Iplt 4201. Farm Power and Machinery (0+6)

TRAINING REPORT

2012 Admission B. Tech. (Agrl.Engg.)

Students – BATCH B

Kerala Agricultural University

Department of Farm Power Machinery and Energy

Kelappaji College of Agricultural Engineering and Technology

Tavanur-679573, Malappuram, Kerala

2016

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INTRODUCTION

As a part of the inplant training on the Department of Farm Power Machinery and Energy, we had a four week training program at Southern Region Farm Machinery Training and Testing Institute (S.R.F.M.T.T.I.), Garladinne, Anantapur district, Andhra Pradesh.

This institute enjoys the pioneer status under the ministry of agriculture, Dept. of agriculture and co-operation, Govt. of India. The responsibility for organization and management is vested with director. He is assisted by the technical and other staff responsible for testing, training, farm and other sections at the institute. The training staff consists of senior agricultural engineer, agricultural engineer, senior technical assistant, training assistants and technicians. A library with a large collection of technical and other reference books, periodicals and magazines on mechanized farming, general agriculture and related subjects is provided for the use of trainees and staff.

The whole batch was divided into two groups. Each group was guided by two persons during the entire training program. We were the group B having strength of 20 members. Er. Bhargavi and D. Varaprasad guided us in our training program. Classes were taken according to the training schedule prepared by the institute. The objectives of the training were:

1. Study of various sub-assemblies, their operation, maintenance and repair of a single cylinder diesel engine and tractor.

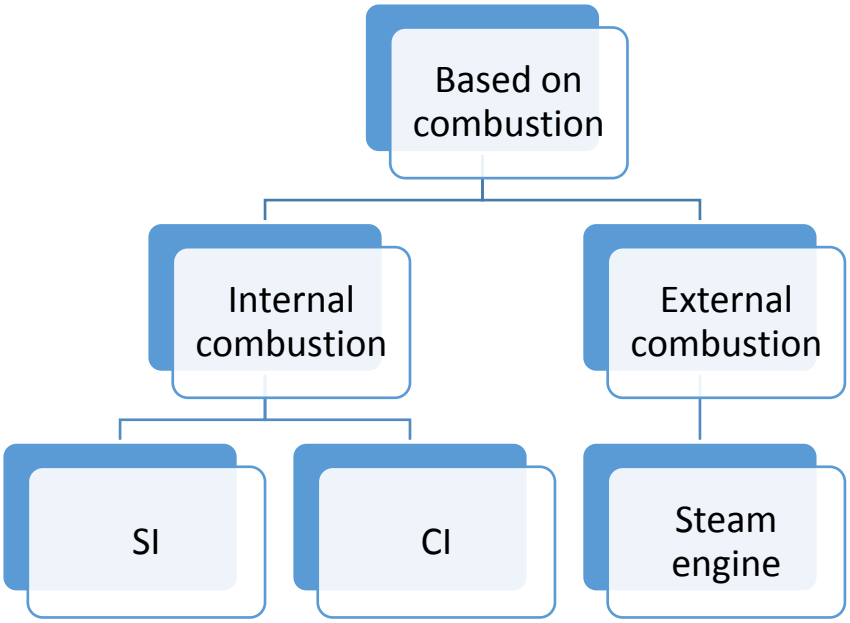
2. Study, operation, adjustment and maintenance of various agricultural implements and machinery, plant protection equipment and irrigation equipment.
3. Study of soil health card and electrical system.

ENGINE

Engine converts energy from one form to other. Input chemical energy is converted into heat energy which in turn converted into mechanical energy. The output of engine can be obtained at the crankshaft but practically the output can be obtained at the flywheel.

CLASSIFICATION OF ENGINE

1. Based on combustion



2. Based on number of strokes
    a) Two stroke engine
    b) Four stroke engine
3. Based on number of cylinders
    a) Single cylinder
    b) Multi cylinder
4. Based on fuel
    a) Diesel engine
    b) Petrol engine
    c) Petrol started kerosene run engine
5. Based on cooling system
    a) Air cooled

b) Water cooled

6. Based on speed
    a) Low speed
    b) Medium speed
    c) High speed

7. Based on valve arrangement
    a) I shaped
    b) L shaped
    c) F shaped
    d) T shaped
8. Based on number of valves
    a) 3 valves per cylinder(2 inlet and 1 exhaust)
    b) 4 valves per cylinder(2 inlet and 2 exhaust)
9. Based on position engine
    a) Vertical
    b) Horizontal
    c) V shaped
    d) Opposite
    e) Rotary
    f) Inline arrangement

TERMS RELATED TO ENGINE

- Stroke length (L)

Distance between bottom dead centre (BDC) and top dead centre (TDC)

- Stroke volume

It is also termed as swept volume. It is volume between bottom dead centre (BDC) and top dead centre (TDC)

Stroke volume = $\frac{\pi}{4}D^2L$

D: diameter of cylinder

- Clearance volume

Clearance volume is the volume of cylinder above TDC

- Total volume

It is the sum of clearance volume and swept volume

Total volume = clearance volume+ swept volume

- Compression ratio

It is the ratio between total volume to the clearance volume

Compression ratio = $\frac{Total\ volume}{Clearance\ volume}$

- Indicated hp

Indicated hp = $\frac{PLAN}{4500} \times \frac{n}{2}$

P: Mean effective pressure (Kg/cm^2)

L: Stroke length (m)

A: Area (cm^2)

N: rpm

n: number of cylinders(n/2: four stroke; n: two stroke)

- Brake hp (BHP)

Brake hp = $\frac{2\pi NT}{4500}$

T: Torque

- Valve clearance

Clearance between valve tip and rocker arm is termed as valve clearance.

- Tappet clearance

Clearance between tappets and valves in cylinders doesn't have any push rods.

- Bumping clearance

Clearance between piston head surface and cylinder head inner surface when piston is at TDC is termed as bumping clearance.

- Firing interval

It is the interval between successive firing

Firing interval = $\frac{720^0}{no:of\ cylinders}$

- Firing order

Sequence of successive firing is termed as firing order.

TWO STROKE ENGINE

In two stroke engine two stroke comprises one cycle. During one cycle crankshaft rotates one times.

Upward movement: Suction + Compression

Downward movement: power + Exhaust

Camshaft and valves are absent in two stroke engines. Instead of valves ports are present

- ✓ Inlet port
- ✓ Exhaust port
- ✓ Transmission port

FOUR STROKE ENGINE

In a four stroke engine all the four strokes comprises one cycle. During one cycle crankshaft rotates two times and camshaft rotates one times.

1. **Suction stroke**
   - Piston moves from TDC to BDC and a vacuum is created inside the cylinder
   - Inlet valve is opened and exhaust valve is closed
   - Fresh air is enters into the cylinder

- Pressure : 3 Kg/cm^2
- Temperature : normal atmosphere temperature

2. Compression stroke

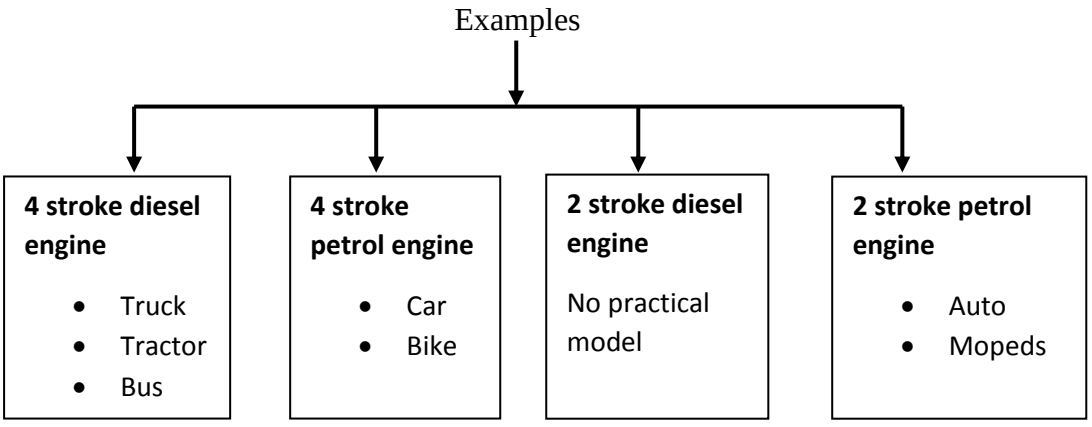
- Piston moves from BDC to TDC
- Both valves are closed
- At the end of compression stroke spark plug gives spark in case of SI engines or injectors sprays fuel at high pressure in case of CI engines
- Pressure : 35 – 45 Kg/cm^2
- Temperature : 650^{0}C - 800^{0}C

3. Power stroke

- Piston moves from TDC to BDC
- Both valves are closed
- Pressure : 45 – 55 Kg/cm^2
- Temperature : 1600^{0}C -2000^{0}C

4. Exhaust stroke

- Piston moves from BDC to TDC
- Exhaust valve open and inlet valve closed
- Burnt gases went through the exhaust valve, exhaust manifold and silencer
- Pressure : 3 - 5 Kg/cm^2
- Temperature : 650^{0}C



DISMANTLING OF ENGINE

At Anatapur we are familiarised with 5 hp Kirloskar diesel engine. The specification of the Kirloskar engine is given below.

Engine	: Kirloskar watercooled stationary 5 hp diesel engine
Type	: A.V/1 engine
Description	: Cold starting, vertical, water cooled, totally enclosed, compression ignition, 4 stroke cycle engine
Horse power	: 5 HP, at 1500 rpm
No: of cylinders	: 1
Bore diameter	: 80 mm
Stroke length	: 110 mm
Fuel	: High speed diesel
Cubic capacity	: 553 cc
Oil tank capacity	: 2.85 l
Fuel tank capacity	: 4.87 l
Compression ratio	: 16.5:1
Fuel injection pump	: Bosch type S.P.E.I.A
Fuel injection timing	: 27^0 before TDC
Fuel injection pressure	: 211 Kg/cm^2
Bumping clearance	: 0.90 to 1.005 mm
Inlet valve clearance	: 0.20 mm
Exhaust valve clearance	: 0.25 mm
Crankshaft end clearance	: 0.125 to 0.30 mm
Connecting rod big end clearance	: 0.10 to 0.254 mm

Minimum piston ring end gap	: 0.20 to 0.25 mm
Maximum piston ring end gap	: 0.87 mm
Piston ring end clearance	
Top ring	: 0.05 to 0.08 mm
Compression ring	: 0.04 to 0.05 mm
Oil ring	: 0.025 to 0.05 mm
Small end bearing clearance	: 0.20 to 0.25 mm
Maximum permissible wear	: 0.075 mm
(On the crankshaft, ovality)	
Maximum permissible wear	: 0.025 mm
Maximum ovality	: 0.125 mm
Maximum permissible linear wear	: 0.125 mm
Linear ovality	: 0.05 mm
Crankshaft main journal diameter	: 57 mm
Crankshaft crankpin diameter	: 54 mm
Distance between wall face and cylinder head place	: 0.80 to 2.5 mm
Valve seat angle	: 45^0 (inlet & exhaust)
Lubricating oil consumption	: 2.758 g/ BHP/ h
Fuel oil consumption	: 199 g/ BMP/ h
Tighting torque	
Connecting rod bolts	: 5.7 Kg/m (40 ft/lb)
Balancing weight bolts	: 9 kg/m (62 ft/lb)
Cylinder block stud in crankcase	: 9 kg/m (62 ft/lb)
Cylinder head nut in cylinder block	: 13.4 Kg/m (94 ft/lb)

Injector nut	: 2 Kg/m (14 ft/lb)
Fuel injection pump	: 2 Kg/m (14 ft/lb)

PROCEDURE FOR DISMANTLING AN ENGINE:

1. Give proper support to engine.
2. Empty liquids of machine (water, oil, diesel etc.)
3. Remove electrical connections and keep battery for charging.
4. Clean the internal parts neatly using cloth.
5. Selection of specific tools.
6. Disconnect external pipes or linkages.
7. According to position, dismantle from side, top etc.

The following order must be followed while dismantling a tractor.

1. Remove the Silencer making bonnet free to be removed.
2. Radiator must be removed next.
3. Belt, connecting pulley, fan, alternator and that from engine must be removed.
4. Fan must be removed next.
5. Alternator must be removed next.
6. Drain the oil by opening the drain plug from oil sump (crankcase).
7. Remove the engine from tractor frame.
8. Steering wheel, steering shaft comes next.
9. Front axle along with wheels must be removed while the rest of tractor is supported on a jack.
10. Invert the engine and remove the crankcase.
11. Oil filter must be removed afterwards.
12. Pipe lines coming from fuel tank and fuel tank must be disconnected.
13. High pressure pipe lines for fuel supply must be removed.
14. Baby filter (for fuel) must be detached.
15. Secondary and primary filter must be separated.
16. FIP along with primer must be removed.
17. Rocker arm assembly must be removed.
18. Cylinder head must be detached.
19. Cam shaft along with timing gear is pulled out.

20. Timing gears must be removed.

21. Clutch must be separated.

22. Flywheel must be removed.

23. Pistons along with connecting rod should be taken out.

24. Crank shaft must be removed making removal of main bearing easy

ASSEMBLING OF ENGINE:

The order that must followed while reassembling is as follows

Before reassembling

• Remove all sharp edges

• Clean all internal & external threads

• Check lifter bores for rust & burrs

• Check cam bores for burrs

The order that must followed while reassembling is as follows

1. Place main journal.

2. Insert the crank shaft and suitably place piston and connecting rod and bolt them tightly.

3. Bolt flywheel and clutch to crank shaft.

4. Attach the timing gear to crank shaft and check for its correct meshing for proper timing.

5. Check for valve timing and suitably place cam shaft with timing gear.

6. Connect the FIP in a manner that cam shaft in FIP is properly placed so as to get proper firing order. This is by adjusting pump timing.

7. Place the cylinder head.

8. Place valve into proper slots.

9. Rocker assembly must be then properly arranged and fitted.

10. Place the crank case and bolt it properly.

11. The rest of the reassembling can be done in any order but is mostly done in reverse order of dismantling.

PARTS OF ENGINE

Engine consists of three main parts

- Cylinder head
- Cylinder block
- Crankcase or oil sump

Moving parts of an engine are: Crankshaft

Piston with connecting rod

Flywheel

Camshaft

Tappets

Push rods

Rocker arms

Valves

Valve mechanism

Fan (for air cooled engines)

Crank shaft

All parts get drive from the crankshaft. It is made of high carbon steel. Converts vertical motion to rotary motion. Intermediate part between piston and flywheel.

Fig. Crank shaft with flywheel

Piston

The movement of piston is termed as stroke. It acts as a guide for piston rings (oil rings and compression rings). It is made of Aluminium alloy.

Fig. Piston with connecting rod

Connecting rod

It is the intermediate part between crankshaft and piston. One end of connecting rod which is connected to the piston pin or gudgeon pin is called as small end. Other end connected to the crank pin is called as big end.

Cam shaft

It consists of three loops which operates tappets and fuel injection pump in single cylinder engine. It made of steel

Fig. cam shaft

Push rod

Push rod operates rocker arm. It is made of steel.

Fig. Push rods

Rocker arm

Rocker arm made of cast iron and it operates inlet and exhaust valves.

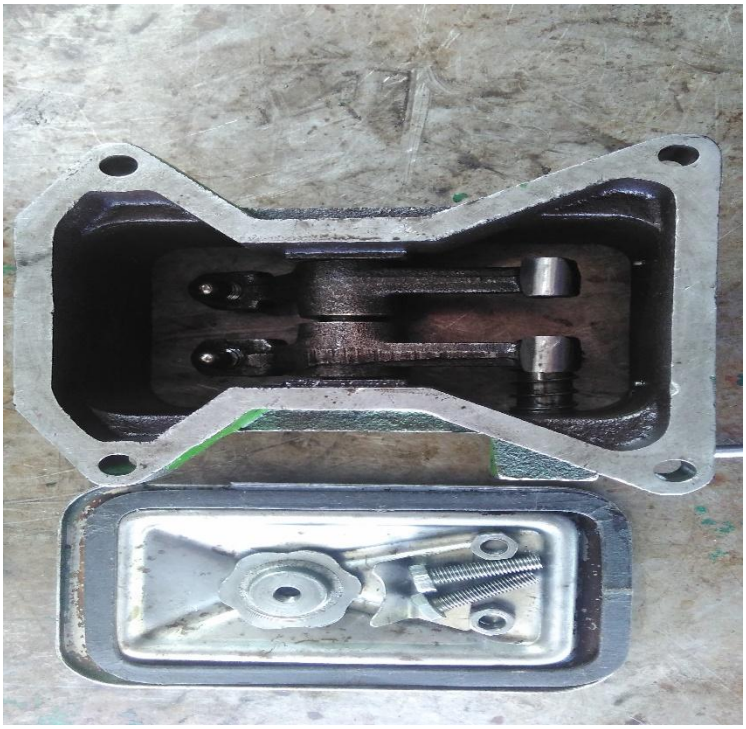


Fig. Rocker arm box

Stationary parts of engine: Cylinder head

Cylinder block

Oil sump

Radiator

Fuel tank

Air cleaner

Silencer

FIP (for diesel engine)

Carburettor (for petrol engine)

Gaskets

Shim

Mufflers

Main bearings

Manifolds

TROUBLE SHOOTING OF ENGINE

CAUSES	REMEDIES
a) Engine doesn't start	
1). No fuel in tank	1. Fill tank with diesel fuel.
2. Cock on tank pipe closed.	2. Open cock.
3. One or several fuel pipes are closed.	3. Wash and blow with compressed air
4. Air in fuel system.	4. Remove the air from fuel pipe and inlet To the fuel injection pump, and high pressure line by cranking the engine
5. Clogged fuel filter.	5. Clean or replace the fuel filter depending upon The material of the element.
6. Defective fuel feed pump	6. Remove the fuel feed pump, inspect and eliminate Fault.
7. Defective fuel injection pump: a) Pump element worn out. b) Pump plunger jammed.	7. Send the pump for repairs to an authorized dealer.

c) Delivery valves do not close.	
d) Spring broken.	
8. Nozzle orifice choked.	8. Clean.
(B). Irregular performance and lack of power :	
1. Same as causes, 4, 5, 6, 7, &8 for trouble (a).	1. Clean.
2. Nozzles worn off or seized.	2. Replace nozzles.
3. Fuel pumps timing inaccurate.	3. Adjust fuel pump.
4. Fuel injection pressure inaccurate.	4. Adjust injection pressure.
5. Poor compression.	
(a). Loss of compression through valves do to:	
i) Coke deposits on the valves	i.) Clean and regrind valves.
ii) Wrong tappet clearance	ii.) Adjust taper clearance.
iii.) Worn valves or valve seat	iii.) Regrind valves
(b). loss of compression at cylinder head gasket	b. Fasten the cylinder head and if necessary change the gasket
(c). Worn out piston group i.e. pistons rings and liners	c. change worn out parts
6. Air cleaner clogged	6. Clean air cleaner
(c) smoky exhaust: (I) black smoke (incomplete fuel combustion).	
1. Same as causes 7 & 8 for trouble (a)	1. Same as above.
2. Engine overloaded	2. Lower engine load or engage lower speed.
3. Poor fuel quality	3. Change fuel
4. Insufficient air supply	4. Clean air cleaner

5. Improper fuel pump timing	5. Adjust
6. Improper valve timing	6. Adjust
7. low injection pressure	7. Adjust

(ii) White smoke

1. Engine too cold	1. Warm up
2. Insufficient compression	2. As per remedy 5 of trouble (b)
3. Presence of water in fuel	3. Change fuel

(i) blue smoke (burning of oil in combustion chamber)

1. Excessive oil in crankcase	1. Remove extra oil
2. Thin grade oil used	2. Change oil
3. Worn out piston parts i.e. piston, piston rings or liners	3. Replace worn out parts

TRACTOR SYSTEMS

1. FUEL SUPPLY SYSTEM
2. AIR INTAKE AND EXHAUST SYSTEM
3. TRANSMISSION SYSTEM
4. LUBRICATION SYSTEM
5. COOLING SYSTEM
6. ELECTRICAL SYSTEM

FUEL SUPPLY SYSTEM

Fuel tank

Suction pipe

Filter

Flexible pipe

FIP

High pressure pipe line

Injector

Over flow pipe line

Fuel tank

FUEL TANK

- The fuel tank store fuel
- It has 3 openings, each for inlet, outlet and one for ventilation. The holes are indirect for avoiding blocking

- Ventilation hole is provided on the fuel tank cap, which make pressure difference in the tank and thus helps the fuel flow under gravity
- A sedimentation bowl is provided at the bottom of the tank. The outlet pipe is projected beyond the sedimentation bowl to make free of sediments
- Dipstick is provided to check the fuel level in the tank

SUCTION PIPE

- It delivers fuel from fuel tank to filter. Since the flow is under gravity the pipe delivers low pressure fuel, so made flexible
- The suction pipe have more diameter, so called as suction pipe

BANJO BOLTS

- In fuel system special bolts called banjo bolts are used. It has input and output passages for the fuel.
- It also acts as gasket, so made soft. It is not used for long time

Fig. Banjo bolts

FUEL FILTER

- A paper filter of cylindrical shape is used
- Filters are of two types.
    - Side to centre type
    - Centre to side type
- A side to centre type or centrifugal type filter is used in this engine
- The filer used are mostly of changeable type, but strainers are of cleanable type

- Generally for a tractor, the fuel system consists of 2 filters.
    - primary filter (cloth type)
    - secondary filter (paper type)

FLEXIBLE PIPE

- It connects filter and FIP (Fuel Injection Pump). It supply low pressure fuel to the FIP

FIP (Fuel Injection Pump)

- It pumps the fuel from fuel tank to the engine through the injectors
- It has the following functions
    - Pressurise the fuel
    - Maintain the quantity of fuel
    - Maintain the timing of fuel injection
    - Regulate the supply rate
- FIP pressurise the fuel up to 211 Kg/cm^2
- According to the FIP the engines are classified into 4
    - Jerk type : the engine in which the FIP, injector and cylinders are placed separately and the number of FIP and cylinder are equal (e.g. single cylinder engine)
    - Inline jerk type : the engine in which the numbers of FIP, injector and cylinders are same but they are arranged in a common border (e.g. multi cylinder engine, most tractors)

- Distributor type : the engine in which distributors are placed instead of FIP
- Unit type : the engine in which the number of FIP, injectors and cylinders are same also each FIP and injector arranged as one unit

➢ The pump used is reciprocating type. The discharge is constant even though the suction head is different, so called positive displacement pump

➢ The pump is plunger and barrel type in which plunger is moving and barrel is stationary

Fig. Fuel injection pump

➢ The FIP consist of

- Plunger and barrel
- Delivery valve
- Delivery valve return spring
- Delivery valve holder
- Rack and sleeve

➢ FIP is linked with the middle loop of the cam shaft to maintain the timing

- The up and down movement of the plunger occurs due to cam. During the downward movement (BDC) of the plunger, fuel sucks and during the upward movement (TDC), pressurise and delivers
- The delivery valve will be in closed position until the required pressure of the fuel is attained. The required pressure is adjusted using the delivery valve return spring. When the pressure increases beyond the limit, the valve opens and releases the pressure.
- After releasing the pressure the delivery valve will close. The spring helps to close the valve very fast so called the delivery valve return spring
- The delivery valve holder holds the valve

HIGH PRESSURE PIPE

- It delivers the high pressure fuel to the injector
- The material, diameter and length of pipe are important

FUEL INJECTOR

- It is the device which injects the high pressure fuel to the cylinder
- It atomises the fuel and the spherical shape helps to increase the efficiency
- The overflow will go back to the fuel tank

Fig. Fuel injector

- The components are
  - Nozzle
  - Nozzle holder
  - Nozzle pin
  - Nozzle extension
  - Spring
- Splashing takes place by lever. For higher viscous fluid splashing will be lower

QUALITIES OF FUEL

- Low viscosity
- Immediate burning
- Lubrication, cooling and cleaning agent

FUEL SYSTEM IN 4 STROKE ENGINE

Fuel tank

Suction pipe

Feed pump

Primary filter

Secondary filter

FIP

High pressure pipe

Injector

- Sedimentation bowl and baby filter is attached with the feed pump
- The primary filter is of cloth type which removes the fine dust particles and the secondary filter is of paper type which removes the heavy dust and water particles
- Feed pump is provided to remove the air mixed with fuel by loosening the screws provided in the feed pump
- A water separating bowl is associated with the fuel system only in case of tractors. Because the tank is placed in a higher position and thus direct exposure to the sun light which causes heating and separation of air, and thus water is produced.

GOVERNOR

- It controls the speed of the vehicle
- They are classified as
    - Variable speed governor &
      Constant speed governor (e.g. pumps)
    - Pneumatic governor &
      Mechanical governor
- The governor in this engine is mechanical, centrifugal, constant speed governor
- The continuous operation of the engine results increased speed, then the governor reduces the speed and maintain constant speed
- The governor consist of
    - Governor balancing weight
    - Governor retaining spring
    - Governor pushrod

- At high speed the centrifugal force increases, the weight expands, pushrod moves outward and touches the throttle lever. The outward movement of the throttle lever reduces the fuel flow, thus reduces the force and speed
- The speed reduction is achieved by controlling the quantity of fuel injected using the rack and sleeve mechanism in the FIP
- Bolt of the throttle lever is connected to the rack and pinion gears which are the controlling ones. When the throttle valve moves to and flow, the rack also moves to and flow giving rotational motion to the sleeve. The sleeve is fixed with plunger as one unit while rotary movement but not with reciprocating motion of the plunger
- According to the movement of the throttle valve, the opens in the barrel get matched with the slanted cut in the plunger so results zero, partial and full quantity fuel flow

AIR INTAKE AND EXHAUST SYSTEM

This system is used for air intake and exhausting the used air.

Air intake system

An engine air intake system is an arrangement of tubes, filters and fittings that conduct the air into the cylinders. Engine intake system has several parts such as pre-cleaner, air cleaner, intake manifold, intake valve, and cylinder

Pre-cleaner

It excludes and arrests large particles of dirt, chaff and lint from the incoming air to prevent their entry into the engine and guard against likely damage. It is mounted on the extension pipe above the air cleaner assembly. Centrifugal forces cause the heavier dust and other foreign matters to be thrown into the space between inner and outer shells.

Fig: Pre-cleaner

Air cleaner

The function of the air-cleaner is to supply clean air to the engine. The characteristics of ideal air cleaner include high efficiency in dust removal from air, small air restriction, small size etc. There are two types of air cleaner wet type and dry type air cleaner

1 .Dry type air cleaner

- ✓ 100% clean the air
- ✓ Maintenance cost is high
- ✓ Inside the air cleaner paper is used it consists of numerous micro pores
- ✓ Do not use air pressure above 200kPa (30 psi). High pressure might puncture a hole in the filter paper
- ✓ Cleaning of filter is done from inside to outside
- ✓ Change the filter after 10000km of operation

2. Wet type air cleaner

- ✓ 80% clean the air
- ✓ Also called oil bath type air cleaner
- ✓ Inside the bowl oil of grade SAE 30/40 is used to clean the air

EXHAUST SYSTEM

The exhaust gas goes out from cylinder bore through exhaust valve, exhaust port, exhaust manifold and silencer

Silencer

It is used for silencing the engine sound. In this the high pressure exhaust gas is permitted to pass through the small pores. By slow releasing the exhaust gas the sound get reduced. When the silencer is blocked the pressure of the burnt gases will increases and there is a chance of entering co_2 into cylinder bore. This results the incomplete combustion.

Fig: silencer

TURBO CHARGER AND SUPER CHARGER

Turbo charger and super charger is driven by exhaust gases. In super charger some engine power is required. These are providing for increasing the mileage. Super charger is suitable for hilly areas and mines. A turbo charger increases the power of the engine by pushing extra air into the cylinders to burn the fuel better. Turbo charger wears out fast, if engine is shut off at higher speed because its bearings will run out of oil before they stop spinning. Super chargers are employed in sports cars which have meant for fast speed rather than better economy

COOLING SYSTEM

Cooling system is the one which controls the engine temperature. The necessity of an efficient cooling system includes:

- The temperature of the burning gases in the engine cylinder reaches up to 1500 to 2000°C, which is above the melting point of the material of the cylinder body and head of the engine.
- Due to very high temperatures, the film of the lubricating oil will get oxidized, thus producing carbon deposits on the surface. This will result in piston seizure.
- Due to overheating, large temperature differences may lead to a distortion of the engine
- Components due to the thermal stresses set up. This makes it necessary for, the temperature variation to be kept to a minimum.

TYPES OF COOLING SYSTEM

There are two types of cooling systems:

(i) Air cooling system

(ii) Water-cooling system

AIR COOLING SYSTEM

In this type of cooling system, the heat, which is conducted to the outer parts of the engine, is radiated and conducted away by the stream of air, which is obtained from the atmosphere. In order to have efficient cooling by means of air, providing fins around the cylinder and cylinder head increases the contact area. The fins are metallic ridges, which are formed during the casting of the cylinder and cylinder head.

The amount of heat carried off by the air-cooling depends upon the following factors:

(i) The total area of the fin surfaces,

(ii) The velocity and amount of the cooling air and

(iii) The temperature of the fins and of the cooling air.

Air-cooling is mostly tractors of less horsepower, motorcycles, scooters, small cars and small aircraft engines where the forward motion of the machine gives good velocity to cool the engine.

WATER COOLING SYSTEM

This cooling system has four types of systems:

- Direct or non-return system
- Thermo-Syphon system
- Pump/forced circulation system

DIRECT OR NON-RETURN SYSTEM

This is suitable for large installations and where plenty of water is available. The water from a storage tank is directly supplied to the engine cylinder. The hot water is not cooled for reuse but simply discharges.

THERMO-SYPHON WATER COOLING SYSTEM

This system works on the principle that hot water being lighter rises up and the cold water being heavier goes down. In this system the radiator is placed at a higher level than the engine for the easy flow of water towards the engine. Heat is conducted to the water jackets from where it is taken away due to convection by the circulating water. As the water jacket becomes hot, it rises to the top of the radiator. Cold water from the radiator takes the place of the rising hot water and in this way a circulation of water is set up in the system. This helps in keeping the engine at working temperature. This system is mostly used in power tillers.

FORCED CIRCULATION SYSTEM

This system is similar in construction to the thermo-syphon system except that it makes use of a centrifugal pump to circulate the water throughout the water jackets and radiator. The water flows from the lower portion of the radiator to the water jacket of the engine through the centrifugal pump. After the circulation water comes back to the radiator, it loses its heat by the process of radiation. This system is employed in cars, trucks, tractors, etc.

THERMOSTAT VALVE

It is a kind of check valve which opens and closes with the effect of temperature. It is fitted in the water outlet of the engine. During the warm-up period, the thermostat is closed and the water pump circulates the water only throughout the cylinder block and cylinder

head. When the normal operating temperature is reached, the thermostat valve opens and allows hot water to flow towards the radiator.

Standard thermostats are designed to start opening at 70 to 75°C and they fully open at 82°C.

There are three types of thermostats:

(i) bellow type
(ii) bimetallic type
(iii) pellet type.

Bellow type valve*:* Flexible bellows are filled with alcohol or ether. When the bellow is heated, the liquid vaporises, creating enough pressure to expand the bellows. When the unit is cooled, the gas condenses. The pressure reduces and the bellows collapse to close the valve.

Bimetallic type valve*:* This consists of a bimetallic strip. The unequal expansion of two metallic strips causes the valve to open and allows the water to flow in the radiator.

Pellet type valve*:* A copper impregnated wax pellet expands when heated and contracts when cooled. The pellet is connected to the valve through a piston, such that on expansion of the pellet, it opens the valve. A coil spring closes the valve when the pellet contracts.

SERVICING AND CLEANING OF COOLING SYSTEM

For smooth and trouble-free service, the cooling system should be cleaned at periodic intervals to prevent the accumulation of excessive rust and scale. The commercial cleaning compounds available must be carefully used in accordance with the manufacturers' instructions.

Cleaning Procedure:

1. Drain the system by opening the drain cocks. Prepare a solution of washing soda and water, with a ratio of 1 kg soda to 10 litres of water. Fill up this solution in the radiator and engine block and run the engine on idle load for 8 to 10 hours. Drain this solution and flush the system with clean water.
2. In case the scale formulation is bard and cannot be completely removed with washing soda, another cleaning agent can be prepared with 40 parts of water, 5 parts of commercial

hydrochloric acid and 1part of formaldehyde. This solution is allowed to remain in the system for 2 to 3 hours at normal load. Afterwards this could be drained and the system flushed with clean water.

LUBRICATION SYSTEM

The lubricating system of an engine is an arrangement of mechanism and devices which maintains supply of lubricating oil to the rubbing surface of an engine at correct pressure and temperature. Lubricating oil can be supplied to the various engine components by a splash system or by a pressurized system or a by a combination of both.

NEED FOR LUBRICATION

- Reduces the frictional resistance between different engine parts, and thus protects from wear and tear.
- Acts as a cushioning agent between the bearings
- Forms a seal between the piston rings and the cylinder walls.
- Removes the impurities from the lubricated region.
- Serves as a cooling agent by picking up the heat.

PROPERTIES OF LUBRICATING OIL

The oil used in an engine must serve as a lubricant, a coolant, and an agent for removing impurities.

- **Viscosity**

It's the measure of oil's resistance to flow. If the oil viscosity is too high then more work is required to pump it and shear it between the moving parts. If the oil is too thin it will be forced out from between the moving parts, resulting in rapid wear. Lubricating oil is generally rated by using a viscosity scale established by SAE (Sociey of automotive engineers). SAE 20, SAE 25, SAE35 grade oils are used as engine oils. SAE5, SAE10 grade oils are used in hydraulic system. SAE90 grade oils are used in gear box. In gear box, mechanical energy is converted to heat energy are to withstand this heat a high viscous oil is

added to the gearbox. Multi viscosity oils such as SAE20W40 are also used whish has a viscosity of 20 in winter and 40 in summer.

- **Oiliness**

It's the property of the lubricating oil to spread and attach itself firmly into the bearing surfaces.

- **Flash point**

It's the minimum temperature at which the lubricating oil will flash when a small is passed across its surface.

- **Fire point**

If the lubricating oil is further heated after the flash point has been reached, the lowest temperature at which the oil will burn continuously is called fire point

- **Cloud point**

It's the temperature at which the lubricating oil changes its state from liquid to solid

- **Pour point**

It's the lowest temperature at which the lubricating oil will pour.

TYPES OF LUBRICANTS

Lubricants are of following three types

1.Solid-graphite,mica etc which are used in bearings.

2.Semi solid-grease.

3.Liquid-mineral oil ,vegetable oil, animal oil etc.

DIFFERENT TYPES LUBRICATING SYSTEMS

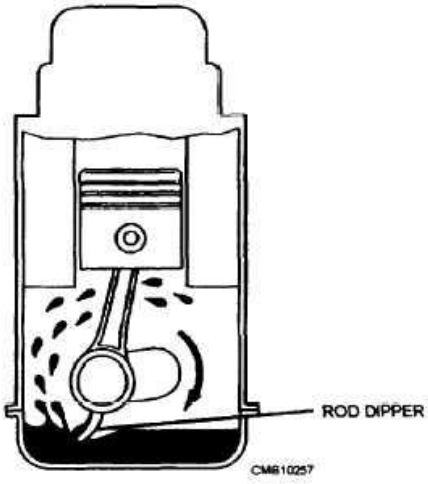
- Splash system
- Force feed system

- Vapour system

In multi cylinder engines only splash and force feed lubricating systems are used.

SPLASH SYSTEM

In this system, there is an oil trough, provided below the connecting rod. Oil is maintained at a uniform level in the oil trough. This is obtained by maintaining a continuous flow of oil from the oil sump or reservoir into a splash pan, which has a depression or a trough like arrangement under each connecting rod. This pan receives its oil supply from the oil sump either by means of a gear pump or by gravity. A dipper is provided at the lower end of the connecting rod. This dipper dips into to oil trough and splashes oil out of the pan. The splashing action of oil maintains a mist of oil that drenches the inner parts of the engine such as bearings, cylinder walls, pistons, piston pins, timing gears etc.



Fig,Splash lubrication system

VAPOUR SYSTEM

Lubricates the rocker arm, cam shaft, push rod, tappets, valve guide, rocker arm bush. Lubricating oil condenses from lube plate on the rocker arm cover and it falls on the holes present in the rocker arm.this system, the oil is pumped directly to the crankshaft, connecting rod, piston pin, timing gears and camshaft of the engine through suitable paths of oil.

FORCE FEED SYSTEM

In usually the oil first enters the main gallery, which may be a pipe or a channel in the crankcase casting. From this pipe, it goes to each of the main bearings through holes. From

main bearings, it goes to big end bearings of connecting rod through drilled holes in the crankshaft. From there, it goes to lubricate the walls, pistons and rings. There is separate oil gallery to lubricate timing gears. The oil also goes to valve stem and rocker arm shaft under pressure through an oil gallery. The excess oil comes back from the cylinder head to the crankcase. The pump discharges oil into oil pipes, oil galleries or ducts, leading different parts of the engine. This system is commonly used on high speed multi-cylinder engine in tractors, trucks and automobiles.

The parts of force feed system includes sump, pump, filter. The pump used is rotary or gear type. It consists of plunger, barrel and a strainer. The pressure of lubrication oil is 3-4 kg/cm^2.Pump is powered by crankshaft. Lube oil filter used bypass filter. The direction of filtration is center to side.

ENGINE MEASUREMENTS

Engine measurements are done for checking and solving engine problems. Some of the major problems occurring in the working of engine are mainly due to the wear and tear of engine parts. After some period of working, engine parts get worn out and due to this there will be reduction in the engine efficiency , pick up, millage and increase the fuel consumption, pollution, maintenance cost etc. Normally engine measurements are done when millage loss occurs in no load condition, presence of black smoke, no pick up in full accelerated condition, more engine oil requirement, oil leakage, over heating of engine, compression leakage, uneven sounds, etc. If any one of the problem is identified normal remedies. If most of the above problems are seen we will do engine measurements.

Mainly 3 types of engine measurements are done

- Ovality
- Taperness
- Valve clearance

Ovality

Ovality is the degree of deviation from perfect circularity of the cylinder bore. It is caused due to the unequal pressure on the piston. According to force acting on the bore 2 sides are there, thrust side and non-thrust side. The cylinder bore in the direction of travel is the thrust side and the other side is the non thrust side. Thrust side is the side in which more force acting. So that, in this direction the cylinder diameter will increase. Non thrust side means where less force acting, so the bore diameter will not have much change. Due to this an uneven force will act on the cylinder bore and the circular shape of bore will transformed to an oval shape. That's why this measurement is known as ovality. If the measured diameter increase is greater 2 thou, we will go for the replacement of engine bore.

The instrument used for ovality measurement was dial bore gauge. It measures the bore directly. The gauge has 3 symmetrical anvils that are connected to the dial mechanism. As the knob is rotated it moves the anvils in or out with respect to the measurements. The knob usually has a slipping mechanism to take the feel out of the device and increase reliability between measurements.

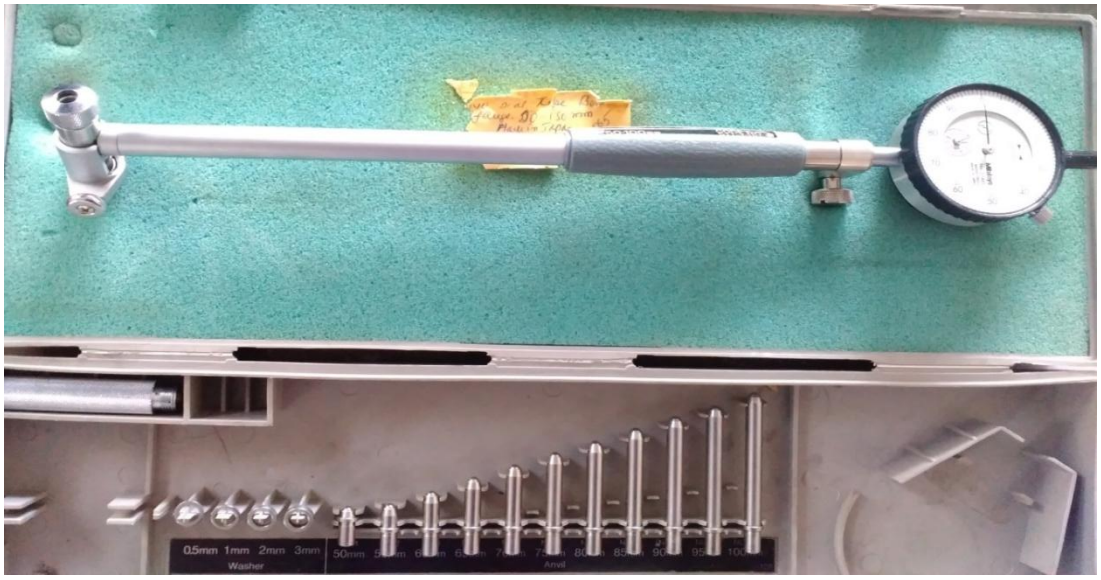


Fig. Dial type bore gauge

Tapperness

Tapperness is the length wise change in the diameter of cylinder bore. It is caused by the piston rings rubbing on the cylinder walls. To measure it, we also use bore gauge. For that we placed the bore gauge across the cylinder just below the unknown ring ridge, moves the gauge slowly up and down to measure taper at top middle and bottom of the ring travel in cylinder. Tapperness also indicates the wear and tear of cylinder bore.

Valve clearance

Normally a minimum valve clearance is provided for the inlet valves and exhaust valves. For the proper timing of exhaust and inlet stroke the clearance should be proper. If valve clearance is above the specified limit, the valves open for short time. If inlet valve opening lagged, lack of air input will occur. If exhaust valve opening lagged mixing of

exhaust air and fresh air occurs. Similarly if valve clearance is less, the valves opens for more time and strokes will not be proper. The instrument used for this measurement was feeler gauge. Feeler gauge is a tool used to measure gap widths. They consist of a number of small lengths of steel of different thickness with measurements marked on each piece. Valve clearance is adjusted according to the company specification**.**

Fig. Feeler gauge

- For checking the wear and tear of the connecting rod big and crank, verniercaliper was used. Vernier caliper with 0.02 mm as least count is used for the measurement. If the difference between connecting road big end diameter and crank journal should be less than 0.25 mm. inner diameter, outer diameter and depth can be found out using vernier caliper.

Fig. Vernier caliper

DISMANTLING OF A MULTI CYLINDER ENGINE

To study the dismantling of engine we used a 45 hp 4 stroke direct injection water cooled MDI2500 tractor engine. M stands for Mahindra, DI for direct injection.

Fig. Multicylinder engine

Procedure:

1. Give proper support to engine.
2. Empty liquids of machine (water, oil, diesel etc.)
3. Remove electrical connections and keep battery for charging.
4. Clean the internal parts neatly using cloth.
5. Selection of specific tools.
6. Disconnect external pipes or linkages.
7. According to position, dismantle from side, top etc.

The following order must be followed while dismantling a tractor.

1. Remove the Silencer making bonnet free to be removed.
2. Radiator must be removed next.
3. Belt, connecting pulley ,fan, alternator and that from engine must be removed.
4. Fan must be removed next.
5. Alternator must be removed next.
6. Drain the oil by opening the drain plug from oil sump (crankcase).
7. Remove the engine from tractor frame.
8. Steering wheel, steering shaft comes next.
9. Front axle along with wheels must be removed while the rest of tractor is supported on a jack.
10. Invert the engine and remove the crankcase.
11. Oil filter must be removed afterwards.
12. Pipe lines coming from fuel tank and fuel tank must be disconnected.
13. High pressure pipe lines for fuel supply must be removed.
14. Baby filter (for fuel) must be detached.
15. Secondary and primary filter must be separated.
16. FIP along with primer must be removed.
17. Rocker arm assembly must be removed.
18. Cylinder head must be detached.
19. Cam shaft along with timing gear is pulled out.
20. Timing gears must be removed.
21. Clutch must be separated.
22. Flywheel must be removed.
23. Pistons along with connecting rod should be taken out.

24. Crank shaft must be removed making removal of main bearing

MAIN COMPONENTS OF THE ENGINE

- Cylinder Head
- Engine block
- Oilpan / sump
- Manifolds
- Gaskets
- Cylinder
- Piston, piston rings, piston pin
- Connecting rod
- Crank shaft
- Main Bearings
- Camshaft
- Valves
- Mufflers

ASSEMBLING OF ENGINE

The order that must followed while reassembling is as follows

Before reassembling

• Remove all sharp edges

• Clean all internal & external threads

• Check lifter bores for rust & burrs

• Check cam bores for burrs

The order that must followed while reassembling is as follows

1. Place main journal.
2. Insert the crank shaft and suitably place piston and connecting rod and bolt them tightly.
3. Bolt flywheel and clutch to crank shaft.
4. Attach the timing gear to crank shaft and check for its correct meshing for proper timing.
5. Check for valve timing and suitably place cam shaft with timing gear.
6. Connect the FIP in a manner that cam shaft in FIP is properly placed so as to get proper firing order. This is by adjusting pump timing.
7. Place the cylinder head.

8. Place valve into proper slots.

9. Rocker assembly must be then properly arranged and fitted.

10. Place the crank case and bolt it properly.

11. The rest of the reassembling can be done in any order but is mostly done in reverse order of dismantling.

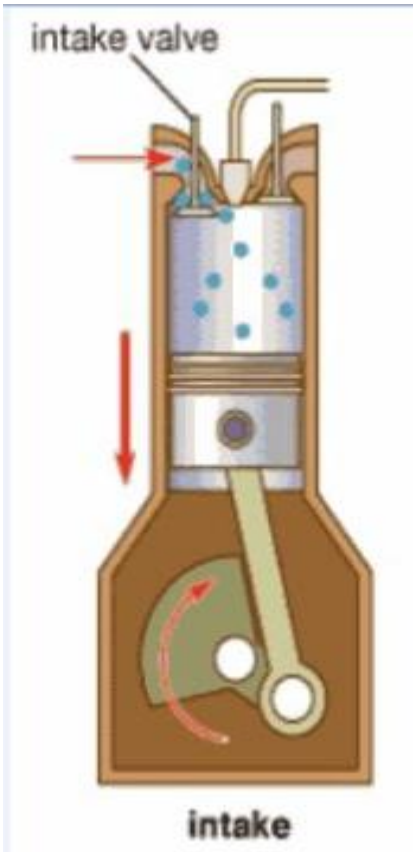
Ovality and Tapperness

Ovality is the difference between thrust and non-thrust side along the radial side and tapperness is the difference of thrust and non thrust side along the piston length.

WORKING OF FOUR STROKE ENGINE

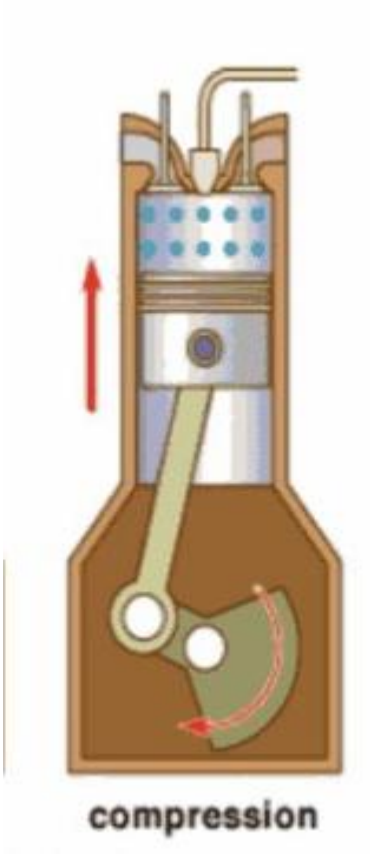
Working of an engine is a cycle of 4 strokes which are suction, compression, power and exhaust. The cycle starts with suction stroke.

In suction stroke, pure air is drawn into the cylinder through the inlet valve, while the exhaust valve is closed. In suction stroke, piston moves from TDC to BDC. The pressure inside the cylinder is less than atmospheric pressure.

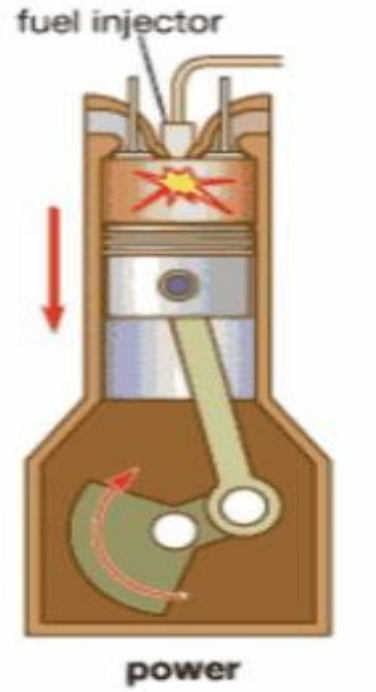


In compression stroke, the piston moves from BDC to TDC. During this stroke, both the valves are closed. The air is compressed to a volume comparable to clearance volume. Pressure built inside the cylinder ranges from 30 - 45 kg/cm2 and the temperature range is

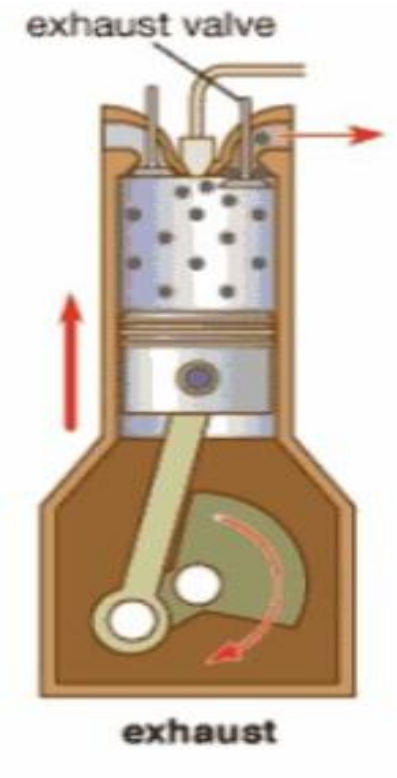
from 650 – 800oC. The pressure built in cylinder at the time of injection ranges from 47 – 55 kg/cm2 and temperature from 1650-1925°C.



During power stroke burning of fuel takes place moving the piston from TDC to BDC while both the valves are closed. Energy is stored in flywheel during power stroke which operates the rest of strokes.



Due to burning of fuel air expanse pushing the piston towards the BDC. This is the exhaust stroke, and the burnt out gases escape through exhaust manifold. The exhaust pressure ranges from 3.5- 5 kg/cm2 and the temperature is 650°C. Burning of fuel in engine is an instantaneous process and uses less fuel. This process requires presence of air. This must be pressurised, as at normal pressure mixing of air and fuel become difficult and instantaneous burning does not takes place. For effective and instantaneous burning, fuel must form droplets and be surrounded by air.



Tappet clearance

Tappet clearance is a space between the top of the valve stem and the rocker arm. Its purpose is to allow for some mechanical expansion and lengthening of the valve stem and push rods as the engine warms up. This clearance is also called valve lash.

If insufficient valve lash is set when the engine is cold the valves will not properly close when the engine warms up. If too much lash is provided (additional clearance) then even after the engine warms up there will be some clearance, which will result in lost motion. Lost motion mean that as the cam tries to open the valve the push rod and rocker arm moves to first take up the clearance before touching the valve to open the valve. The result is late opening of the valve.

When checking tappet clearance on marine engines, we have to ascertain that the piston is at TDC. Though markings are provided on the flywheel, the marine engineer must know the other methods for this like inspection of the camshaft and the fuel pump window.

If tappet clearance is less:

I. Valve will open early & close late

ii. Air induced through inlet valve may leak out. So less air for combustion.

iii. Power will be reduced.

iv. Fuel consumption will increase, engine may become unbalanced, exhaust temp. will be very high. 66

v. In worst condition, valve may remain open, resulting in loss of compression pressure, burning of exhaust valve, T/C fouling will increase.

If tappet clearance is more:

I. Valve will open late & close early.

ii. Lesser heat energy to T/C, so reduction in scavenge air & hence power.

iii. No proper removal of gases

iv. Hammering of valve stem-may cause damage to valve stem.

TRANSMISSION SYSTEM IN A TRACTOR

The tractor is a self propelled machine. It gets its driving force in a combination with an engine and driving wheels or tracks. Engine power is transmitted to the driving wheels or tracks. Engine power is transmitted to the driving wheels through a series of intermediaries called power trains. These power trains consist of clutch, transmission, differential, final drives and driving axles. Tractor power is used from its power take off shaft, pulley, hydraulic system, and drawbar.

Power train connect engine power to the drive wheels, belt pulley, power take off (PTO), hydraulic system by means of the following parts:

i. Clutch to connect and disconnect power,
ii. Transmission to provide different speeds (forward and reverse) and connect power to other parts.
iii. Differential to send equal power to the final drives
iv. Final drives to carry power from differentials to drives

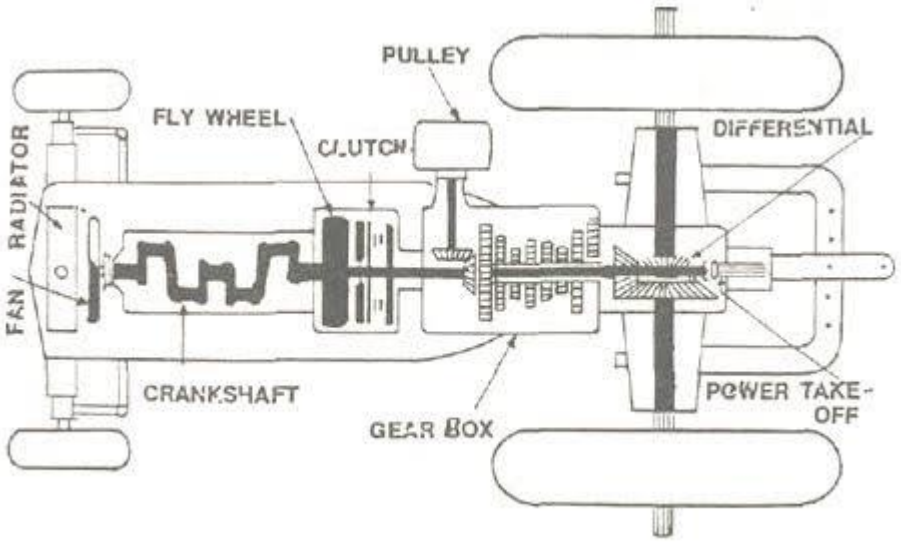


Fig. transmission system in a tractor.

CLUTCHES

A clutch is a device used to connect or disconnect the tractor engines from its power trains for changing gear ratios. The clutch transmits power by means of friction, between driving and driven elements. There are two main types of friction clutches used on tractors, single disc type and multiple disc type.

The single disc or single plate clutch is the dry type clutch. Its driven plate is held against the flywheel by means of spring loaded pressure plate. When the clutch pedal is depressed, release fingers push the pressure plate back against te spring pressure, thus releasing the pressure from the clutch plate. Then the clutch plate stops, where as flywheel continues to rotate. When clutch pedal is released the pressure plate forces the clutch plate against the flywheel with sufficient force to cause the clutch plate and flywheel to turn together as one unit.

Multiple disc clutches are either dry type or wet type. The wet type clutch consists of a number of driving and driven plates alternately arranged. Driving plates are attached to the flywheel and driven plates to the clutch drum, which is an integral part of the input shaft to the gear box. These plates are pressed together by means of clutch springs.

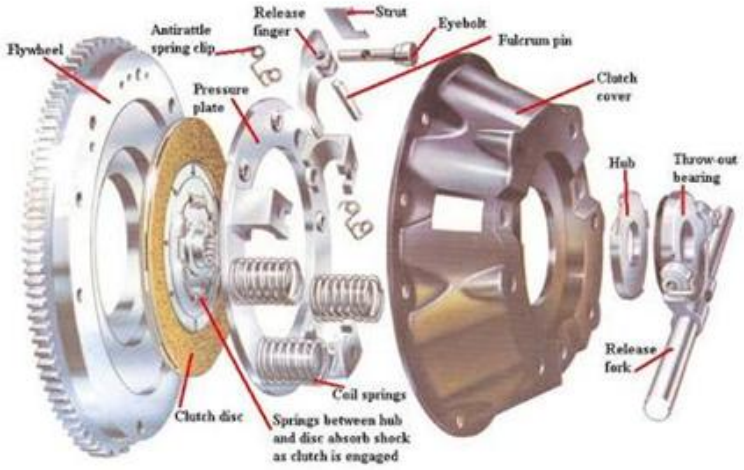


Fig. clutch system in a tractor.

POWER TRANSMISSION

Transmission systems of modern tractors are mostly of the selective sliding gear type. Generally 6 to 8 forward and 2 reverse speeds are achieved through a 2 speed epicyclic unit of 3 forward and one reverse. Selection for gears in which a tractor has to be operated, is generally made with a gear shifting lever mounted above the transmission housing. The gear housing contains a gear on the input shaft9main shaft) and number of gears are mounted on the counter shaft (lay shaft)and on the output shaft (pinion) shaft. In this type of transmission the gear on the input shaft always meshes with one on the counter shaft and other gears remains ideally. To put the transmission in operations, gear is shifted along the shaft to which is splined, to engage with another gear.

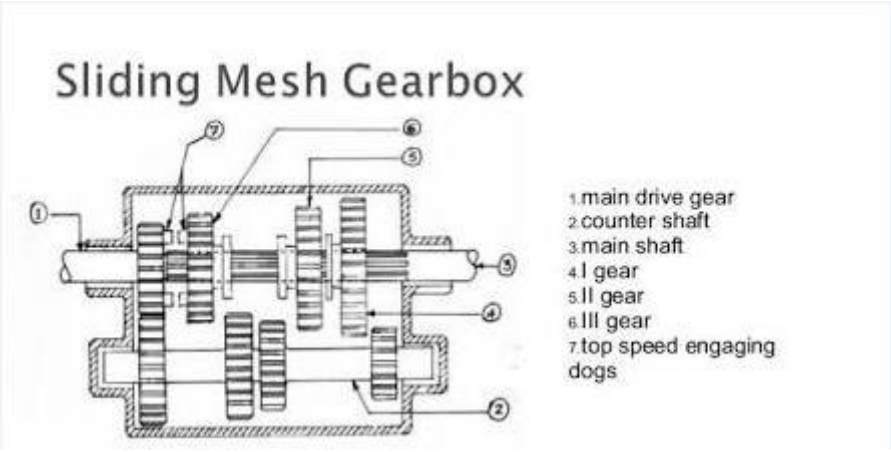


Fig. sliding mesh gear system

The other type of transmission called the constant mesh type is also used on a few tractor models. In this case, gears are always in mesh, and usually helical gears are used. The transmission is put into operation by the engagement of shifting couples which slide along the splines on the counter and output shafts.

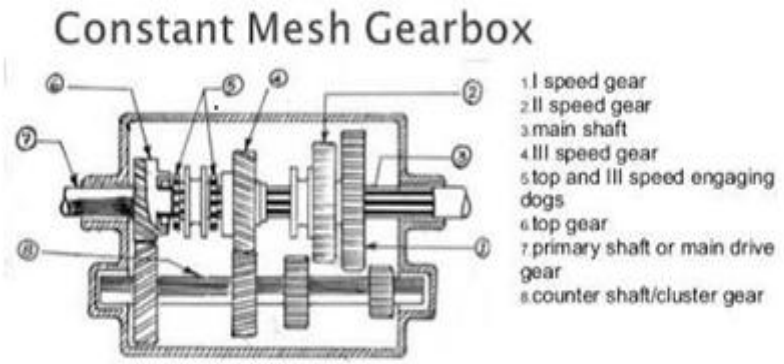


Fig. constant mesh gear system

Lubricants used for tractor transmission are termed as 'Gear Box and Rear Axle' lubricants. SAE 90 oil is generally recommended for use I temperature above 2^{o}C.

A transmission allows the operator to increase or decrease the speed and reverse the direction of the tractor. The lower the gear, the more weight the tractor can pull at the slower speed.

The another type is synchronized transmission, in which the machine need not to be stopped to change the gear whereas in sliding gear type transmission, the tractor has to come to hault before the gears are changed.

Fig. synchronized gear system.

DIFFERENTIAL

The main purpose of the differential unit in a tractor is two fold,

i. To work as compensating mechanism so that when the tractor takes a turn, the outer wheel may move may move faster than the inner one and still share the load equally.
ii. To finish as a second speed reduction point in the tractor power trains.

The standard differential used on tractors having lengthwise arrangement of engine consists of a bevel pinion, ring or crown gear, differential side gears, differential pinions, spider, bearings and differential housing.

The bevel pinion mounted at the end of the output shaft of the gearbox drives the crown gear. When the tractor is travelling in a straight line, the rear wheels revolve at the same speed. The differential side gears and differential pinions rotate along with the housing as one unit. When the tractor turns, the outer rear wheel must travel faster than the inner one. This is accomplished by differential pinions being rolled over the differential side gears as well as by rotating on their own axles. While turning a short corner, the inner wheel is slowed down and the outer one is speeded up. If one wheel is locked, the speed of other is increased by two times.

Fig. differential of tractor

FINAL DRIVES

Final drives on tractor provide additional gear reduction between the engine and rear axle. It also increases the axle clearance without using excessively large wheels and permits use of smaller ring gear. The positive drives employed for this reduction may be either spur gear trains or chains and sprockets which provide about 3 to 5:1 reduction.

POWER TAKE OFF (P.T.O)

Power take off is a part of tractor transmission system. It is provided with a standard splined shaft at the rear of the tractor to operate the P.T.O. operated machines like mowers, forages harvester, combines etc. The P.T.O. shaft is always kept covered at the exposed end to avoid accident during operation. When a P.T.O. driven machine is connected to the tractor, a telescopic shaft with an universal joint is placed in between as a coupler to take care of the angularity of the drive. The existing ASAE standard P.T.O. specification for speed is 540 rpm ± 10 rpm when operating under load.

Fig. Power Take Off

DRAWBAR

Drawbar pull from a tractor is taken by means of its drawbar assembly, which consists of two side members attached to the tractor rear axle housing and a flat cross bar having a no. of 20mm diameter holes. In some of the tractors, an additional attachment called swinging drawbar is also provided. Swinging drawbar is mainly advantageous for taking short turns with machines wider than the tractor. It reduces side draft and leaves only small area uncovered on corners of the field. Nearly all tractors have provision to adjust the height of the drawbar from ground.

Fig. drawbar in a tractor.

TRACTION DEVICES

Traction is achieved by friction and soil reaction between the wheels or tracks and the ground over which the tractor moves. The modern wheel type is provided with the steel rims and pneumatic tyres as the ground drive component. Nearly, all the traction wheel tyres are

marked with an arrow on the sidewalls indicating the direction of travel. The traction tyre is also provided with tread bars which penetrate in the soil and result in better traction. The size of tractor tyre is expressed for example as 12.00-38; which means the sectional diameter of the tyre is 12 inch and it is mounted on a rim of 38 inch diameter. These tyres are available in many sizes with their ply ratings as 4, 6 or 8 which indicates the comparative strength of tyres. Inflation pressure in the rear wheels of the tractor varies between 0.8 and 1.2 kg/cm^2 and that of front wheel varies from 2 to 2.5 kg/cm^2.

Fig. front and rear wheel in a tractor which provides traction.

STEERING MECHANISM

The clutch and brake type steering mechanism is most commonly used on crawler tractors. In this system, the power from one axle is disengaged and there after the tractor is stopped by applying brakes.

The steering mechanism of a four wheel type tractor includes; steering wheel, steering gear and shaft, drag link, radius rod, tie rod and spindle arms. The front axle is properly aligned by the radius rod which is pivoted on the clutch housing of the tractor. The tie rod connects the front wheel spindle arms and ids actuated by the steering shaft through drag link.

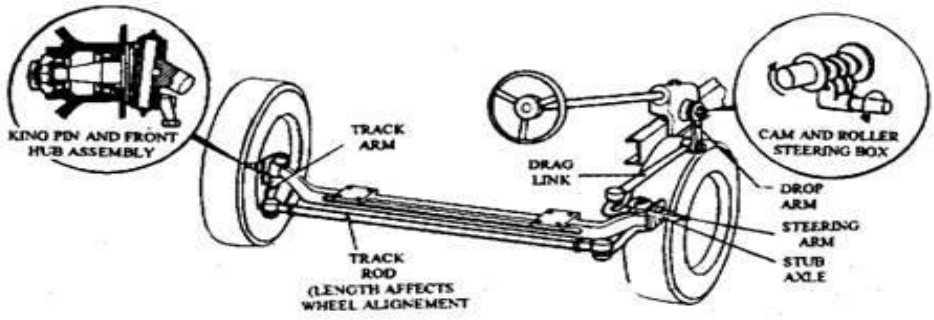


Fig. steering system in a tractor

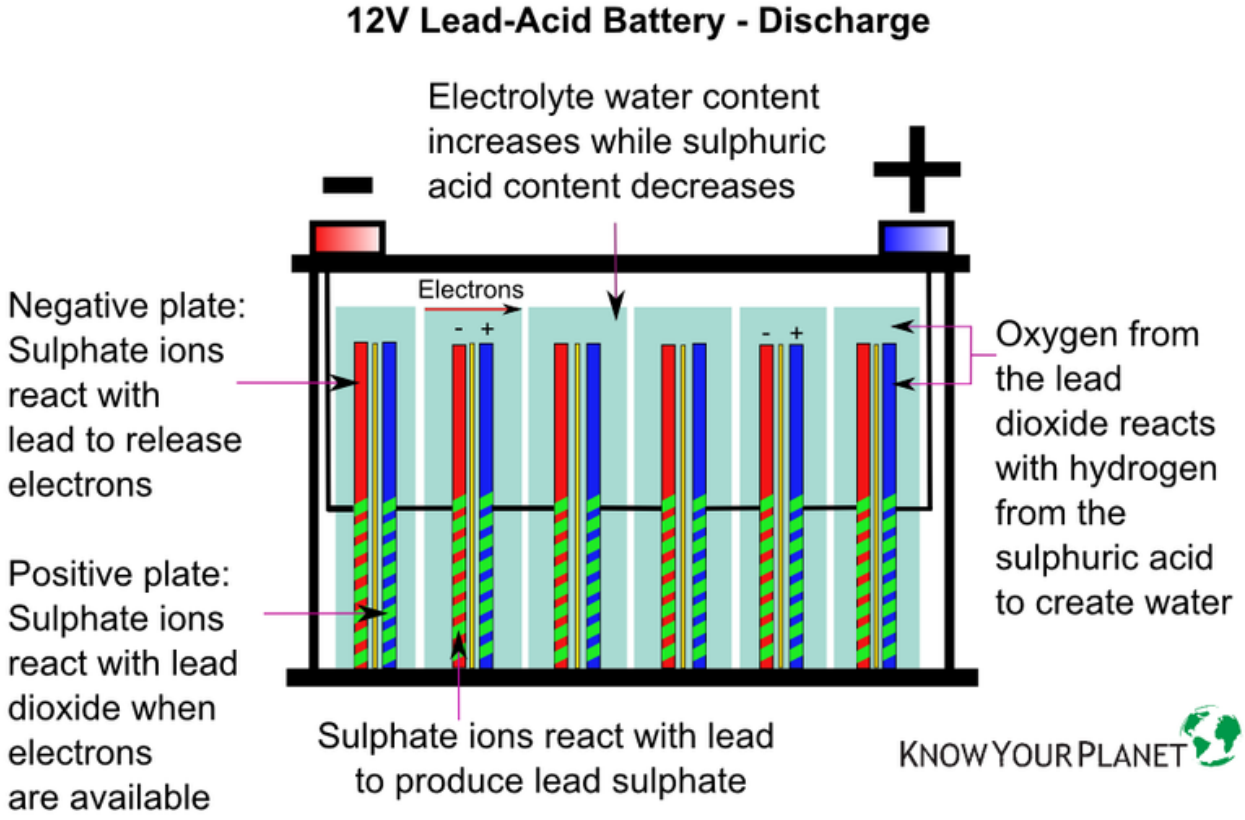
ELECTRICAL SYSTEM

Electrical system of agricultural tractor mainly consists 4 parts,

- Battery
- Self starter
- Voltage regulator / cut out
- Alternator dynamo

BATTERY

Battery is an electrochemical device which converts chemical energy into electrical energy and stores the same. Lead acid battery is commonly used in automobiles and tractors.



A lead acid battery consists of six compartments with a number of plates (usually 5 negative and 4 positive plates). The other important parts are:

- Plates: Plates are of two type, positive and negative plate in rectangular shape. Positive plate was made of lead peroxide. Usually chocolate brown in color.

Negative plate, made of spongy lead and ash in color.

- Separator: insulators between plates to prevent them from touching each other for avoiding short circuiting. commonly made of fibre, rubber etc.
- Electrolyte: The electrolyte used in lead acid battery is a mixture of diluted sulphuric acid (33%) and distilled water(66%). Its level should be half inch above the plates. Specific gravity of electrolyte is 1.25.
- Container: the tops are covered with rubber material and sealed with water proof compound. There are few openings (3) on the top for refilling of electrolyte and testing. Made of hard rubber.
- Terminal wires: 2 in number. To connect positive and negative terminals with electric circuit.
- Sediment space: Empty space provided to prevent sulphation.
- Air vent hole: For discharging hot gases.

Charging methods:

1. Fast charging: Battery temperature should not exceed 125 degree farenheit. Time required is very less.
2. Slow charging: For charging 1A current for 20hrs
3. Trickle charging: For storing battery for long time.

A 7 plate battery contains 3 positive plates and 4 negative plates. Each positive plate produce 15A, thus a total of 45A.

SELF STARTER

Self motor convert electrical energy to mechanical energy. Which operates at less rpm and more torque. Components are

1. Armature
2. Commutator
3. Brushes
4. Bendex drive
5. Yoke
6. Solinoid switch
7. End cover
8. Fork or liver
9. Spring

Fig.Self starter

Armature: It consists of cu windings on its core. The number of turns and thickness depends on the current. They have very less number of turns with thick wire

Commutator: Made of copper segments. It receives power from field winding through brushes

Brushes: They are used to transmit motion from stationery component to rotating component. They are usually spring loaded. Negative brushes are placed on non-insulated holders whereas positive brushes on insulated holders.

Yoke: It is the field terminal connected to solenoid having field windings. Yoke has two north and south poles.

Bendex drive: It moves on a worm rotated by the fork of a solenoid.

VOLTAGE REGULATOR

A voltage regulator takes current from a battery with oscillating voltage and puts out constant voltage. A tractor's regulator manages the voltage by reducing it, and sends it on to the alternator at a constant volume that the alternator sends on to the coil. There are 3 wires that must be connected to the correct regulator terminal.

Fig. Voltage regulator

DYNAMO

Dynamo is used to charge the battery. It produces DC power and converts mechanical energy to electrical energy. Components of the dynamo are armature, frame, brusher, fan wheel, brush holder, spring, centre shaft, yoke, commutator, poles, and field windings with North South poles, field terminal, and armature terminal.

Fig. Dynamo

ALTERNATOR

Alternator produces AC current. Here the armature is the conductor. The field windings are replaced by rotor assembly. The slip rings act as rectifier unit.

Fig. Alternator

Alternator dynamo consists of pulley, nut, pulley washer, fan, starter, rotor assembly, slip rings, starter core, windings, carbon brushes etc.

DIFFERENT TRACTORS AND ITS SPECIFICATIONS

SWARAJ 735 FE

• Engine model: RV-3XM+3A

• HP :35-40

• Engine Type: 4S, DI, diesel

• No of cylinders: 3

• Rated engine speed:1800rpm

• Air cleaner type: 3stage oil bath type

• Cooling system : water cooling

• Clutch: single dry disc friction plate (280mm dia)

• No gears :8+2

• PTO speed :1000rpm

• Brake type: dry disc

• Lifting capacity: 1000kgf

• Battery type :12V, 88A h

• Overall length : 3470mm

• Overall width : 1695mm

• Overall height : 2255mm

• Wheel base : 1950mm

• Weight :1895kg

N*3230 NEWHOLLAND PLUS+

• Engine model: Bharat TREM IIIA

• No of Cylinders : 3

• Hp : 42

• Cooling system : water cooled

• Clutch : diaphragm type single

• Gearbox :constant mesh

• No of gears : 8+2

• Brake : oil immersed multidisc

POWERTRAC – 439

• Hp -: 39

• Engine speed : 2200rpm

• No of cylinders : 3

• Cooling system : water cooled

• Engine type: 4S, DI

• Clutch : single plate

• PTO power : 540/1000 rpm

• Fuel Capacity : 46 l

• Weight : 1900kg

• Gearbox : constant mesh type

• No of gears : 8+2

• Overall length : 3260mm

• Overall height : 2080mm

• Wheelbase : 2010mm

NOTE:

Tractor Swaraj 735 FE introduced by the Mahindra company

Tractor 3130 Newholland Plus+ introduced by the NewHolland FIAT (INDIA) PVT LTD

Tractor Power Trac 434 introduced by the Escorts Ltd

PERIODICAL SERVICE AND MAINTENANCE OF TRACTOR

Every 10 Hours

• Check engine oil level

• Check coolant level

• Drain water and sediment from fuel filter

• Lubricate tie rod ends1

• Lubricate steering spindles1

• Lubricate front axle pivot pin(s)1

• Lubricate rear axle bearings1

• Lubricate clutch pedal and right hand brake pedal

Every 50 Hours

• Check every 10 hours maintenance

• Check transmission-hydraulic system oil level

• Clean and check battery

• Inspect all tires

• Lubricate front axle pivot pin(s)

• Lubricate steering spindles

• Inspect tractor for loose nuts and bolts

• Lubricate clutch pedal and right hand brake pedal.

PRE CHECKS OF TRACTOR

We got a practical section on pre-starting steps of the tractor. Following are the different steps prior to starting.

1. We checked the pre cleaner and remove the dust in it.

2. Oil in the Pre cleaner replaced with SAE 30.

3. We checked whether the water in the radiator was up to the neck level.

4. Oil level in the engine is checked with dip stick.

5. Diesel level in the diesel tank is checked.

6. Free play of the clutch pedal is checked with thump pressure.

7. We checked the free play of the brake. Normally it is 1 inch.

8. Front and rear pressure of the tyre was checked.

9. We checked the different gauges such as fuel gauge, oil pressure gauge, temperature gauge and battery charge gauge

Note:
Radiator cap consist of the pressure relief valve. If the tractor allowed running without the radiator cap, boiling of water occurs inside the radiator. It will increase the temperature of the tractor and affects the cooling system

TRACK WIDTH ADJUSTMENT

The centre to centre distance between the rear wheels of the tractor is called track width. To increase the stability of tractor we have to adjust the track width. To pull more load track width should be increased. Also track width is adjusted according to the row to row distance of any crop and the implement size.

There are mainly three types of track width adjustments for a tractor.

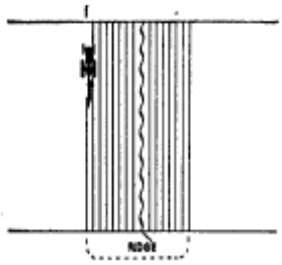
1. Inverse the disc
2. Place bolt outside of the disc
3. Place bolt inside of the disc

The initial track width noted was 1.40m. Instead of inversing the disc we had interchange the rear wheels of the tractor in such a way that both the rear wheels have the same design as before. That time the track width was 1.80m. Then we had removed the bolts, inversed the discs and then replaced the bolts. Thus the track width was changed to 1.64m. Instead of placing the bots inside we had reversed the rear wheels after doing the second step and we got a track width of 1.44m. When we had completed the track width adjustment we replaced the rear wheels as before.

Ploughing methods

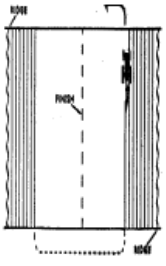
Gathering:

In this method plough works round a strip of ploughed land. Ridge is formed exactly midway between the two side boundaries. This method is used if the field has lower elevation in the centre.



Casting:

Whenever a plough works round a strip of unploughed land it is said to be casting. The tractor with the plough turns to the left each time. A trench will be left in the center in the end .This method is used in fields having higher elevation in the center.



GENDER FRIENDLY EQUIPMENTS AND HARVESTING EQUIPMENTS

HAND WHEEL HOE

This is a horticultural implement which is used for intercultural operations and is suitable for all row crops. It weighs 5 to 6 kg and has a capacity of 0.30 to 0.40ha/day. The equipment has a weeding efficiency of 59 to 82%. It is operated using manual power source and costs rupees 1080.

DRY LAND WEEDER

This is a horticultural implement which is used for intercultural operations and is suitable for all row crops. The overall dimensions (mm) of the equipment is 1100*650*1050(L*B*H). It weighs 3 kg and has an output 0.05 ha/day. Dry land weeder has a working width of 120 mm and has got diamond shaped pegs with straight blade. It cost approximately 360 rupees.

THREE TINED HAND HOE WEEDER

Three tined hand hoe weeder is used for intercultural operations and is suitable for all row crops. It is operated using manual power source. The overall dimensions (mm) of the equipment is 1750*240*160 (L*B*H). The equipments weighs 1.8 kg and has an output of 0.001 to 0.009 ha/hr. It has a working width of 140 to 157mm and a working depth of 21 to 34 mm. The equipment has a weeding efficiency of 59 to 82%. The cost of operation is 990 to 1600 rupees per hectare. It cost approximately 300 rupees.

STAR WEEDER

This is a horticultural implement which is used for intercultural operations and is suitable for all row crops. It is operated using manual power source. The overall dimensions (mm) of the equipment is 1400*250*850 (L*B*H). It approximately weighs 3-5kg and has an output of 0.025ha/hr. Star shaped and notched disc types of rotors are used. Straight blade type cutting blade is used. It costs approximately 400 rupees.

CONO WEEDER

This is a horticultural implement which is used for intercultural operations and is suitable only for paddy row crops. It is operated using manual power source. The overall

dimensions (mm) of the equipment is 372*4500 (W*H). The equipments weighs 5 to 6 kg and has an output of 0.18 ha/day with 2 rotors. It costs approximately 1180 rupees.

GROUNDNUT DECORTICATOR FOR WOMEN

This equipment is used for separating kernels from groundnut pods and is suitable only for groundnuts. It is operated using manual power source. The overall dimensions (mm) of the equipment is 500*270*640 (L*B*H). It has a concave clearance of 10 to 25mm. The equipments weighs 5.7 kg and has an output of 35 to 40 kg/hr. In this equipment groundnut seeds of size 45*9mm can be used. In groundnut decorticator the percentage of broken kernels is 2.30 to 2.65% and total grain loss is 2.30 to 2.65%. Shelling efficiency is 93 to98%. It costs approximately 900 rupees.

Fig. Groundnut decorticator manufactured by CIAE NabiBagh,

MANUAL DOUBLE SCREEN CLEANER

This equipment is used for sieve the grain for cleaning then separate dust etc. It is suitable for wheat, Bengal gram, soyabean cereals etc and during operation the sieves are changed as per grains. It is operated using manual power source. The overall dimensions (mm) of the equipment is 900*600*140 (L*W*H). It has a screen effectiveness of 75.4 to 86.3% and it weighs 14 kg. The top screen size of the equipment varies between 5 to 8.5mm

and bottom screen size 18*20 to 32*20mm. The equipment has a cleaning efficiency of 99 to 99.8% and an output of 150 to 225kg/hr. It costs approximately 900 rupees.

Fig. Manual double screen cleaner

ROTARY TYPE MAIZE SHELLER

This equipment is used for maize shelling. It is operated using manual power source. Rotating pegged plate type action and it has an output of upto25kg/hr. It costs approximately 6200 rupees.

HAND RIDGER/ FURROW OPENER

This equipment is used for making furrow of seeds in garden and is suitable for placing the seeds in nurseries and gardens. It is operated using manual power source. The equipment has a handle length of 560 mm and blade length of 100 mm with a working width of 30 to 40 mm. It costs approximately 450 rupees.

SELF-PROPELLED RICE TRANSPLANTER

This implement is used for transplanting mat type rice seedling. The power source of the transplanter is 3.7kw (4hp) air cooled diesel engine. The overall dimensions (mm) of the implement is 2410*2130*1300 (L*B*H). It has fixed opening type finger with 8 rows and weighs 320kg. It has a working depth of 20 to 30mm and row spacing of 238mm with hill to hill spacing of 100 to200 mm. It has a working speed of 1.5 to 2 kmph and 8.24 kmph on road with an output of 0.13 to 0.2 ha/hr.

Fig. Self- propelled rice transplanter

SUNFLOWER THRESHER

The sunflower thresher was designed as a hold-on, pedal operated, light weight and low cost machine. The threshing efficiency and cleaning efficiency are 100 and 96 to 98% respectively. The output capacity of machine is about 40kg/hr.

Fig. Sunflower thresher

FERTILIZER BROADCASTER

This is used for broadcasting of fertilizer and is suitable for granule fertilizers. It is operated using manual power source. The overall dimensions (mm) of the equipment is 450*410*280 (L*B*H) and it weighs 5kg. It has a hopper capacity 10kg with an adjustable opening metering system. The output capacity of broadcaster ranges between 0.8 to 1.0 ha/hr. It saves the labour and time by 60% and cost of operation by 55%. It has an approximate cost of rupees 1000 to 1300 and is developed by PAU, Ludhiana.

REAPER BINDER

It is used for harvesting and binding of grain crops in a single operation. It is operated using 10.2hp diesel air cooled engine. It has got four forward and one reverse gear with a fuel consumption of 1litre per hour. The reaper binder has a cutting width of 4 feet and height of cut 5to 7cm. It requires 1 spool of rope per acre. The overall dimensions (cm) of the

equipment is 360*185 (L*B) and it weighs 4 quintal. It has a field capacity of 1 acre/hr. The main parts include crop collector, fingers, cutterbar, pitman shaft.

Fig. Reaper cum binder

COMBINE HARVESTER

It is used for harvesting, threshing, cleaning, separation and storage in a single operation. There are two types of combine harvester, self propelled and mounted type. Panesar TDC 513 was operated, where TDC represents Tractor Driven Combine, 5 for number straw walker and 13 size of cutterbar (expressed in feet). It has chasis dimension of 46" (1168mm) with 5 number 5 steps straw walker. Combine has a cutter bar width of 141" (3581mm) and height of 2" to 41" (55 to 1050 mm). The main parts of combine:

- Reel: feeds crop to cutter bar
- Cutter bar: cut crops
- Auger: transport of crops. Its of three types, right auger (right to centre), left auger(left to centre) and feeding unit.
- Conveyor
- Peg type thresher: it has an rpm of 600 to 800rpm

- Concave clearance: 10 to 15mm
- Threshing drum flywheel
- Straw walker: it is five in number
- Sieve and blower
- Auger: convey grains to storage drum
- Elevator: between drum and auger.
- Air compressor: for cleaning and filling tyre

Fig. Combine harvester PANESAR TDC 513

PLANT PROTECTION EQUIPMENTS

Few of the plant protection equipment's are discussed below

Hand compression sprayers

The compressed air sprayer consists of an air pump mounted in an airtight chamber, which is filled three quarter with spraying material. The pressure is developed by pumping air into the tank and spray is forced out under pressure. Here no continuous cranking of handle, so spraying is non-uniform. The tank capacities are up to 14 litres.

Rocking sprayer

This type of sprayer has an externally placed horizontal centrifugal pump. It is a hand operated sprayer. Due to the spherical shape of pressure chamber more and more pressure can be created inside the chamber.

Knapsack sprayer

The knapsack sprayer is provided with a vertical reciprocating pump inside tank. Here the spraying handle is fixed on one side. The side fixed pump is a drawback as the whole sprayer sags to one side. Due to this, the load is not equally spread. To overcome this, backpack sprayers are introduced. Tank capacity varies up to 23 liters.

Backpack sprayer

This is the modification of knapsack sprayer. Here continuous cranking can be done, thus achieves uniform spraying. The pump is centrally fixed and the length is reduced. The spraying handle can be shifted from left to right. The main drawback is, the pump and pressure chamber is inside the tank, which restricts the ease of repair and maintenance. These defaults are erased by hi-tech sprayers.

Power weeder

• The equipment consists of five hp light weight diesel engine mounted on frame. The engine power is transmitted to the grounds wheel and rotary through gear reduction unit.

• Used for weeding and earthing of standing plants like sugarcane, cotton, maize banana and cocoanut

• Wheels spacing and depth are adjustable.

• Width of coverage is 35-37 cmand output is .06 ha/h and .14 ha/h in weeding.

• It cost around Rs. 50000/- & developed by CIAE. 30

Orchard sprayer

• The sprayer consists of fluid tank, rotary atomizer with hydraulic motor and a flow control valve. The atomizer blows the chemical upto a max swath providing uniform and efficient spraying pattern.

• Uniformity at max height also.

• Volume can be adjusted.

• It is operated by 35 hp tractor.

• Output is 0.20- 0.50 ha/h with 3 m penetration of droplets inside the plant canopy.

Self-propelled high clearance sprayer

• The machine consists of two rear steered wheels and two front lugged wheels which is powered with a 20 hp diesel engine thorough a gear box, tank, hydraulic pump and boom fitted with 15 nozzles.

• Its cost of operation is around Rs. 35 /ha.

• Effective field capacity & field efficiency are 1.6-2.0ha/h and 70-80 % respectively.

Electro- static sprayer

• Agricultural sprays are charged by applying induction potential up to 10 KV. These charge droplets experience an electro static force in addition to the normal gravitational and air drag forces which tend to attract the drops to the target plant and result in greater deposition of sprays even underneath the surface of the leaves where insect population is higher.

• Good result at lower application rates thus saves cost of spray material.

• It requires special pesticides which do not chemically disintegrate at such high voltage ultimately limits its large scale application.

SOIL HEALTH CARD SCHEME

Soil is a dynamic natural body, contains air, water and nutrients. It is a perfect organic media for plant growth. Soil contains 18 essential elements needed by plant growth. They are C, H, O, N, P, K, Ca, Mg, S, Zn, Fe, B, Ca, Mo, Mn, Cu, Na and Si. From this carbon, hydrogen and oxygen are the basic nutrients which compose 96% of the plant dry matter. Major or macro nutrients can be classified into primary and secondary, Where N, P and K comes under primary (highly mobile elements in plant) and Ca, Mg and S are the secondary (carriers). Zn, Fe, B, Ca, Mo, Mn, Cu, Na and Si are the micronutrients which are catalyst in nature.

Nutrients	Functions	Deficiency
N	Vegetative growth(leaves, shoot, stem) Delaying maturity of fruits	General yellowing of older leaves(bottom of plant).The rest of the plant is often light green
P	Root growth and development Found in flowers and seeds	Leaf tips look burnt, followed by older leaves turning a dark green or reddish purple.
K	Sugar translocations Maintains fruit size, flavor and color	Older leaves may wilt, look scorched, Interveinalchlorosis begins at the base, Dryness from leaf apex
Ca	Found in leaves as calcium pectate	Irregularly shaped leaves, Causes blossom end rot
Mg	Main constituents of chlorophyll	Older leaves turn yellow at edge leaving a green arrow head shape in the center of the leaf.
S	Improves oil percentage in crops	Younger leaves turn yellow

Soil health card scheme is implemented by government of India and promoted by department of agriculture corporation and farmers welfare.

Soil testing

Soil health card gives the health details of soil tested under following method.

- Mark the entire area in a random way(zig zag marking)
- Take about 10-15 subsoil samples
- Sampling is done in such a way that a V shaped dig is made to a depth of about 15-30cm and that soil is removed
- Dig out the soil parallel to the V shaped dig to a width of 1inch
- Quattring method is used to reduce soil sample quantity
- Sample of 0.5kg is selected for testing

- Sample should contain an information tag having details about farmer, field, crop and soil.
- Sample should not be drawn from the boundaries, pathways, manure fields, water logged areas, fencing areas and high duration shading areas.

SEEDING AND PLANTING EQUIPMENTS

Seeding is the art of planting seeds for proper growth

1. Seeders/ seed drills: seeders maintains the row to row distance in the field
2. Planters: planters maintain the row to row as well as the hill to hill distance

Raised bed planter

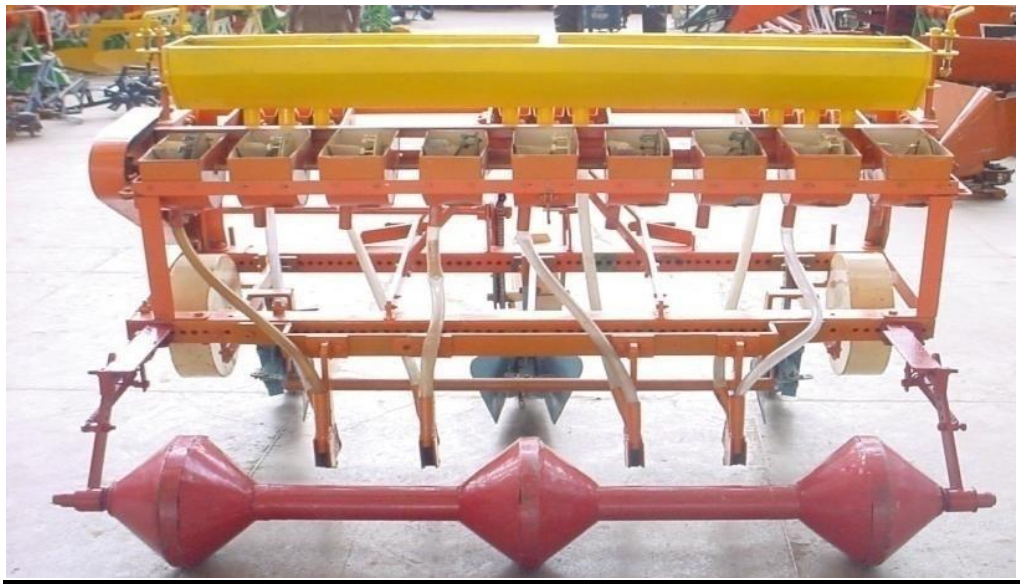


Fig. Raised bed planter

- This is helpful for irrigation and easy cultivation.
- 35 hp or above tractors are needed for its operation.
- Makes bed and simultaneously plants on the bed.

Tractor mounted pneumatic planter

- This is operated with tractor p.t.o
- High quality seeds are necessary

- Initial cost is high
- Suitable for sowing ground nut, cotton, maize, bhindi, soybean, sunflower etc.
- 35 hp or above tractor is needed
- Field capacity = 0.5 to 0.6 ha/h

Seed drill calibration Steps

- Find out the total working width
  = number of furrow openers * distance between two openers
- Take the drive wheel circumference
- Attach the drill to tractor and rotate the drive wheel and calculate the area covered in 10 revolutions
  = working width * circumference of drive wheel * number of revolutions
- Collect the seeds fallen in each furrow in 10 revolutions and take the weight
- Measure the distance covered in 10 revolutions
- Seed rate per ha (kg) = (weight of seeds * 10000)/ area covered

Plastic mulch laying machine

- Mulching helps in conserving the soil moisture as well as weed control
- Plastic mulching is a high-tech technology which uses poly ethylene films instead of organic residues
- For this purpose mulch laying machine is used in the field
- This is suitable for row crops like chilli, potato, capsicum, tomato etc.
- 35- 45 hp tractor is required for its operation
- Field capacity = 0.16 ha / h
- Cost of the machine = Rs. 35000/-
- Developed by CIAE

TILLAGE IMPLEMENTS

We got familiarize with different primary and secondary tillage implements such as mould board plough, disc plough, cultivator, reversible mould board plough. We also had tractor driving practice with these implements.

1. **Mould board plough**

   It is a primary tillage implement used for tillage operation. Its main purposes are cutting the furrow slice, lifting the soil, turning the furrow slice and pulverize the soil. Its depth of cut is usually 20-30 cm. it can be used in hard soils but not suitable for stony soil.

   Parts: Main frame, share, mould board, land side, frog, tail piece

   Adjustments of Mould board plough: for proper penetration and efficient work some clearances are provided in the plough, these clearances are called suction of the plough. There are two types of suctions such as vertical suction and horizontal suction. Vertical suction (vertical clearance) is the maximum clearance under the landside and the horizontal surface in the working position. It helps the plough to penetrate into the soil to a proper depth. Horizontal suction (horizontal clearance) is the maximum clearance between the land side and horizontal plane touching point of share at its gunnel side and heel of the land side. It helps the plough to cut the proper width of furrow slice. Both these suctions are usually 5-15 mm.

   Note: A two bottom MB plough is usually attached to a 35-45 hp tractor.

   Usually the tractor will be in low 1^{st} or low 2^{nd} gear with a forward speed of 2-4 kmph. Plouhing can be done by casting or gathering.

2. **Disc plough**

   It cut, turns and in some cases breaks furrow slices by means of separately mounted large steel discs.it can be used in hard soil ,sticky soil, stony soil, rooty soil, as well as in stumpy soil without much danger of breakage. Disc ploughs are commonly used than MB plough.

   Parts: main frame, concave disc, scrapper, furrow wheel, spring

   Disc angle: it is the angle at which the plane of cutting edge of the disc is inclined to the direction of travel. It varies between 40-45º. By adjusting disc angle width of cut can be adjusted.

Tilt angle: It is the angle at which the plane of cutting, edge of the disc is inclined to a vertical line. It is usually 15-22º.

Note:Usually the tractor will be in low 1st or low 2nd gear with a forward speed of 2-4 kmph. Plouhing can be done by casting or gathering.

3. Cultivator

It is a secondary tillage implement for inter cultivation with laterally adjustable tines or discs to work between crop rows. This can be used for seed bed preparation and for sawing with seeding attachments. It stirs the soil and breaks the clods. Usually tractor drawn cultivators are of two types, depending upon the flexibility and rigidity of tines they are cultivator with spring loaded tines and cultivator with rigid tines.

Parts: main frame, spring, tyne, shovel.

4. Rotovator

Rotovator is used as primary as well as secondary implement.it helps to conserve previous soil moisture and pulverizes soil up to 6 inches of depth. It is tractor mounted fully pto operated implement. It is used for both wet and dry land cultivation. These are used for early seed bed preparation. While in operation rotovator creates negative draft so less slippage. Rotovators are available in 5ft, 6ft, 7ft and 8ft width. There are 30 blades in a 5ft wide rotovator and as the width increase by 1ft the number of blades increases by 6.

The blades are 'L' shaped. Depth of operation is adjusted by skid and safety bolts are provided to safe guard the implement while interfering with stone etc. when the pto shaft rotates at 540 rpm a reduced speed of 200-300 rpm is obtained at the rotor shaft and for heavy duty rotovatorspto speed must be 1000 rpm. Cost of rotovator is about 70000-150000.

Parts: pto drive shaft, primary reduction gear box, secondary reduction gear box, rotor shaft, skid, tail board.

CONCLUSION

The four week training program at Southern Region Farm Machinery Training and Testing Institute, Garlidinne, Andra Pradesh, was a resourceful and informative one.

There were excellent practical classes on the dismantling and assembling of single cylinder engine which made us more aware about the workingof different parts of the engine. The various clearances, ovality and tapperness of the cylinder etc. were measured for a multicylinder engine which imparted us more practical experiences in handling the engine. Also, we were given excellent theoretical as well as practical classes on the five important working systems of tractor engine namely electrical system, cooling system, fuel system, lubrication system and air intake system.

We got an opportunity to acquire more practical knowledge on the various farm machinery equipments, their practical uses and available adjustments. We were given driving practices on various farm machines such as tractors, power tillers, transplanters etc., so that we became confident in dealing them both in field as well as in road conditions. The complete servicing of different tractors including greasing, changing the engine oil, replacing oil filter etc were also practiced. Toe in, toe out, king pin inclination, track width etc. of the tractors were measured by us for the first time

In a nutshell, the institute has given us tremendous knowledge and practical experience in the field of farm machinery and equipments. As an Agricultural Engineer, the training program from S.R.F.M.T.T.I. was very much effective and quite worthy for us.