Training Programme
on
Fishing boat engine
operation and maintenance

TRAINING MANUAL

Department of Fisheries and Fishermen Welfare

Fisheries Staff Training Institute
Chennai-600035

Fishing boat engine operation and maintenance

INDEX

Introduction

Engine is a machine which converts heat energy into mechanical energy (work).The heat energy is obtained by burning a fuel and it is supplied to the engine. According to the method of combustion, they are classified into two groups.

1. Internal combustion engines

2. External combustion engines

Internal combustion engines:

In internal combustion engines, the combustion of fuel takes place inside the engine cylinder. Then, the heat energy is transferred to where the work to be done. Examples: Diesel engines, petrol engines, gas engines, gas turbines etc.

External combustion engines:

In external combustion engines, the combustion of fuel takes place outside the engine cylinder. Then, the heat energy is transferred to where the work to be done. Examples; Steam turbines used in thermal power plant and steam engines used as in railway engines.

Classification of internal combustion engines

I.C. engines may be classified into several groups according to

1. Number of strokes/ cycle:

a. Two stroke cycle engines

b. Four stroke cycle engines

2. Operating thermodynamic cycle:

a. Otto cycle engines

b. Diesel cycle engines

c. Dual combustion engines

3. Type of fuel used

a. Petrol engines

b. Diesel engines

c. Gas engines

4. Type of ignition method

a. Spark Ignition (SI) engines

b. Compression Ignition (CI) engines

5. Arrangement of cylinders

a.Vertical engines

b. Horizontal engines

c. V - type engines

d. In – line engines

e. Opposed cylinder engines

f. Radial engines

6. Number of Cylinders

a. Single cylinder engines

b. Multi cylinder engines

7. Type of cooling system

a. Water cooled engines

b. Air cooled engines

8. Lubrication systems

a. Petroil or mist lubrication system

b. Wet sump lubrication system

c. Dry sump lubrication system

9. Field of application

a. Stationary engines

b. Mobile engines

c. Portable engines

10. Working speed

a. low speed < 500rpm

b. medium speed 500-1200 rpm

c. high speed 1200-2500 rpm

d. very high speed > 2500rpm

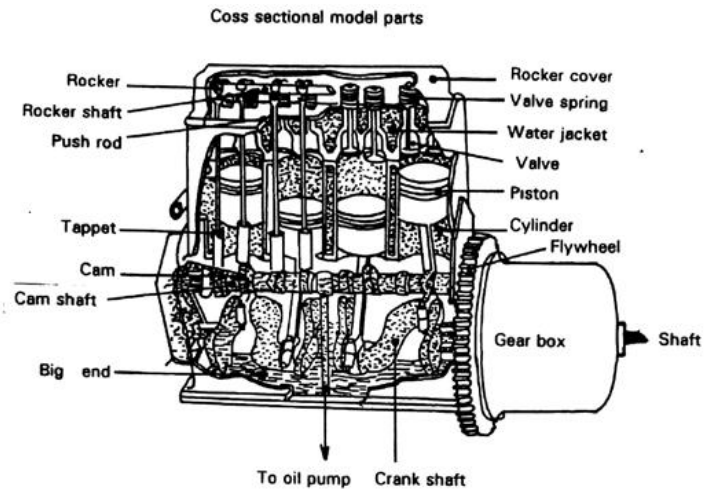
Starting system

a. Hand starting < 60HP

b. Electricity starting 60 HP to 200HP

c. Air starting > 200HP

Major component of an IC engine:



The major components of the above engine are divided into 3 compartments

1. Top –

Cylinder head – Valves, valve actuating mechanism , Rocker arm, Rocker shaft, Spark plug or Fuel injector, Push rod, water jacket, Thermostat, Fulcrum, Cooling system

2. Middle –

Cylinder block - Piston, Camshaft, Piston rings, Fly wheel,

3. Bottom -

Crank case – Sump (oil pan) crank shaft, connecting rod, Bed plate, Oil filter,

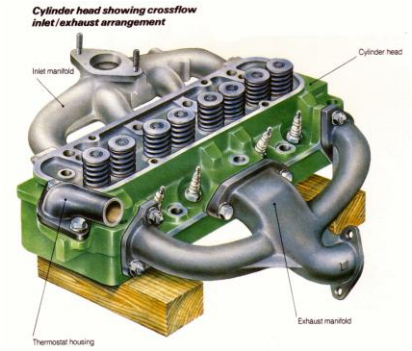
4. Fuel supply system

A cylinder block is fitted with cylinder head on the top and crankcase at the bottom.The piston carrying rings reciprocates inside the cylinder. The reciprocating motion of the piston is converted into rotary motion of the crankshaft through a connecting rod and crank. The crank pin while its larger end is connected to the crankshaft. The cylinder head is provider with inlet, exhaust valves and spark plug or injector. The inlet and exhaust valves are actuated by camshaft through springs to close or open the valves.The crankcase is provided with oil pan at bottom containing lubricating oil. A water jacket is provided around the cylinder to carrying away the heat from cylinder.

a).Cylinder block:

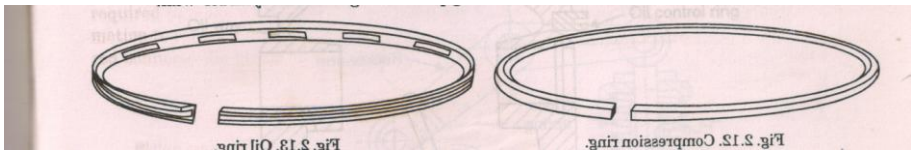
Cylinder block forms the main body of an engine. It contains cylinder to accommodate a piston. It houses crank, camshaft and other engine parts. It is provided with openings for valves and water jackets. Around the cylinders, there are passages for the circulation of cooling water. Generally it is made of a single casting and materials used are grey cast iron or aluminum and its alloys.

b).Cylinder head



Cylinder head is also a single casting bolted to the top of cylinder block. It consists of combustion chamber, spark plug or injector and valves. Passages or jackets are provided for the circulation of cooling water. It is usually made with grey cast iron or aluminium alloys. A gasket is placed in between the cylinder head and cylinder block to prevent leakages caused by compression.

c.)Cylinder liner



Cylinder liner

Cylinder liner are made in the form of barrel or sleeve from special alloy iron containing silicon, manganese, nickel and chromium. It is fitted into the cylinder bore. It provides wear resisting surface for the cylinder bore. They are two types namely dry liners and wet liners.

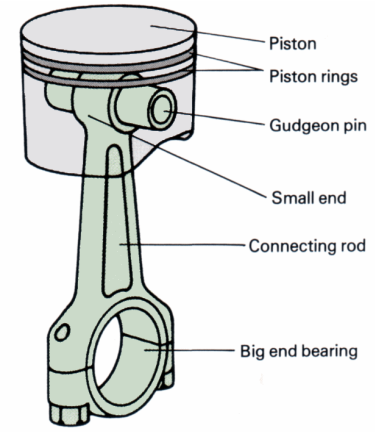
i) Dry liners

Dry liner is made in the form of barrel. They are not directly touch with cooling water and hence it is called as dry liners.

d. Crankcase and oil pan

Crankcase is cast integral with cylinder block or cast separately and it is attached to the block at the bottom. It is connected to the oil pan or sump containing lubricating oil. A drain plug is provided at the bottom of the oil pan to drain out the lubricating oil. It is made with pressed steel sheet.

e. Piston



It is a cylindrical part and its closed at the top and opened at the bottom. The piston is made crown on top side to deflect the charge. Three grooves are made on the top side to deflect the charge.Three grooves are made on the circumference of piston to carry the piston rings. Generally it is made with cast iron, cast steel, aluminium alloy and chrome nickel alloy.They are produced by casting or forging.

f. Piston Rings

Piston rings are inserted into the three grooves of the piston to maintain a good seal between the piston and cylinder walls. The materials used for piston ring is alloy cast iron. They are two types namely.

(i) Compression rings

Compression rings provide air tight seal to prevent leakage of burnt gases into crankcase. Each piston is provided with two compression rings.

(ii) Oil rings:

Oil rings are used to scrab excess oil from the cylinder walls. It is inserted into the lower groove of the piston. It has a radial passage or slot to scrab the excess oil from the cylinder walls to oil sump.

g. Connecting rod

It is used to convert reciprocating motion of the piston into rotary motion of the crankshaft. It has two ends namely small end and bigger end. The small end is connected to the crankshaft. The big end is always made with split. It is made of carbon steels, aluminium alloys and nickel alloy steels.

h. Crankshaft

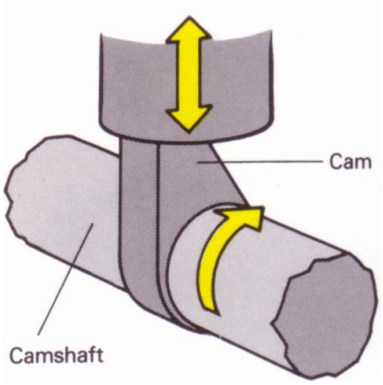
Crankshaft is the engine component from which power is taken over.The crankshaft is supported by minimum two bearings. Counter weights are also provided to keep the system in perfect balance.

It is made with cast steel, forged steel and any other het treated steel. It is manufactured by drop forging or casting.

i) Flywheel

It stores energy during power stroke and release as when required during other strokes. Thus it maintains a constant output torque from the crankshaft. It is generally made of cast iron.

j) Camshaft



Camshaft is used to operate the valves of the four stroke engine. It is connected to the crank shaft through timing gears or by timing chain.

k.) Valves

There are two valves for each cylinder of an engine namely inlet and exhaust valves. Fresh charge enters into the cylinder through inlet valve. The burnt gases are forced out of the engine through exhaust valve. The opening and closing of the valves are controlled by the cams provided on the camshaft.

Timing gear

Timing gear are a set of gears housed on the front or back side of the engine by which rotary motion is transmitted from the crank-shaft to the other operational parts such as cam-shaft, governors, fuel pump etc. and some accessories like water pumps.

Gudgeon Pin or Piston Pin

Gudgeon Pin is the cylindrical connecting pin which connects the connecting rod with the piston.

Rocker arms

It is fitted in a fulcrum on the cylinder head. The shaft of the fulcrum is called rocker arm shaft. The rocker arm has holes inside to allow passage of lubrication oil to lubricate contact surface between push rod and adjusting screw and the rocker arm face and the valve stern. the lubrication is effected by force feed lubrication.

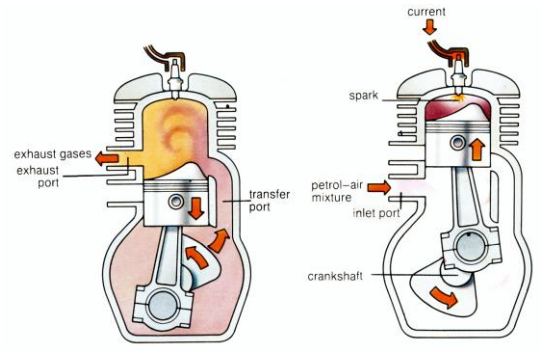
Two stroke cycle diesel (CI) engine

In a two stroke engine, the working cycle (i.e., suction, compression, expansion and exhaust) is completed in two strokes of the piston or one revolution of the crank shaft.

Constructional details

A piston carrying rings reciprocates inside the cylinder. The piston is connected to the crankshaft through a connecting rod and crank. Instead of valves as in four stroke system, there are three ports namely inlet, exhaust and transfer ports are cut in the walls of the cylinder. The piston is made with crown on top side which deflects the fresh charge upwards and forces out the burnt gases through exhaust port. A fuel injector is provided on the cylinder head to atomize the fuel (diesel).

Strokes of two stroke engine



Upward stroke

During the upwards stroke, the piston moves from BDC to TDC.

- During this movement, following events are taken place

(i)First the piston closes the transfer port

ii)Piston then closes the exhaust port

iii)The charge(Petrol &air mixture) already in the cylinder is compressed by the piston(Cylinder compression)
iv)When the piston is nearly at TDC, the charge is ignited by a spark plug and combustion taking place
v)At the same time, the lower edge of the piston opens the inlet port and fresh charge enters into the cranks case.

Downward stroke

Due to the combustion of charge, expansion takes place which pushes the piston downwards

(i) During this movement, the exhaust port opens first. Hence the burnt gases escape to the atmosphere

ii)The fresh charge already filled during up ward stroke through inlet to the crank case is compressed(Crank case compression)

(iii) After some time, transfer port opens which admits the fresh charge from crank case to the engine cylinder (top of the piston)

iv)Finally, piston closes the inlet port

(v) Due to the crown of the piston, the fresh charge goes to the top of the cylinder. Hence it forces out the remaining burnt gases through the exhaust port. This action is known as scavenging

Two stroke diesel engine

Upward stroke

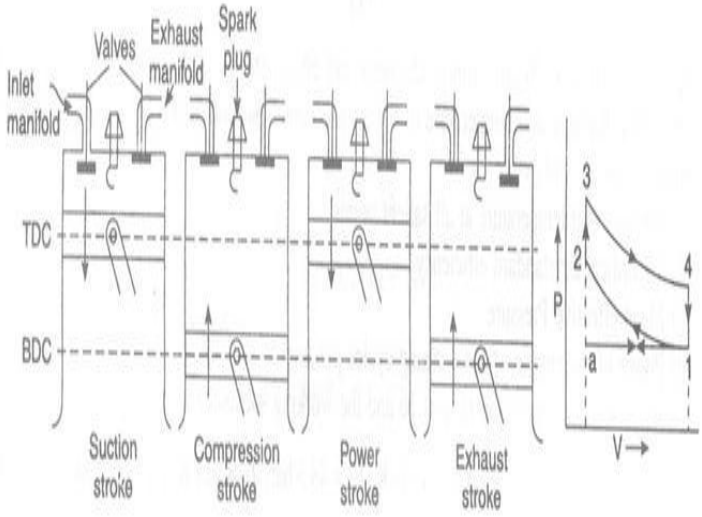
During the upward stroke, the piston moves from BDC to TDC. During this movement, the piston closes the transfer port first and then exhaust port closes and air already in the cylinder is compressed by the piston. When the piston is nearly at the top dead centre, the spark plug ignites the fuel air mixture. At the same time, the lower edge of the piston opens the inlet port and fresh fuel mixture air enters into the crankcase.

Downward stroke

Due to the combustion of fuel, expansion takes place which pushes the piston downwards. During this movement, the exhaust port opens first. Hence the burnt gases escape to atmosphere. After some time, transfer port opens which admits the fresh air from crank case to the engine cylinder (top of the piston) and finally the piston closes the inlet port. Due to the crown of the piston, the fresh air goes to the top of the cylinder. Hence it forces out the remaining burnt gases through the exhaust port. During the downward movement of the piston, the charge under pressure enters into the cylinder from crankcase. This action forces the already burnt gases to atmosphere through exhaust port. During this period, both the exhaust and transfer ports are kept open for a short period. Hence there is a possibility of the fresh charge escaping out with burnt gases. The can be avoided by designing a piston with crown on top side.This crown of the piston deflects the charge upward in the cylinder and prevents to escape fresh charge with burnt gases. When the piston reaches bottom dead, the piston moves upwards again and the cycle is repeated. Thus, in a two stroke engine, the cycle of events are completed in two strokes of events are completed in two strokes of the piston or in one revolution of the crankshaft

Working principle of Four Stroke Petrol and Diesel engine

Four stroke Petrol Engine



Suction Stroke

In the beginning of suction stroke the piston is as TDC and its starts to move towards BDC. Inlet valve is open and exhaust valve is closed. As the piston moves downward, vacuum is created inside the cylinder. The inlet manifold is connected to carburetor on other, the pressure there is atmospheric. Thus, the excess manifold is connected to carburetor on other side, the pressure fuel gets mixed with air and it provides (fuel + air) mixture to the cylinder.

Compression stroke

As the piston reaches BDC during suction stroke, it starts to move reached TDC. The volume in the end of compression is the clearance volume. The compression ratio is generally kept from 5 to 10-5. The temperature attained is in range of 250^{o}C to 500^{o}C, shortly before the piston reached the TDC, charge is ignited (2–3) by using spark plug.

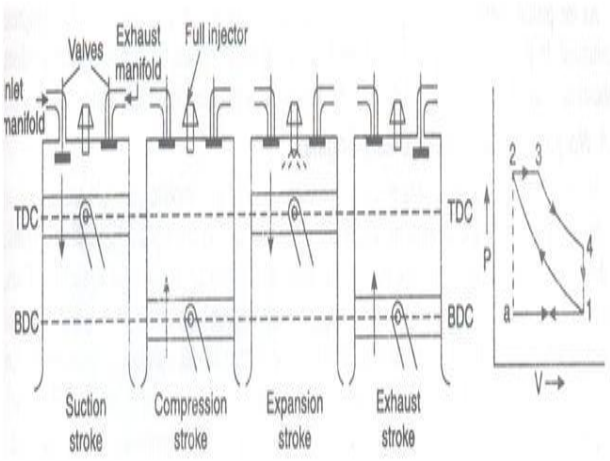
Power stroke

When the charge gets ignited, the hot gases, which are products of combustion, starts to expand. They thrust the piston downwards from TDC to BDC. Thus, power is obtained by piston during this stroke.The flywheel also gets energy during this stroke and provides in other three strokes. During this stroke both valves remain closed. In the end of expansion stroke heat is rejected at constant volume condition process.

Exhaust stroke

During this stroke and gases are removed from the cylinder. The piston moves from BDC to TDC, thrusting the gases to go out of the cylinder through exhaust valve which is open. The inlet valve remains closed. The process of removing gases from the cylinder is also termed as scavenging. In the end of exhaust stroke piston reaches to TDC and the cycle get completed. In case of horizontal engine, TDC is called inner dead centre (IDC) and BDC is called Outer Dead Centre (ODC).

Four stroke Diesel engine



Suction

During this stroke the piston moves from TDC to BDC. The inlet valve remains open and exhaust valve is closed. The air at atmospheric pressure is drawn into the cylinder due to pressure difference through air filter

Compression

During this stroke the piston moves from BDC to TDC, Both valves remain closed. The compression of air takes place. The compression ratio is kept 12 to 25 generally. It helps to increase the temperature of air sufficiently high to auto-ignite the fuel. The fuel is injected as soon as the piston reaches at TDC from fuel injector at very high pressure. As the piston starts moving downwards from TDC, the fuel starts burning at constant pressure as shown by line

Power stroke

At point 3, fuel supply is cut-off. The hot gases of the cylinder now expand and thrust the piston to move towards BDC. Thus, power is obtained by piston and flywheel during this stroke. Both valves remain closed during this stroke. In the end of expansion stroke the heat is rejected at constant volume.

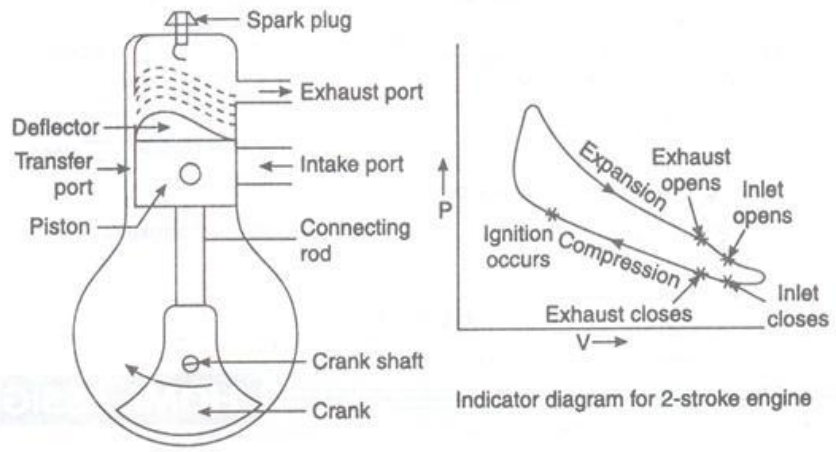
Exhaust stroke

During the stroke, the piston moves from BDC to TDC and exhaust valve gets open while intake valve remains closed. The upward moving piston thrust the gases to move of the cylinder

Working principle of Two Stroke Petrol and Diesel engine

Two stroke Petrol Engine

Design of two-stroke engine was given by Dugald-Clerk in 1878.In this engine, suction and exhaust strokes are eliminated. Instead of valves, ports are used. The exhaust gases are driven out of the cylinder by the fresh charge entering the cylinder

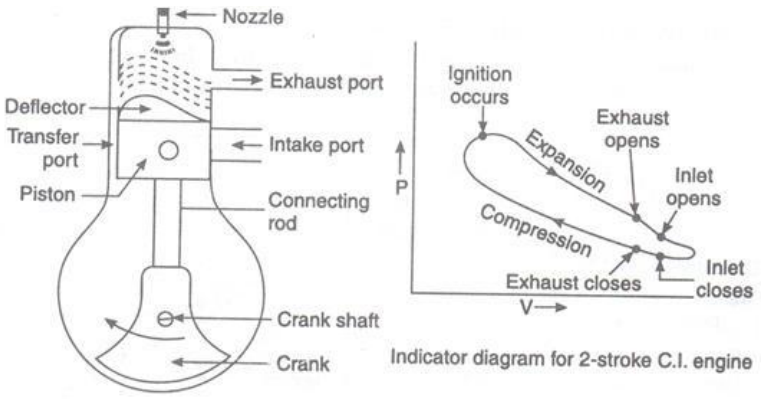


Indicator diagram for 2-stroke engine

All the events in the two-stroke cycle are completed in two strokes. In two strokes crank shaft makes one revolution, so the cycle is completed in one revolution of crank shaft. The control of admission and exhaust in the engine is by ports; which open and close by movement of piston.The charge enters the crankcase through inlet port due to pressure difference when the piston is moving upward for compression.The crankcase works as an air pump as the piston moves up and down.The charge is compressed by the pumping action of the piston due to the design of crankcase.The partially compressed charge is supplied to engine cylinder through transfer port from the crankcase.As the piston continues to move upward, exhaust and transfer port get closed and the compression is continued. In the end of

compression the spark is created which ignites the charge and the products of combustion thrust the piston from TDC to BDC. This cycle is repeated again and again.

Two stroke Diesel Engine



TwoStrokeDieselEngine

Upward stroke

In case of two stroke diesel engine all the processes needed to complete the cycle are carried out in two strokes of piston. In the upward motion of the piston the suction takes place in the closed crankcase and the air enters the closed crankcase through the plate valves with get opened due to suction. Thus, for suction no extra stroke is required.This air is supplied to cylinder through transport port, and compression starts in cylinder when all valves get closed. As the piston further moves upward compression continuous. Just before the end of compression the fuel is injected and as soon as piton reached TDC fuel gets simultaneously being burnt for some part of downward motion of piston after reaching TDC.

Downward stroke

On the downward stroke of piston the products of combustion, maintained at very high pressure inside the cylinder, start to expand to provide power and simultaneously, air below the piston inside the crankcase starts to compress. The compression increases the pressure, so plate valves get closed. This combustion is released to atmosphere.

A little later the transport port gets uncovered and supplies the partially compresses air to cylinder.This air is deflected by deflector to push the exhaust gases to move out of cylinder, the process is called scavenging.The exhaust continues till the piston reaches BDC, therefore no additional stroke is required for exhaust, and the two strokes are sufficient to complete the cycle.

Starting system:

Important method of starting a marine diesel engines are:

Hand starting:

- It is usually use on small engine upto 50 HP. The starting handle is connected directly to the crank shaft or cam shaft extension
- The decompressor is fitted to assist the starting operation

Electrical starting:

- It is most common s.s use on high speed multicylinder larger engines
- An electric motor is fitted with a pinion gear which meshes with the toothed ring on the engines flywheel and turns when the starter switch is operated

Air starting:

- The compressed air is use to start the engine
- Air under pressure is admitted into the cylinders, either by means of separate compressor in the case of larger engine or the engine itself taking care of charging as in smaller engines

Fuel injection system:

- To provide the right amount of fuel at the right moment and in a suitable condition for the combustion process
- Injection of fuel is achieved by the location of cams on a camshaft.

- Main components of the FIS are fuel tank, fuel feed pump, fuel-injection pump, fuel injectors and pipe-lines including leak off and excess fuel-return pipes.
- Fuel is stored in fuel tank from which it is deliver to the fuel feed pump via an inlet valve
- Fuel feed pump is mechanically operated on injection pump cam shaft or engine cam shaft
- Fuel injection pump delivers the fuel oil under pressure to the injector on the cylinder head. It supplies the fuel in quantities to match with the amount of power required
- Fuel filter – wire gauge, cotton cloth, felt or some special type of impregnated paper
- Fuel injector is a spring controlled valve inserted into the engine cylinder head which allows the fuel under pressure from the injection pump to enter the cylinder in the form of a fine spray
- The choice of pressure for a particular engine is governed by its design, application and size of the nozzle hole
- The injection pressure of fuel ranges between 112-189 kg/cm2 in high speed engine to 210-420 kg/cm2 in large slow speed marine engines

Lubrication system:

- Main function of lubrication is to reduce wear and tear of moving parts
- It is also use as a coolant and cleaner
- L.o is stored in sump place beneath the crank case
- The oil is drawn from the sump through a strainer to a pump
- After allowing it to pass through a filter, it is sent through a cooler before entering the engine and then distributed to various branch pipes

- An alarm at the end of the distribution pipe ensures that adequate pressure is maintained by the pump
- After use, the lubricating oil drains back to the sump for reuse

Cooling system of engine:

- Due to combustion, the temperature in the engine cylinder increases considerably
- Thus cooler are an essential part of the marine diesel engines
- The usual coolants use are F.W, S.W or air

Liquid cooling:

- It is done by f.w. or s.w
- Seawater cooling is the most inexpensive method of cooling
- S.w. is picked up by a pump through the sea cock on to the engine and returned overboard with the exhaust or separately. However, corrosion is a major problem
- The scale formation takes place in the cylinder block leading to blocking
- F.w is use for cooling and the heated f.w. is cooled by seawater either using a heat exchanger or a keel cooler
- F.w circulates inside the engine and gives up heat to s.w. in the heat exchanger
- It is more expensive
- In case of leakage, f.w. and s.w. mix up
- Keel cooler consist of long coil of pipe fixed outside and underneath the hull of the boat
- The f.w. is led to this coil where it is cooling by surrounding s.w.
- Suitable for small boats and some engine

Air cooling:

- Air circulates inside the engine to absorb the heat
- Air is forced round the cylinder by a mechanical blower or fan driven by the engine
- It is suitable for beach-landing craft as it is easy to install in open boat
- More reliable needing very little maintenance
- It is less expensive too as no heat exchangers are needed
- However, main drawbacks are that its use in confined to small engines and it is noisier than the liquid-cooled engines

Super charging Vs. Turbo charging

S.C. is a system of inducting more air into the engine cylinder at high pressure. Air is forced at 0.14-0.56 kg/cm2 of pressure depending on the desired output. It is also called as Boosting. Main objective of s.c. is to increase the power output of the engine for the same size of cylinder. It is possible to reduce the bulk of the engine to fit into a limited space

Advantages:

a) Increase in thermal efficiency

b) Reduction of fuel consumption to about 2%

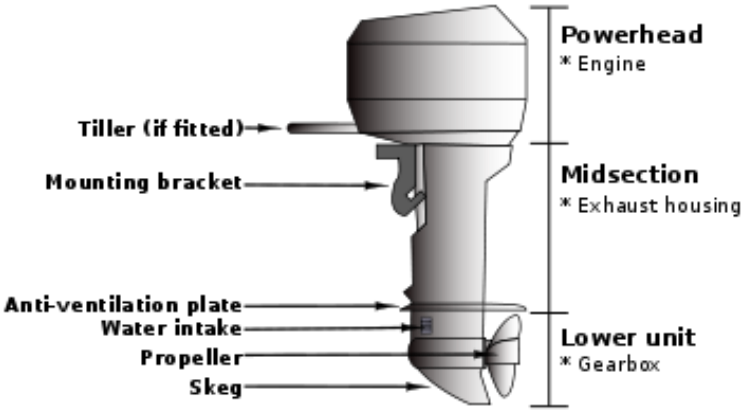
c) More power output for same cylinder size

- These are mainly achieve with better combustion because of increased turbulence, better mixing of the fuel and air, and increase mechanical efficiency

T.C is applicable only to slow-speed engines and preferred for trawlers which need more power from a smaller volume

Out Board Engine VsIn Board Engine

- OBE is a machine which is fixed outside of the hull of the boat and which drives the propeller and moves the boat
- Integral mechanism
- Has an internal combustion engine and the propeller unit coupled together as a compact unit



Advantages:

- It is easy to manoeuvre
- It is easy to maintain the boat fitted with OBE

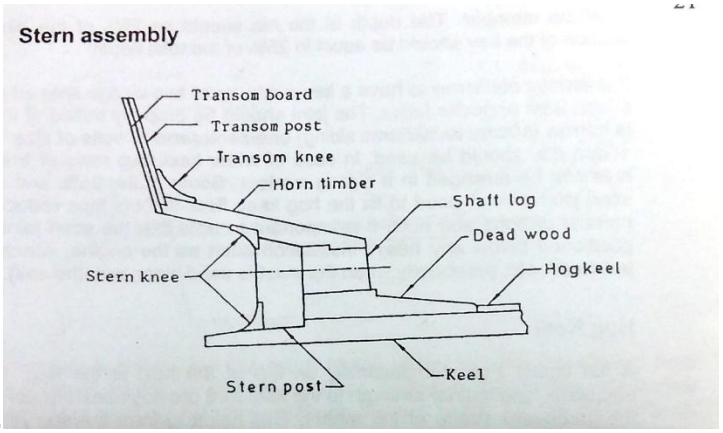
- Can be removed from the boat and the boat can be beached anywhere
- It is easy to handle the boat fitted with OBE
- It can be fitted on any restricted space
- Powered with ICE run by petrol/kerosene
- Of late diesel are used

In Board engine (IBE)

- For bigger vessels more power is required for propulsion
- IBE are installed inside the vessel hull or bed plates which serve as the prime movers for navigating the vessels
- The power developed by these prime movers to be transmitted to the propeller for navigating the vessel
- Series of transmission machinery are used in a vessel
- Propeller – should be able to give both ahead and astern movement to the vessel
- It also give enough thrust for pulling the fishing gear

Stern tube arrangement

It is a pipe extends from the stern post of the hull below the transom of the vessel. The purpose of the stern tube is to support the shaft with the help of stern tube bearings and to make a water tight joint on the hull where the shaft enters the hull. It also keeps the propeller shaft on thecentre line of the vessel.



- Made up of steel in modern vessel
- Brass or steel bushes are fitted on the forward and aft ends of the tube – stern tube bushes
- The bushes are locked to the stern tube
- The bushes are lined inside with soft material like lignum vitae, cutlass rubber and white metal
- This complete part is called stern tube bearings

Care and maintenance of engine

Performance of an engine degrades with time as its components deteriorate or wear out Cleaning, inspection and maintenance of various parts have to be carried out periodically for the purpose of smooth engine operation and to avoid engine troubles

Maintenance can be classified as

Preparations before starting

The following points need to be checked for starting any engine

- Check batteries for specific gravity, loose terminal connections, and proper battery voltage for an electrically started engine
- Check the air pressure in the air bottles, and fill it 30kg/cm2 for air started engine
- Check lubrication oil level of engine gearbox, turbo charger
- Remove water from fuel service tank, strainers, fuel pumps and also purge air from fuel system
- Check and oil the valves if they are hand lubricated
- Preheat the cooling water in cold weather or cold temperature places
- De clutches the engine from propeller shaft

- After all the above check are performed before start the engine, observe its performance for sometimes and then the load to the engine can be give

Precaution for stopping the engine

- Make sure the air bottles have sufficient air for next starting.
- Keeps air bottles always with the max. of 30kg/cm2 pressure
- Lubricate manually the valves etc if required to prevent sticking
- Run the engine at no load before stopping
- Check the condition of bearing, crank pin etc.
- Drain out the cooling water for long shut downs
- Operate the auxiliary cooling water pump and lubrication oil pump for larger engines so that the engine is cooled effectively
- List out the repairs to be carried out before next operations
- The maintenance cycle varies according to the type of engine, service conditions purpose etc.
- Daily inspection
- Inspection at every 100hrs. of operation or 10 days
- Inspection at every 500hrs. of operation or 1.5 months
- Inspection at every 1000hrs. of operation or 3 months
- Inspection at every 3000hrs. of operation or 6 months
- Inspection at every 6000hrs. of operation or 1 year

Power and Efficiencies of IC Engines

Brake Power of I.C Engines

- The power developed by an engine at the output shaft is called brake power. It is given by.

  $BP = 2\pi NT / 60 \times 1000$ kW

Where N = speed in rpm

T = Torque developed as shaft

Frictional Power:

The difference of indicated power and brake power is termed as frictional power (F.P.) i.e.

- FP = IP – BP

Indicated Power of I.C Engines

This is the total power developed by combustion of fuel in the combustion chamber. It is given by IP = Work given by cycle X number of cycles/sec X number of cylinder.

Engine Efficiencies

Mechanical Efficiency

It is the ratio of brake power and indicated power.

η_{mech} = B.P. / I.P.

Volumetric Efficiency:

It is defined as the ratio of actual volume (reduced to N.T.P.) of the charge, drawn in during suction stroke to swept volume of the piston.

Thermal Efficiency:

It is the ratio of indicted power to energy supplied by the fuel. It is of two types:

1.Indicator thermal efficiency- quantity of heat which is converted to work

in the engine cylinder

2. *Brake thermal efficiency*- quantity of heat available for doing external work

Powering of fishing vessels

It is defined as the rate of doing work and the unit of power is the horse power (HP)

i. Brake horse power (BHP)
ii. Indicated horse power (IHP)
iii. Shaft horse power (SHP)
iv. Effective horse power (EHP)
v. Quasi-propulsive coefficient (QPC)

Power

The standard metric unit of power is the Watt. As is implied by the equation for power, a unit of power is equivalent to a unit of work divided by a unit of time. Thus, a Watt is equivalent to a Joule/second. For historical reasons, the *horsepower* is occasionally used to describe the power delivered by a machine. One horsepower is equivalent to approximately 750 Watts.

Shaft horse power

The horse power generated in the propeller shaftBrake horse power (BHP):

Amount of power generated at end of the crank shaft

This is about 75% of the indicated HP

BHP = IHP – frictional losses in gearing

Indicated horse power (IHP):

The power generated in the inside of the engine cylinder. The power available at the end of the propeller shaft is only about 60% of the IHP and this can be expressed as:

Ps = 0.6

Effective horse power (EHP):

This is the power required to overcome the total resistance of the ship

EHP = Rt x V x 0.5144

where, Rt = total resistance

V = speed in knots

Quasi-propulsive coefficient (QPC):

The relationship between Pe and Ps is called the quasi-propulsive coefficient or propulsive efficiency. The most fishing vessels depending on the displacement, it may vary from 0.4 to 0.5.

Slip:

Percentage by which the actual distance steamed falls short of the theoretical distance. It is calculated from propeller, pitch and the number of revolutions.

Thrust:

Power delivered to the propeller equal to effective horse power plus slip

Relationship between powers:

IHP – Friction losses in gearing = BHP

BHP – Friction losses in engine bearings = SHP