-Stroke Diesel, Four Stroke Petrol / Four Stroke Diesel
4. **Type of ignition:** Spark Ignition, Compression Ignition
5. **Number of Cylinders –** From 1 to up to 18 cylinders (in a car)
6. **Arrangement of cylinders:** Inline, V, W, Horizontal, Radial
7. **The motion of Pistons –** Reciprocating, Rotary
8. **Size / Capacity**
9. **Bore-to-Stroke Ratio**
10. **Engine cooling methods:** Air-cooled, Liquid-cooled (Water-based), Oil-cooled (Oil is cooled separately)
11. **Breathing:** Naturally Aspirated, Turbocharged / Supercharged
12. **Applications:** Bikes, Passenger Cars, Racing cars, Commercial Vehicles, Marine, Agricultural equipment, and Earth-moving equipment, etc.

4.1. Engine Components in General

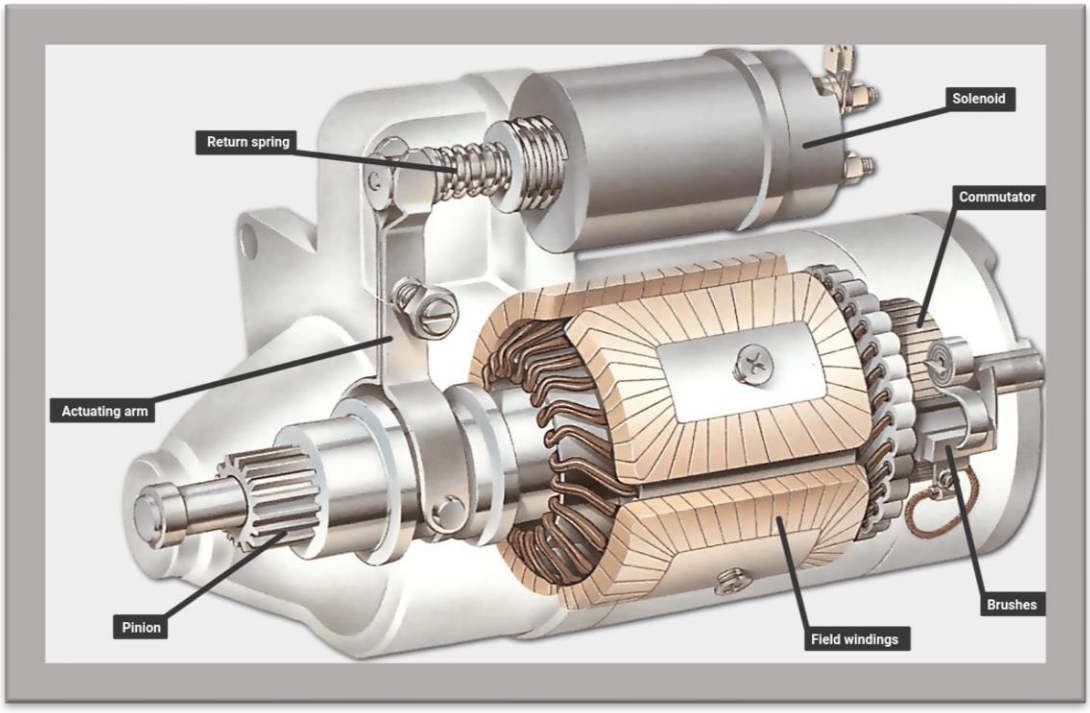
1. **Cylinder Block:** This is a housing in which entire components are placed.
2. **Cylinder head:** The upper part of the engine in which the valves and fuel injectors/ Spark plugs are placed.
3. **Cylinder:** This is a hollow cylindrical structure in which the piston reciprocates.
4. **Connecting rod:** This part connects piston to the crankshaft.
5. **Piston pin:** It connects piston head to connecting rod. It is also called as gudgeon pin.
6. **Piston:** It is the reciprocating part placed inside the cylinder for transferring motion to crankshaft.
7. **Crank shaft:** It is a shaft which transfers reciprocating motion of piston to rotary motion of the flywheel.
8. **Cam shaft:** It is connected to the flywheel trough gear arrangements and it helps in controlling inlet and exhaust valves using rocker arm arrangement.
9. **Flywheel:** It is a huge rotating gear attached to crankshaft for storing and transferring the energy to wheels using transmission system.
10. **Inlet & Exhaust Ports:** These are tubes connected to cylinder head for transferring fresh air to inlet valve and removing exhaust gases from exhaust valve to tail pipe.
11. **Inlet & Exhaust valves:** These are openings provided for cylinder head for sucking the fresh air in and sending the exhaust gases out.
12. **Fuel injector:** Used in CI engines for atomizing fuel and spraying into combustion chamber.
13. **Piston Rings:** These rings will act and seal for leakage of fuel into oil sump.
14. **Turbo charger:** An accessory provided for supplying more air to inlet valves for better combustion.

15. **Starter motor:** Helps in starting the engine when it is in off condition, it couples with flywheel and after starting the engine it decouples.
16. **Oil sump:** It holds and supplies the lubricating oil to the engine components whenever necessary.
17. **Oil pump:** Helps in pumping lubricating oil to engine parts.
18. **Alternator:** It helps in charging the battery.
19. **Fuel pump:** It helps in pumping the fuel from fuel tank to fuel injector.
20. **Radiator & fan:** It supplies coolant to different parts of the engine and cools the hot coolant after coming back to it.
21. **Water pump:** It pumps water to the engine parts if it is a water-cooled engine.
22. **Thermostat:** It helps in maintaining the temperature of the engine.
23. **Belts:** Different types of belts are used to transfer motion from one part of the engine to other part where ever necessary.
24. **Gear Assemblies:** Different types of gear assemblies are used to transfer motion from one part of the engine to other part where ever necessary
25. **Liners:** If it's a huge engine and costly, then liners are placed in between the piston and cylinder.

4.2. Systems involved in an engine

1. Starting System
2. Fuel System
3. Ignition System
4. Cooling System
5. Lubrication System
6. Intake System
7. Exhaust system

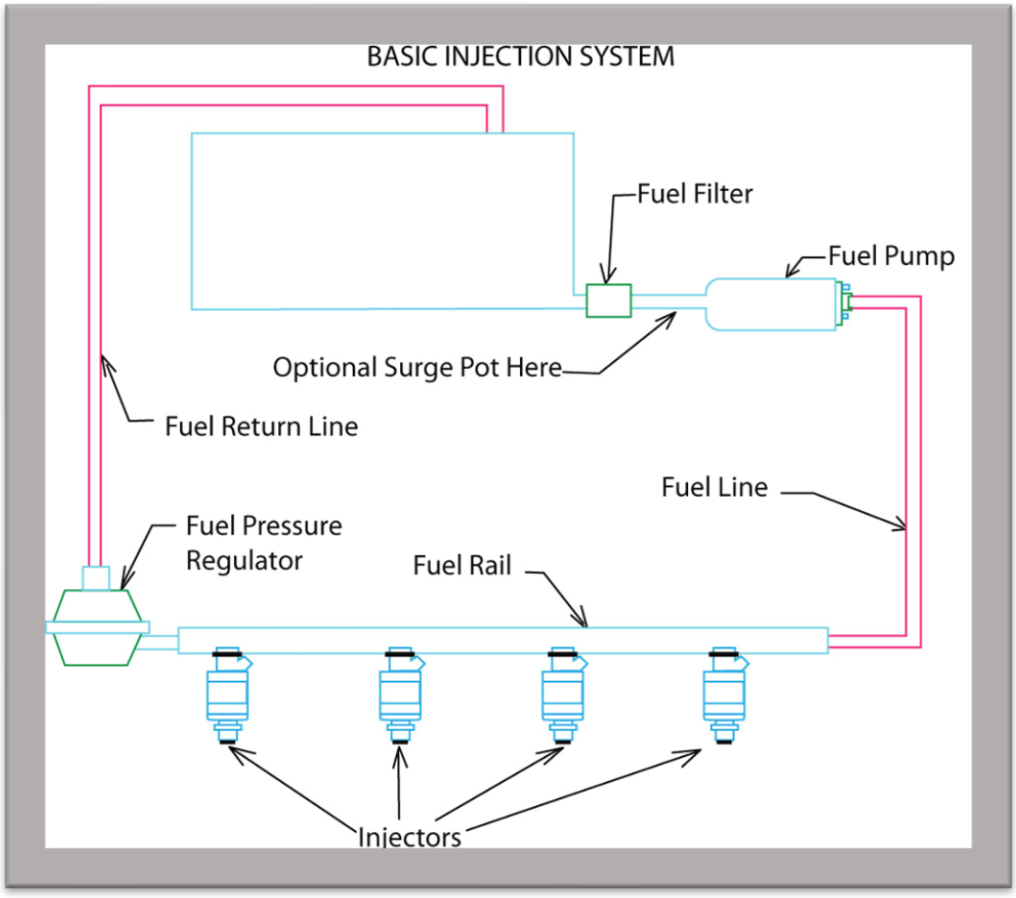
1. Starting System



To make an engine start it must be turned at some speed, so that it sucks fuel and air into the cylinders, and compresses it. The powerful electric starter motor does the turning. Its shaft carries a small pinion (gear wheel) which engages with a large gear ring around the rim of the engine

flywheel. In a front-engine layout, the starter is mounted low down near the back of the engine. The starter needs a heavy electric current, which it draws through thick wires from the battery. No ordinary hand-operated switch could switch it on: it needs a large switch to handle the high current. The switch has to be turned on and off very quickly to avoid dangerous, damaging sparking, so a solenoid is used - an arrangement where a small switch turns on an electromagnet to complete the circuit.

1. Fuel System



There are four basic types of fuel systems

1. carburetor system for petrol engines

2. Fuel injection system for petrol engines

3. Gas fuel systems

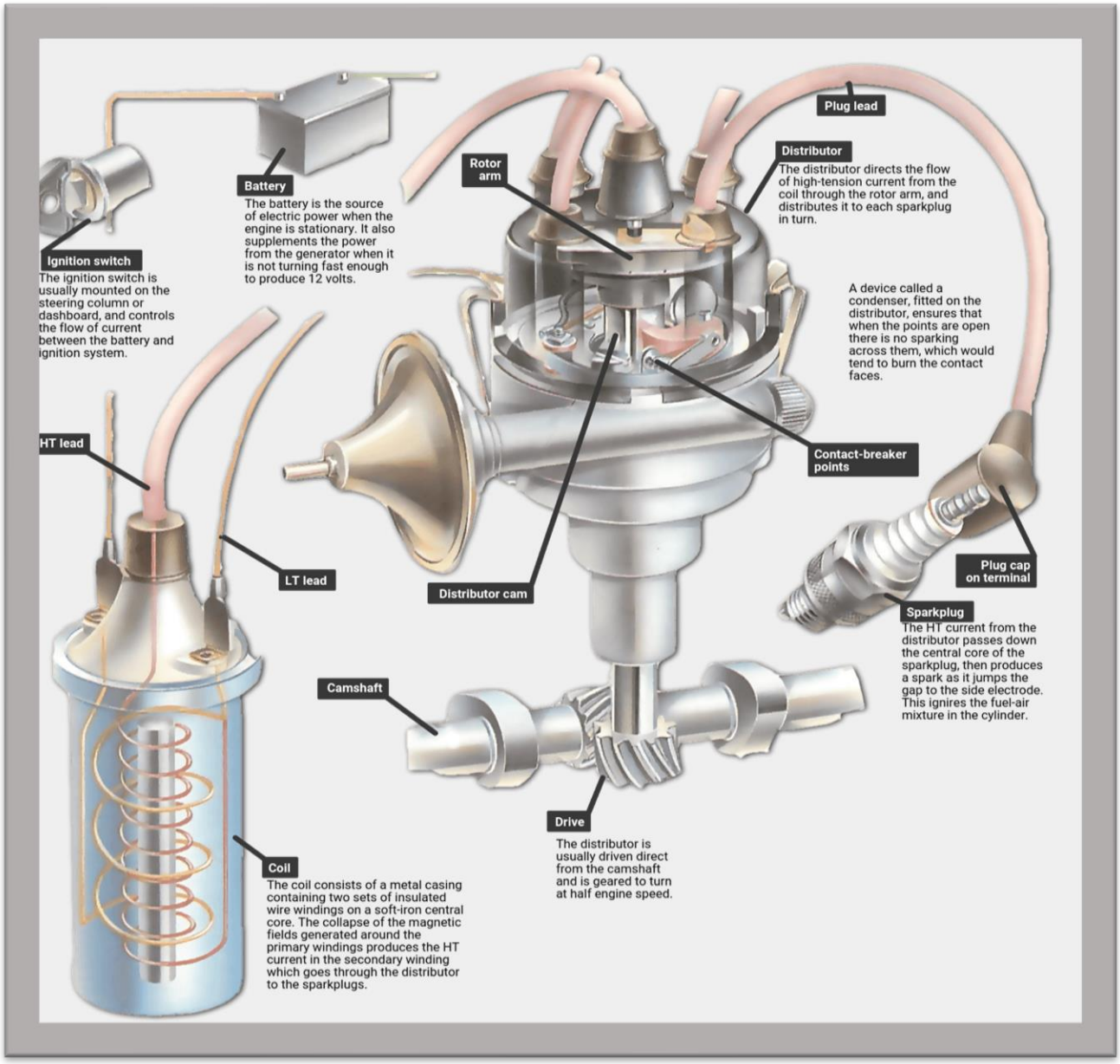
4. Diesel Injection system

All these systems operate in different ways, but they all have somewhere to store fuel (a fuel tank or a cylinder) and a way of supplying the engine with the fuel. They also have a way of supplying air and fuel mixed in the correct proportions so that it can be effectively burnt in the combustion chambers.

The function of the vehicle fuel system is to store and supply fuel to the engine. The engine intake system is where the fuel is mixed with air, atomized, and vaporized. Then it can be compressed in the engine cylinder and ignited to produce energy or power. Although fuel systems vary from engine to engine, all systems are the same in that they must supply fuel to the combustion chamber and control the amount of fuel supplied in relation to the amount of air.

The fuel is stored in the fuel tank and the fuel pump draws fuel from the tank. It then travels through the fuel lines and is delivered it through a fuel filter to the fuel injectors (carburetors and throttle body injection were used on older vehicles). As the fuel is delivered, the final conditions for providing complete combustion are atomization and the spray pattern of the fuel. Atomization is accomplished as a result of the injection pressure, due in part to the diameter of the holes in the injector. The spacing, angle and number of holes in the injector tip determine the spray pattern.

2. Ignition Systems



The purpose of the ignition system is to generate a very high volt age from the car's 12-volt battery, and to send this to each sparkplug in turn, igniting the fuel-air mixture in the engine 's combustion chambers.

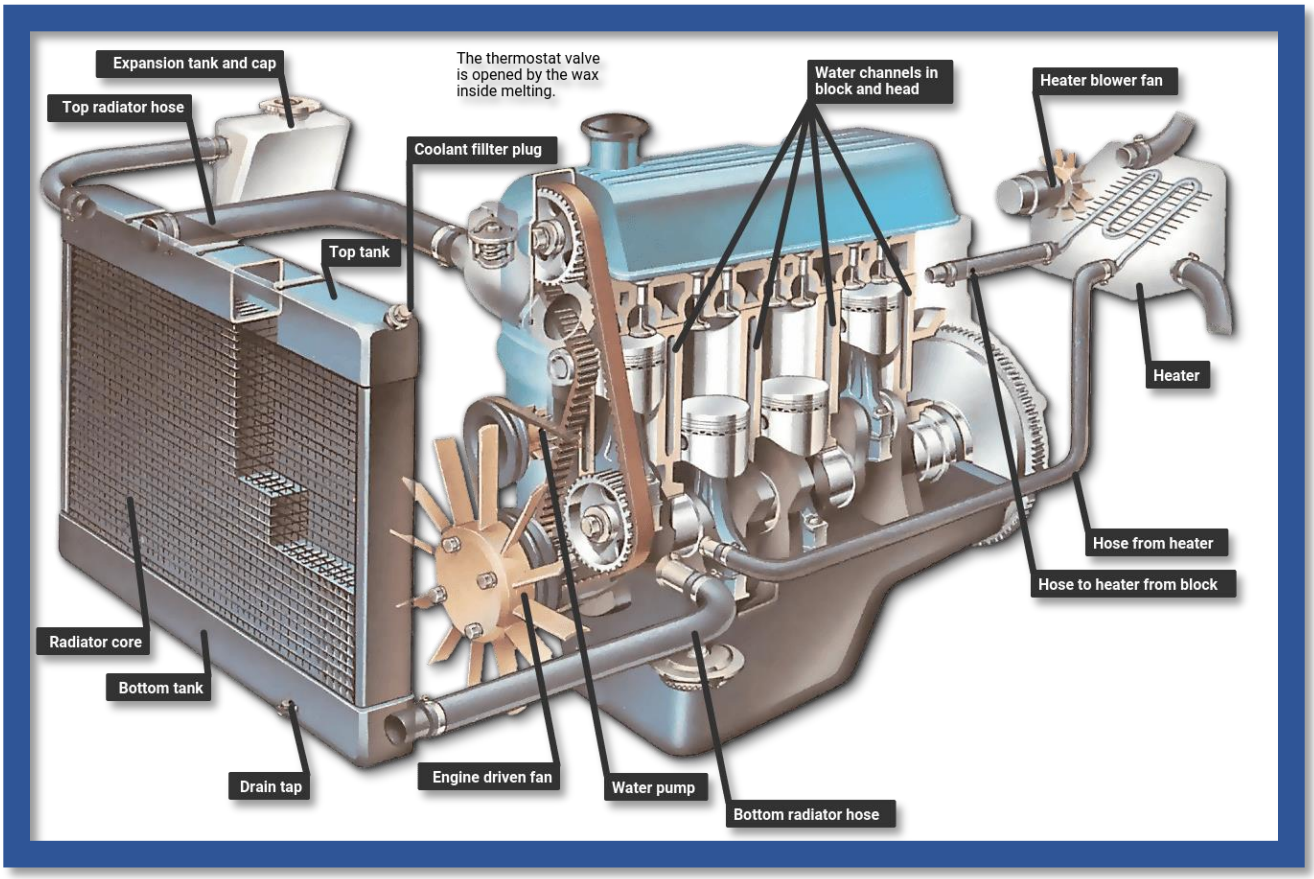
3. Cooling System

There are two types of cooling systems involved in an engine

1. Water Cooled Engine
2. Air Cooled Engine

In FMD we are using **Water Cooled Engines** because this method is more efficient than air cooling, so let us discuss the method of water cooling of engines

Water Cooled Engine



The different components involved in water cooled engine are shown in the above figure such as Radiator, Water Pump, Thermostat, Pipes etc.

The working of water-cooling system is easy to understand. The coolant (Water+ Antifreeze liquid) is sent into the engine block from radiator with the help of tubes and after it is circulated to the entire engine wherever necessary then it comes to the thermostat with the help of the pump and the thermostat works on the basic principle of melting of wax and opening the valve and allowing the hot coolant into the radiator. Then with the help of cross flow heat exchangers arrangement in the radiator the hot coolant is cooled down and again it is recirculated. This process continues while the engine is in running condition and also steady condition. The main purpose of the fan is to cool down the hot coolant by passing air to the heat exchangers in radiator.

4. Lubrication System

Lubrication system is nothing but which reduces heat generation between rubbing surfaces by supplying a film of lubricant between the surfaces.

The Engine Lubrication System supplies lubricant for the following engine parts

1. Crankshaft main bearings
2. Big end bearings
3. Piston pins and small end bushes
4. Cylinder walls
5. Piston rings
6. Timing Gears
7. Camshaft and bearings
8. Valves
9. Tappets and push-rods

10. Oil pump parts
11. Water pump bearings
12. In-Line Fuel Injection Pump bearings
13. Turbocharger bearings (if fitted)
14. Vacuum pump bearings (if fitted)
15. Air-compressor piston and bearings (in commercial vehicles for air-brake)

There are 4 types of lubrication systems used in an automotive engine

a. **Mist Lubrication System**
b. **Wet Sump Lubrication System**
c. **Dry Sump Lubrication System**

a. Mist Lubrication System

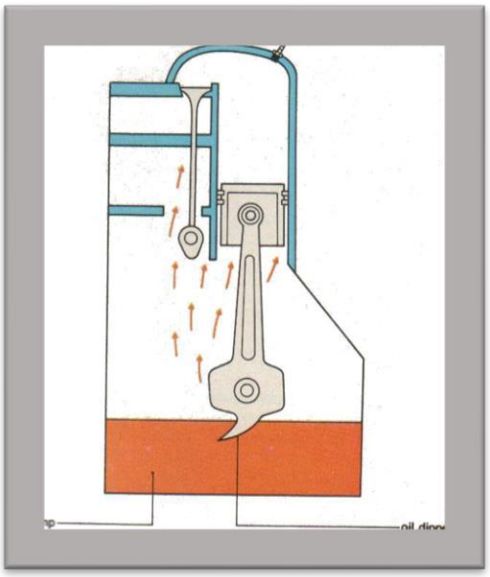
It is the simplest of all types of lubrication. This method is used in light vehicles such as motor cycles and scooters. About 3 to 6% of lubricating oil is mixed with petrol in the fuel tank. Here, there is no separate sump and pump. The oil mixing with petrol acts as a lubricant.

b. Wet Sump Lubrication System

In this method, the lubrication oil is stored in the oil sump. From the oil sump, the oil is supplied to various parts of the engine. This system may be further classified as:

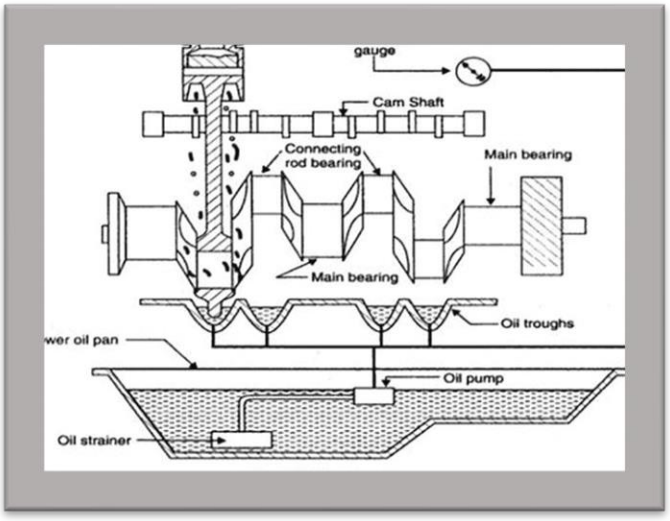
I. Gravity lubrication system
II. Splash lubrication system
III. Pressure lubrication system
IV. Semi-pressure lubrication system

Splash Lubrication System



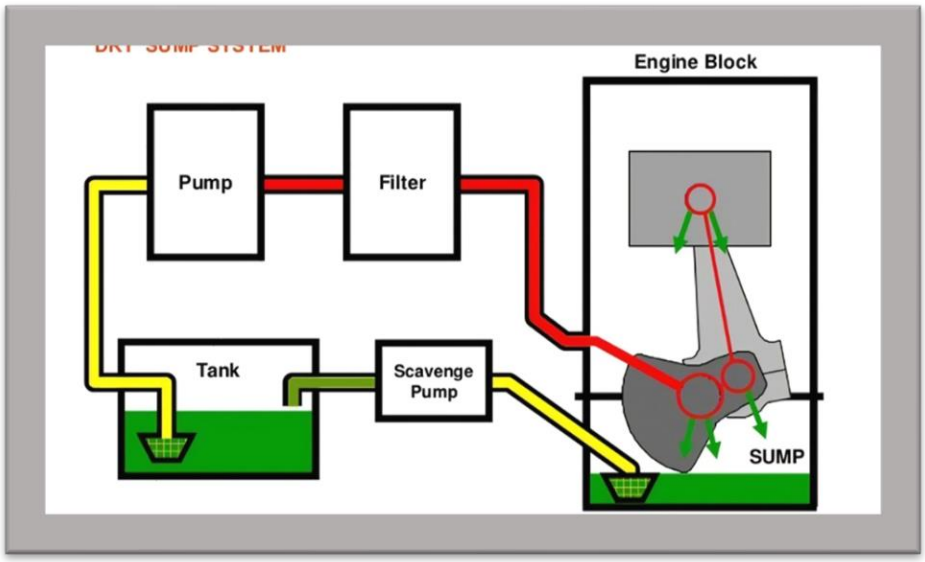
In this type of lubrication system, the oil is stored in the oil sump and it is distributed to the engine parts when the dippers on the connecting rod bearing caps take the oil and splash it to the cylinder and piston.

Pressure Lubrication System



Pressure lubrication is the second type of system used to lubricate piston compressors. It is a more technically advanced and usually more costly method, but it results in longer life for a compressor. The Pressure lubrication is a process where an oil pump precisely distributes oil to key areas of the pump. Typically, the oil is pumped through an oil filter and into the pump where it is then recycled and reused; using a replaceable oil filter can further improve the life of the oil. The oil is transported to the key area by use of an oil pump.

c. Dry Sump Lubrication System



The lubricating oil stored in the oil sump is called wet sump system. But the system in which the lubricating oil is not kept in the oil sump is known as dry sump system. In this system, oil is carried in separate tank and fed to the engine.

The oil which falls into the oil sump after lubrication is sent back to the oil tank by a separate delivery pump, thus the system consists of two pumps. One pump is used to feed the oil. The other pump is used to deliver the oil to the oil tank. This system is used in aircrafts.

The main advantage of this system is that there is no chance of break down in the oil supply during up and down movement of the vehicle.

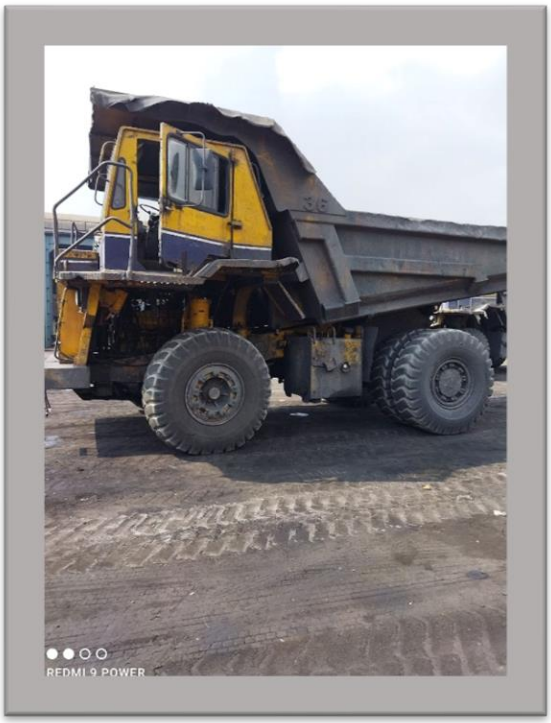
5. Intake System

Intake system is the one which helps the engine to breath in fresh air from atmosphere and help in successful combustion process. It mainly consists of these parts Air Filter, Intake Manifold, Intake Port, Intake valves and super charger if necessary.

6. Exhaust system

The exhaust system collects exhaust gases from the engine and expels them out. The system consists of exhaust valve, exhaust port, exhaust manifold, turbo charger, muffler.

4.3. How Does an Engine work?



Let us understand the working principle of an engine with the help of **NTA855** which is the engine of dumper available at FMD.

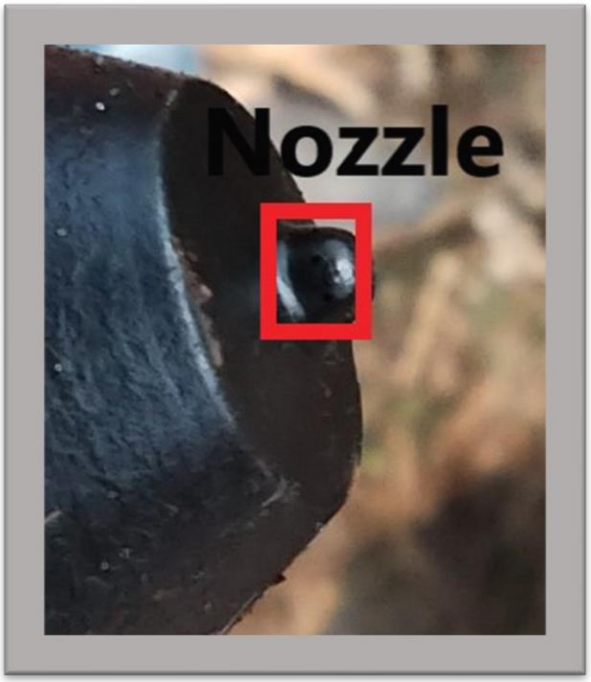
The NTA full form is New Head Turbocharged aftercooled engine. The basic purpose of any engine is to convert chemical energy obtained by burning fuel into mechanical energy, this is what NTA855 does.

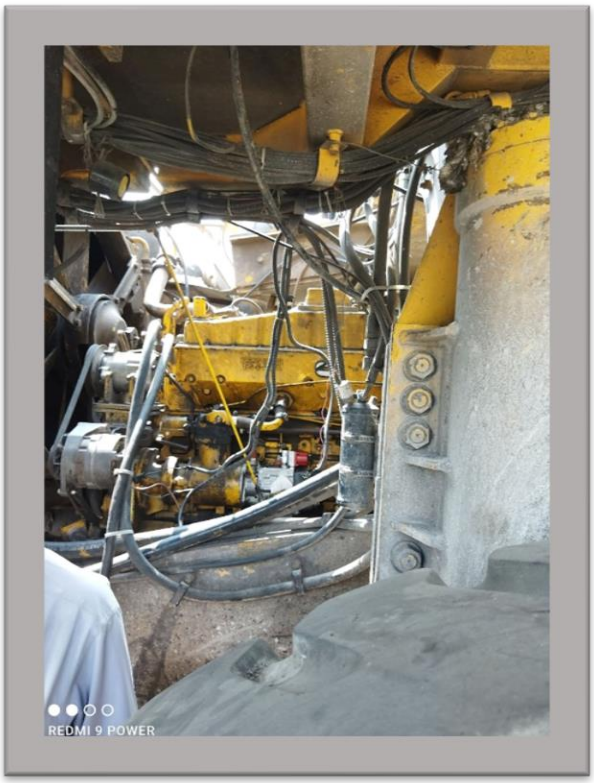
Once the ignition switch is turned on the ignition circuit is closed and the starter motor is powered. Then it couples with a flywheel connected to the crankshaft of the engine through which the pistons are reciprocated from TDC to BDC.

Now the intake valve opens and the air is sucked in which is named as suction stroke. Then the piston is moved from BDC to TDC for compressing the air taken into it. Then the air is compressed to its max temperature and then by plunger and spindle mechanism the fuel is injected into the cylinder and the air-fuel mixture is ignited due to the high temperature of compressed air. Now the power stroke occurs and the piston is moved from TDC to BDC by rotating the crankshaft in turn which rotates the flywheel drives the transmission system through which the power is given to the wheels through a differential unit which is connected to the transmission system using a propeller shaft. There are different systems involved in working an engine successfully.

The lubrication & cooling system which maintains the temperature of the engine using the thermostat. The turbocharger provided will allow more air into the cylinder and this is powered by exhaust gases.

The NTA855 engine is a 6 cylinder, 4 stroke diesel engine. The firing order is 1-5-3-6-2-4. The purpose of an aftercooler is to cool the output air from the turbocharger.





5. Exhaust Gas Emissions

Exhaust gas emissions are nothing but the products of combustion process in gaseous form coming out from the exhaust valve and then to exhaust pipe (tail pipe). The main constituents of exhaust smoke are CO, NOx, HC etc. For a better efficiency and also for protecting environment from pollution we need to maintain some restricted quantity of these gases, for this the government have introduced Bharat Stages such as BS-I, BS-II, BS-III, BS-IV, BS-V. Bharat Stage or BS Emission Standards are government-instituted emission standards that all motor vehicles have to comply with if they are to be sold and driven in India. Currently, all new vehicles sold and registered in India should be compliant with the BS-VI iteration of emission standards.

5.1. How Emissions are Tested?

Before knowing about the procedure there are some basic definitions to be remembered.

Smoke: It is a visible suspension of carbon or other particles in air, typically one emitted from a burning substance. Smoke of the engine exhaust is visible indicator of combustion process happening in the engine cylinder.

Smoke Density (k): It is usually associated with opacity of air. Opacity (N) is nothing but the amount of light reduction happening when certain amount of light is transferred through the smoke. Opacity 10% means the light source of 10% is absorbed and 90% is unabsorbed.

Why Smoke is produced in engine emissions?

- Incomplete combustion of air and fuel in the combustion chamber of the engine
- Improper usage of oils
- Blown head gasket
- Worn cylinder or rings
- Rich fuel air mixture used all the time
- Improper maintenance of the engine
- Bad nozzle spray characteristics

5.2. Types of smoke

Black Smoke: This type of smoke occurs when partially burned smoke is passed into the combustion chamber.

White Smoke: This type of smoke occurs when the raw diesel comes into the combustion chamber or water enters the combustion chamber or temperature of the combustion chamber is too low.

Blue Smoke: This type of smoke occurs when there is excess lubricating oil in the engine cylinders during combustion. When the oil is burnt it comes out as exhaust smoke.

Diesel Exhaust **Smoke meters**, also referred to as **opacity meters**, detect and measure the amount of light blocked in a sample of smoke emitted by diesel engines from cars, trucks, ships, buses, motorcycles, locomotives and large stacks from industrial operations. The smoke meter readout displays the smoke density giving a measure of the efficiency of combustion. This makes the smoke meter an excellent diagnostic tool to ensure proper maintenance of diesel engines for improved fuel economy and protection of the environment. The opacity meter consists of an optical unit mounted inside a measuring head and a separate electronic control unit. The measurement principle is based on light extinction detection. The collimated beam from the light-source (SLED) is absorbed and scattered by the particulate exhaust emissions. A photodiode determines the light intensity of the attenuated beam and the corresponding opacity value is transmitted to a separate remote display. Partial flow continuous gas sampling combined with a heated and temperature-controlled smoke chamber compensates for changes in pressure and test conditions to give you the most accurate readings possible. All modern Diesel Exhaust Smoke Meters should measure diesel emissions (dark smoke) in Opacity (N) and Smoke Density (K) according to SAEJ1667.

Engine exhaust gas analyzer can measure Oxygen (O_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Nitrogen Oxide (NO), Nitrogen Dioxide (NO_2), and Hydrocarbons (HC's).

Oxygen: Filtered ambient air enters the engine and forms part of the fuel mixture. Ambient air contains 20.9% O_2. Ideally, in most engine types, this O_2 should be consumed as the fuel is burned. Oxygen levels analyzed at the tailpipe indicate unburned O_2 and represent a lean air/fuel mixture.

Hydrocarbons: The HC's channel is calibrated as hexane or propane depending on the vehicle type the analyzer is to be used on. The measurement itself represents unburned fuel and is measured in the ppm (parts per million). Modern automobiles in good running order frequently show 10ppm or less. Trucks and forklifts may have higher levels due to fuel type or engine style.

Carbon Dioxide: The level of CO_2 represents the amount of fully burned fuel. Therefore, a higher CO_2 level indicates a higher engine efficiency. Many fuel injection engines will show approximately 15% CO_2.

Carbon Monoxide: Partially burned fuel results in CO. High CO levels indicate a 'rich' fuel mixture. A perfect fuel mixture meters in exactly enough fuel to consume all of the O_2 entering the engine. A perfect ratio is not sustainable in real-life operation. A fuel mixture that contains excess fuel is usually referred to as a 'rich' condition. A 'lean' condition refers to an excess of O_2. CO may be measured in percent or ppm amounts depending on type / age of engine.

NO_x: NO_x generally, refers to NO and NO_2 (Nitric Oxide and Nitrogen Dioxide). This measurement is in ppm and represents the combustion products of burning nitrogen. This occurs at the higher engine temperatures. In the NO_x output of a typical engine, the NO component will usually make up the highest proportion. Diesel engines are generally associated with higher NO_x and particulate emissions.

5.3. What are Bharat Stages?

Bharat Stage or BS Emission Standards are government-instituted emission standards that all motor vehicles have to comply with if they are to be sold and driven in India.

- Currently, all new vehicles sold and registered in India should be compliant with the BS-VI iteration of emission standards.

- The standards and timelines for their implementation are set by the **Central Pollution Control Board (CPCB)** under the Minister of Environment, Forests and Climate Change.
- The BS norms are based on the European Emission Standards (Euro norms) and were first set in 2000. Equivalent to the Euro-1, the first iteration was known as 'India 2000', and not BS-I.
- Subsequent emission standards were called BS-II, BS-III, and BS-IV.
- The government decided to jump directly from BS-IV to BS-VI skipping BS-V in view of the long time it took to move from BS-III to IV.
- With the implementation of the new norms, pollution levels are expected to reduce to a large extent as the particulate matter (PM) concentration should decrease. About one-third of the air pollution is caused by motor vehicles and cars.

Fuel Type	Pollutant Gases	BS6 (BSVI)	BS4 (BSIV)
Petroleum Distillate Vehicle	Nitrogen Oxide (NOx) Limit	60 mg	80 mg
	Particulate Matter (PM) Limit	4.5 mg/km	-
Diesel Fuel Vehicle	Nitrogen Oxide (NOx) Limit	80 mg	250 mg
	Particulate Matter (PM) Limit	4.5 mg/km	25 mg
	HC + NOx	170 mg/km	300 mg

The above table depicts the emission standards in BSVI and BSIV.

Date	Particulars
1995	Cetane number: 45; Sulphur: 1%
1996	Sulphur: 0.5% (Delhi + selected cities)
1998	Sulphur: 0.25% (Delhi)
1999	Sulphur: 0.05% (Delhi, limited supply)
2000	Cetane number: 48; Sulfur: 0.25% (Nationwide)
2001	Sulphur: 0.05% (Delhi + selected cities)
2005	Sulphur: 350 ppm (Euro 3; selected areas)
2010	Sulphur: 350 ppm (Euro 3; nationwide)
2016	Sulphur: 50 ppm (Euro 4; major cities)
2017	Sulphur: 50 ppm (Euro 4; nationwide)
2020	Sulphur: 10ppm (Euro 6; entire country)

We can observe that the sulfur content decreases year by year, we can observe drastic change of sulfur content from BS3 to BS4.

BS3 vs BS4 Diesel Engine

Let's get into the nuts and bolts to understand the difference between BS3 and BS4 engine and how the phasing out from old to new-gen will affect engine performance.

At a top level we need to understand that a BS4 engine is able to manage and control evaporative vehicular emissions much better than a BS3 engine, resulting in a cleaner, less polluting vehicle.

Take a look at the **change in emission levels from BS3 to BS4** for CE vehicles based on their engine power output. The big change is about 90% reduction of PM (particulate matter) in BS4 engines higher than 50 HP

POWER RATING	BS3-CE VEHICLES		BS4-CE VEHICLES	
HP	NOx + HC	PM	NOx + HC gms/KM	PM gms/KW
<10.72 HP	7.5	0.6	No Change	
49.61 HP ≤ 75 HP	4.7	0.4	4.7	0.025
75 HP ≤ 174 HP	4	0.3	0.4 + 0.19	0.025

The highly toxic Nitrous Oxide (NO_x) vapor emissions go down by a whopping 92% in BS4 engines higher than 75 HP.

The major technology shift is that BS4 diesel engines have to use the more advanced common rail technology instead of the old direct injection technology. Although, most OEMs had already made the shift to Common Rail Direct injection (CRDi) when BS3 was announced. This was necessary so that their diesel engine powered vehicles were compliant with the new emission standards.

Another important change now to meet BS4 norms is that BS4 diesel engines have to be fitted with a bigger more powerful catalytic converter known as a Diesel Oxidation Catalyst (DOC). This mandatory fitment in diesel vehicles makes the fuel combustion process more efficient and reduces emission of harmful hydrocarbons and carbon monoxide.

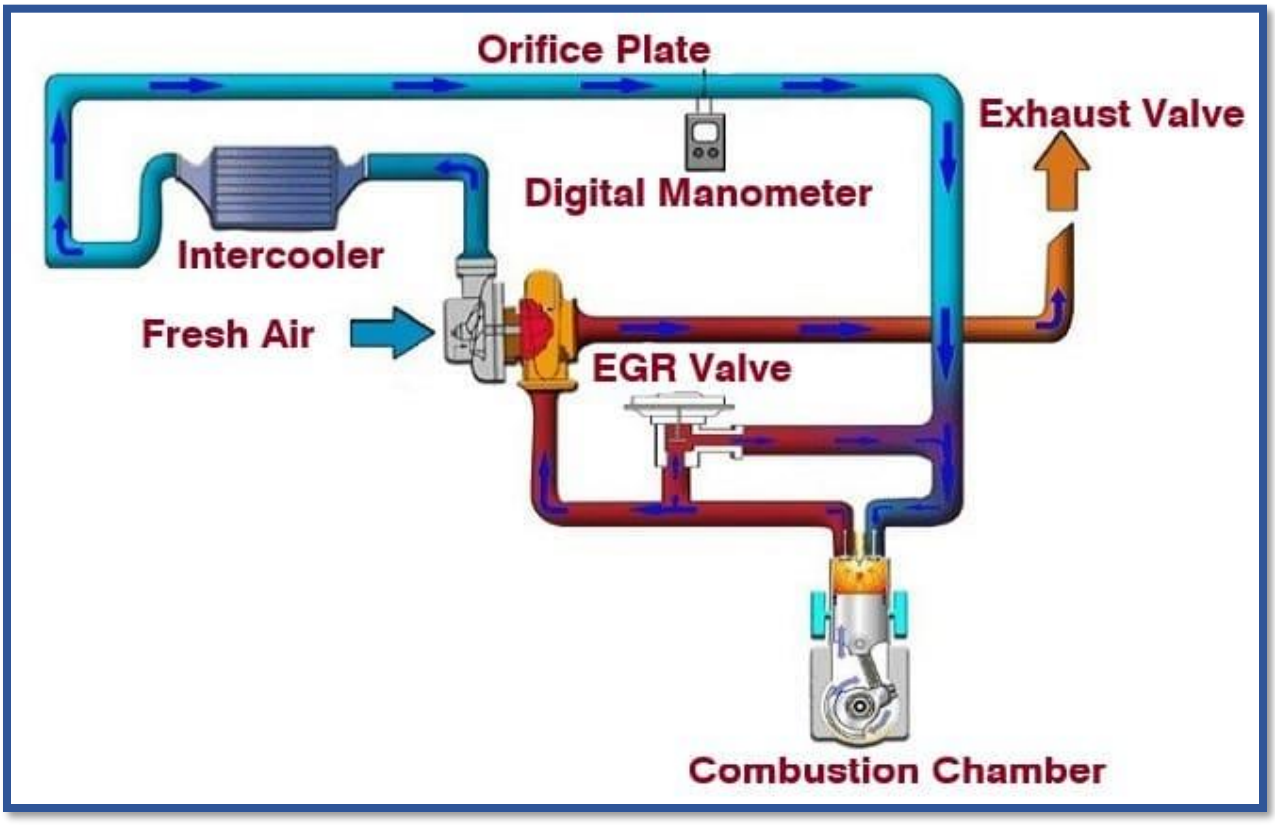
Also, all diesel vehicles in the new BS4 era have to be fitted with an Exhaust Gas Regulator or EGR, and a Urea injector called Selective Catalytic Reduction (SCR). The latter cuts down NO_x vapour emissions by breaking it down and converting NO_x molecules into Nitrogen and H_2O.

6. Methods to reduce emissions and decrease fuel consumption

- ***EGR (Exhaust Gas Re-Circulation)***
- ***MPFI (Multipoint Fuel Injection)***
- ***CRDi (Common Rail Direct Injection)***
- ***ACERT (Advanced Combustion Emission Rejection Technology)***

6.1. EGR

EGR stands for **Exhaust Gas Recirculation** which helps in reducing the NOx emissions in the diesel engines by recirculating the exhaust air to the inlet manifold to reduce the oxygen content in the air at the inlet.



Nitrogen oxide (NOx) produces inside the engine cylinder due to the high compression ratio and the high temperature of the engine cylinder. To reduce and control NOx emission, manufacturers

introduce the “EGR (Exhaust Gas Recirculation)” technique in the various vehicles’ engines. This technology is used in modern internal combustion engines (gasoline/petrol engines and diesel engines) to reduce nitrogen oxide emissions. It is one of the most important parts of a vehicle engine. Exhaust Gas Recirculation system can protect the environment and human life from the engines harmful gases.

When the product of combustion leaves the cylinder through the exhaust manifold, then some part of the exhaust gases in the engine is recirculated through the intake manifold. Therefore, the unburned fuel in the exhaust gas recirculation system mixes with the fresh raw material (fuel-air mixture) and ignites at the end of the compression stroke. Therefore, less CH3 (hydrocarbons) are generated in the exhaust stream. These hydrocarbons produce because of unburnt fuel. The disadvantage is that engines with EGR system have overheating problems due to the heat of the exhaust gases.

To overcome the problem, automakers have come up with an EGR intercooler that cools the exhaust gas and increases the oxygen density in the exhaust gas, which results in better combustion and much less emission, even better than the traditional air injection system.

6.2. MPFI

Multi Point Fuel Injection is a technique of fuel injection in petrol (or gasoline) engines.

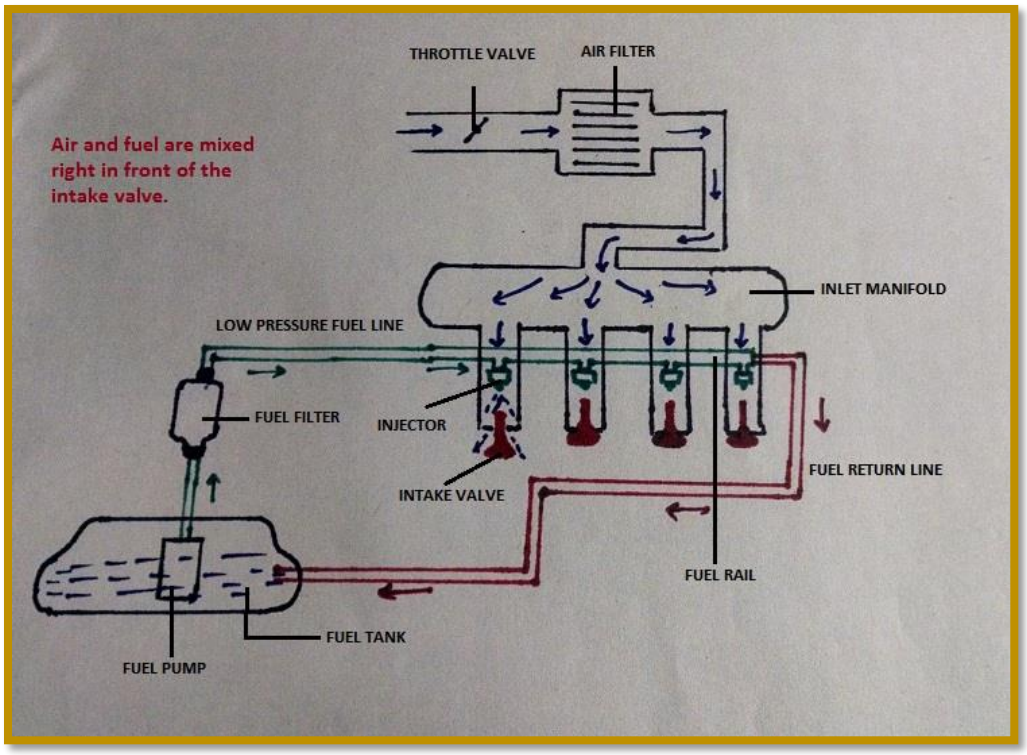
In general, a petrol engine uses carburetor to mix air and fuel but it has poor response acceleration and deceleration. Another big problem with carburetor is increased emissions.

In MPFI fuel is injected directly in the cylinder with the help of multiple fuel injectors. These fuel injectors help in injecting precise quantity of fuel into the combustion chamber.

These fuel injectors also produce better atomization and swirl of fuel in the combustion chamber.

Types of multi point fuel injection (MPFI) systems

1. **Sequential Multi Point Fuel Injection system**
2. **Simultaneous Multi Point Fuel Injection system**
3. **Batched Multi Point Fuel Injection system**



In the sequential MPFI system, injection is timed to overlap with intake stroke of each cylinder. In the simultaneous MPFI system, fuel is inserted to all cylinders at the same time. In the batched MPFI system, fuel is injected to the cylinders without bringing their intake stroke together.

Advantages of Multi Point Fuel Injection (MPFI) system

- It increases fuel efficiency of the engine
- With MPFI system vehicle have less emissions
- Better atomization of fuel

- It encourages better utilization and distribution of fuel with in an engine
- Smooth operation of engine
- It reduces the difference in power, produced by each cylinder
- Better acceleration and deacceleration of engine
- In improves durability and functionality of engine
- It is reliable
- It improves cold start characteristics of the engine
- It reduces vibrations in the engine

Disadvantages of Multi Point Fuel Injection (MPFI) system

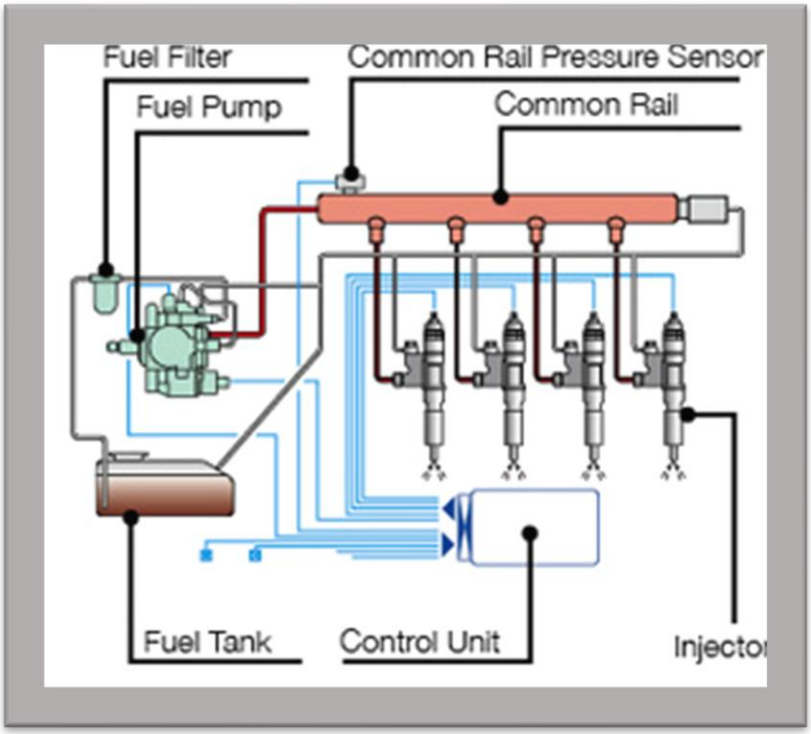
- There could be a case of misfiring sometimes
- Regular inspection of fuel injectors is required
- It is costly as compared to conventional systems

6.3. CRDi Technology

CRDi stands for **Common Rail Direct Injection** system which is being widely used in present diesel engines for timely injection of required amount of fuel into the combustion chamber using a common rail for all cylinders and individual injectors for each cylinder connected to the common rail. In petrol engines it is called as GDI means **Gasoline Direct Injection System**. This method of injection helps in saving the fuel and also reducing emissions by complete combustion of the air and fuel with required quantity of both. The main components of CRDi system are

- High Pressure Fuel Pump
- Common Fuel Rail
- Fuel Injectors
- Engine Control Unit

A high-pressure pump supplies pressurized fuel. The pump compresses the fuel at the pressures of about 1,000 bar or 15,000 psi. It then supplies the pressurized fuel via a high-pressure pipe to the inlet of the fuel rail. The fuel-rail distributes the fuel to individual injectors which then inject it into the combustion chamber.



Moreover, most modern CRDi engines use the Unit-Injector system with a Turbocharger, which increases power output and meets stringent emission norms. Additionally, it improves engine power, throttle response, fuel efficiency and controls emissions. Barring some design changes, the basic principle & working of the CRDi technology remains primarily the same across the board. However, its performance depends mainly on the combustion chamber design, fuel pressures, and the type of injectors used.

I. Advantages of CRDi System:

- CRDI system can control the flow of fuel in accordance with the load and speed of the engine.
- This system requires only one fuel pump for multiple cylinders.
- CRDI system is beneficial for the environment as it reduces noise, smoke and particulate matter.
- It gives high power output at low rpm.
- The main advantage of the CRDI system is fuel economy.

II. Disadvantages of CRDi System:

- This system is complex than MPFI system and needs good engineering work.
- The CRDI system cannot suit ordinary engines.
- The maintenance cost of this system is higher than the others.
- Vehicles with CRDI system is costlier in comparison to non-CRDI system vehicles.

6.4. ACERT TECHNOLOGY

This is the recent and advanced technology to reduce the emissions of the diesel engines by controlling the proper air fuel mixer by making some modifications in few systems of diesel engine. If proper air fuel ratio is maintained then proper combustion takes place which leads to reduction in emissions.

We can find this technology in C15 and C18 engines for caterpillar Built Machines.

In the engine mainly three systems are taken care.

1. Fuel injection system

2. Cooling system

3. Air inlet and exhaust

ACERT Technology is a synergistic approach utilizing a suite of complementary building block technologies that can be individually adapted to accommodate a specific application. Proven first with on-highway engines, the building blocks of ACERT Technology have been tailored to meet the emissions requirements for stationary diesel generator sets in a variety of applications. ACERT Technology used on a stationary Cat diesel generator set offers the advantage of a smaller footprint and increased power density, which results in lowered installation costs and more flexible installation options. For electric power generation applications, the three building blocks of ACERT Technology include integrated electronics, advanced air management and precise fuel delivery.

Electronic Control

Electronics play an important role in ACERT Technology, not only in lowering emissions, but also in optimizing power and fuel economy. The ADEM(TM) A4 electronic control module sends out signals that fuel injectors convert into mechanical responses, resulting in precise fuel delivery and better response. While the software is newly developed for ACERT Technology, the engine's Electronic Control Module is also used on current Cat products.

Air Systems

Air management is the second key component of ACERT Technology, delivering cool, clean air into the combustion chamber instead of recycled heat. This results in a reduction of oxides of nitrogen, and provides better fuel economy, improved response and emissions reduction. "The system automatically adjusts to the airflow requirements on the engine, allowing for higher boost levels and increased airflow. This ultimately means better engine performance, as well as maintained fuel economy.

Fuel Delivery

The third and final building block of ACERT Technology is fuel delivery. In this system, fuel is introduced into the combustion chamber in a number of controlled injections to precisely regulate the combustion process. Unlike single-injection fuel delivery, this method offers the advantages of lowered peak cylinder temperatures, which allows fuel to burn more completely while simultaneously lowering NOx emissions. Additional benefits of the fuel delivery system include reduced sound and vibration. Engines with ACERT Technology in the 225 eKw to 300 ekW power range feature Caterpillar's proven electronic fuel system. The flexible HEUI fuel system provides multiple injections for low emissions with complete combustion and maximum fuel economy. Determined by the engine's electronic control module, small amounts of fuel are injected at the appropriate times to achieve fuel economy and lower emissions. Larger engines, with ranges above 300 ekW, use the Mechanically Actuated Electronically Controlled Unit Injector MEUI) fuel system that uses a multiple injection technology similar to the HEUI fuel system.

Waste gate turbo charger

A wastegate is a valve that diverts exhaust gases away from the turbine wheel in a turbocharged engine system. Diversion of exhaust gases regulates the turbine speed, which in turn regulates the rotating speed of the compressor. The primary function of the wastegate is to regulate the maximum boost pressure in turbocharger systems, to protect the engine and the turbocharger. One advantage of installing a remote mount wastegate to a free-float (or non-WG) turbo includes allowance for a smaller A/R turbine housing, resulting in less lag time before the turbo begins to spool and create boost.

Electronic Unit Injector (EUI)

The demands for improved power, enhanced fuel economy, quieter operations, and cleaner emissions from our engines has led to the development of the electronic unit injector. An electronic unit injector is a unit injector that has electronic control. Its camshaft-driven delivery of pressurized fuel coupled with management of the internal operations' timing by an engine control unit allows electronic unit injectors to achieve certain benefits over conventional unit injectors.

The electronic unit injector is mechanically pressurized using the electronic control of metering, timing, and governing functions. It consists of a range of basic elements, such as the spring-loaded plunger and barrel (to pressurize the fuel in the injector), the poppet valve (to regulate the pressure build-up), an electric solenoid (to actuate movement of the needle or poppet valve fuel inlet), return passageways (to get an efficient flow of fuel) and the nozzle valve (to enhance atomization).

In a unit injection system, the nozzle and injection pump are integrated into one module. Thus, fuel pressurization, atomization, fuel distribution, and injection timing are accomplished in just one component. An electronic unit injector system is installed directly into a cylinder head over every combustion chamber. An engine camshaft drives the injector typically through the rocker

lever, resulting in an efficient mechanical and hydraulic fuel system that can minimize parasitic losses. Fuel droplet sizes are smaller for enhanced emissions, and this finer atomization enables EGR flow tolerance into combustion mixtures.

With electronic unit injectors, you can expect reduced emissions and fuel consumption as long as the injectors are incorporated in an engine with other compatible components that can together bring out these advantages. High quality electronic unit injectors are designed for high-end, heavy-duty application. They allow for accurate injector control and enhanced fuel economy, thereby bringing optimized vehicle performance.

Fill phase

The constant stroke pump element on the way up draws fuel from the supply duct in to the chamber, and as long as electric solenoid valve remains de-energized fuel line is open.

Spill phase

The pump element is on the way down, and as long as solenoid valve remains de energized, the fuel line is open and fuel flows in through into the return duct.

Injection phase

The pump element is still on the way down, the solenoid is now energized and fuel line is now closed. The fuel cannot pass back into return duct, and is now compressed by the plunger until pressure exceeds specific "opening" pressure, and the injector nozzle needle lifts, allowing fuel to be injected into the combustion chamber.

Pressure reduction phase

The plunger is still on its way down, the engine ECU de-energizes the solenoid when required quantity of fuel is delivered, the fuel valve opens, fuel can flow back into return duct, causing

pressure drop, which in turn causes the injector nozzle needle to shut, hence no more fuel is injected.

Electronic control unit

The Engine Control Module (ECM), also called the Engine Control Unit (ECU), ensures that your vehicle operates at optimal performance. The ECM monitors most of the sensors in the engine bay in order to manage your vehicle's air-fuel mixture and regulate the emission control systems.

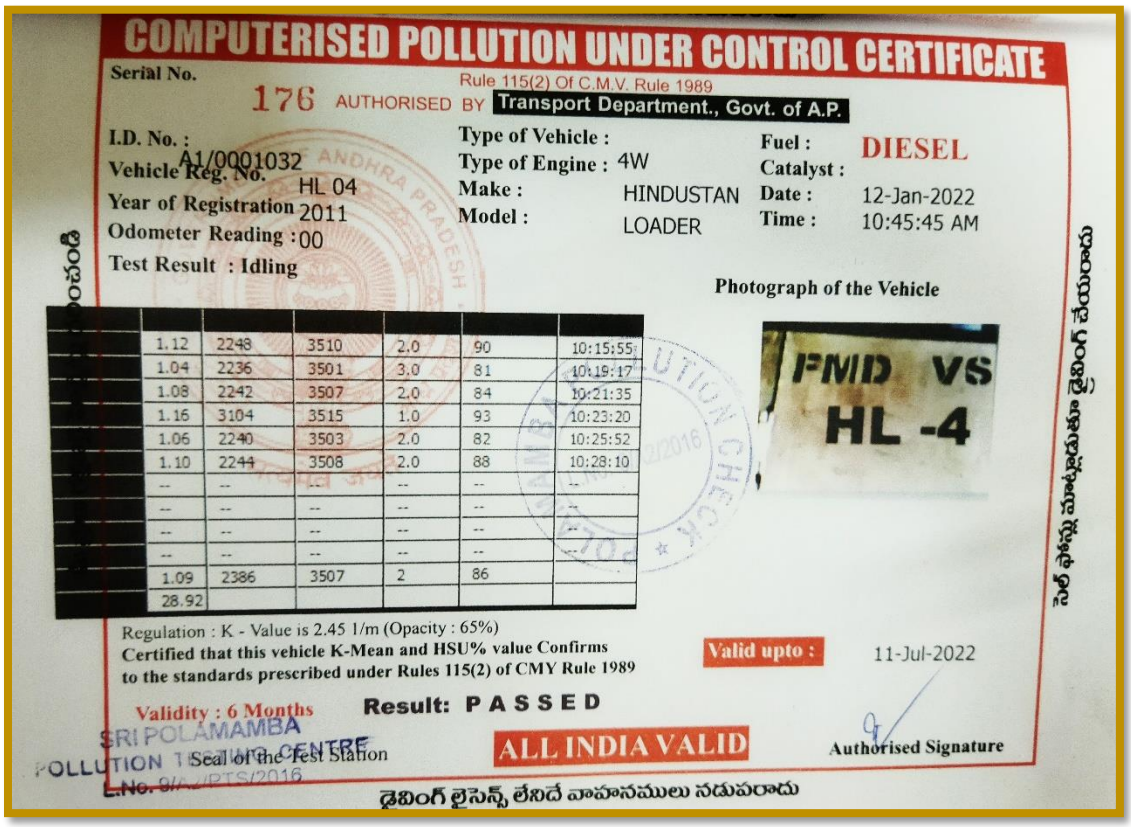
The ECM regulates four main parts of your vehicle's operating systems: air-fuel ratio, idle speed, variable valve timing, and ignition timing. In terms of the air-fuel ratio, the ECM uses sensors to regulate the oxygen to fuel ratio detected in your car's exhaust to detect an engine rich/lean reading. Some of these sensors include the mass airflow sensor(s), the oxygen sensor(s), air-fuel sensor(s). For the idle speed, the ECM relies on sensors located by the crankshaft and camshaft(s) that track your vehicle's RPM and engine load by monitoring the speed of rotation of the engine. (RPM=Revolutions Per Minute) The variable valve timing system controls when the valves are opened in the engine to either increase power or fuel economy.

Lastly, the ECM controls the ignition timing, this is the position at which the spark plug is fired within the combustion cycle. Precise control of this timing allows for more power and/or better fuel economy. The ECM also controls multiple other systems on top of these main tasks. It is often called the brain of the car and rightfully so, because most everything required to operate newer cars go through the ECM, if not directly controlled by it.The above-mentioned technologies came into existence one by one to reduce emissions from diesel engines and to improve fuel economy also.

6.5. Comparison of ACERT and Non-ACERT Engines

Now I will compare two loaders which are having ACERT and Non-ACERT technologies to get an idea about how ACERT is far better in saving fuel and reducing Emissions.

Pollution Test report of HL4 loader



COMPUTERISED POLLUTION UNDER CONTROL CERTIFICATE

Serial No. 176 Rule 115(2) Of C.M.V. Rule 1989 AUTHORISED BY Transport Department., Govt. of A.P.

I.D. No. : A1/0001032
Vehicle Reg. No. HL 04
Year of Registration 2011
Odometer Reading :00
Test Result : Idling

Type of Vehicle :
Type of Engine : 4W
Make : HINDUSTAN
Model : LOADER

Fuel : DIESEL
Catalyst :
Date : 12-Jan-2022
Time : 10:45:45 AM

Photograph of the Vehicle

1.12	2248	3510	2.0	90	10:15:55
1.04	2236	3501	3.0	81	10:19:17
1.08	2242	3507	2.0	84	10:21:35
1.16	3104	3515	1.0	93	10:23:20
1.06	2240	3503	2.0	82	10:25:52
1.10	2244	3508	2.0	88	10:28:10
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--	--	--	--	--	--
1.09	2386	3507	2	86	
28.92					

Regulation : K - Value is 2.45 1/m (Opacity : 65%)
Certified that this vehicle K-Mean and HSU% value Confirms to the standards prescribed under Rules 115(2) of CMY Rule 1989

Valid upto : 11-Jul-2022

Validity : 6 Months
Result: PASSED

SRI POLAMAMBA POLLUTION TESTING CENTRE
Seal of the Test Station
ALL INDIA VALID
Authorised Signature

ధ్రువీంగ్ లైసెన్స్ లేనిదే వాహనములు నడుపరాదు

Pollution Report of LL01 Loader

COMPUTERISED POLLUTION UNDER CONTROL CERTIFICATE

Serial No. 127 — Rule 115(2) Of C.M.V. Rule 1989 — AUTHORISED BY Transport Department., Govt. of A.P.

I.D. No. : A1/0001004
Vehicle Reg. No. LL-01
Year of Registration 2018
Odometer Reading : 00
Test Result : Idling

Type of Vehicle :
Type of Engine : 4W
Make : KOMATSU
Model : LOADER
Fuel : DIESEL
Catalyst :
Date : 12-Jan-2022
Time : 8:18:57 AM

Photograph of the Vehicle

2.08	1546	2150	2.0	105	07:48:55
2.00	1536	2142	3.0	96	07:52:17
2.04	1540	2145	2.0	99	07:54:35
2.12	1552	2156	1.0	108	07:56:20
2.02	1538	2143	2.0	97	07:58:52
2.06	1544	2149	2.0	103	08:01:10
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2.05	1543	2148	2	101	
54.39					

Regulation : K - Value is 2.45 1/m (Opacity : 65%)
Certified that this vehicle K-Mean and HSU% value Confirms to the standards prescribed under Rules 115(2) of CMY Rule 1989

Valid upto : 11-Jul-2022

Validity : 6 Months

Result: PASSED

Seal of the Test Station

ALL INDIA VALID

Authorised Signature

డ్రైవింగ్ లైసెన్స్ లేనిదే వాహనములు నడుపరాదు

Fuel Consumption by different loaders

40	5 CU.M LOADER	DL-01	WK HRS	12.5	24.00
			DS CON	300	
41	2071 LOADERS	HL-03	WK HRS	232	20.00
			DS CON	4640	
42	2071 LOADERS	HL-04	WK HRS	348.5	20.42
			DS CON	7115	

6.6. Conclusion

Using the above report's I can conclude that the loader HL04 consumes 20.42 liters of diesel per hour and HL03 consumes 20.00 liters per hour, which indicates that by using ACERT technology we can save fuel. The Pollution test reports suggest that "k" value for HL03 is less than the "k" value for LL01.

So using ACERT technology will definitely reduce fuel consumption and reduce exhaust emissions too