(DKM30142)
INTERNAL COMBUSTION ENGINE

(TOPIC 3 & 4)
BASIC CONSTRUCTION MARINE DIESEL ENGINE

Presenter / Lecture by:
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Marine Diesel Engine - Part 1

- **Classification of Internal Combustion Engine:-**

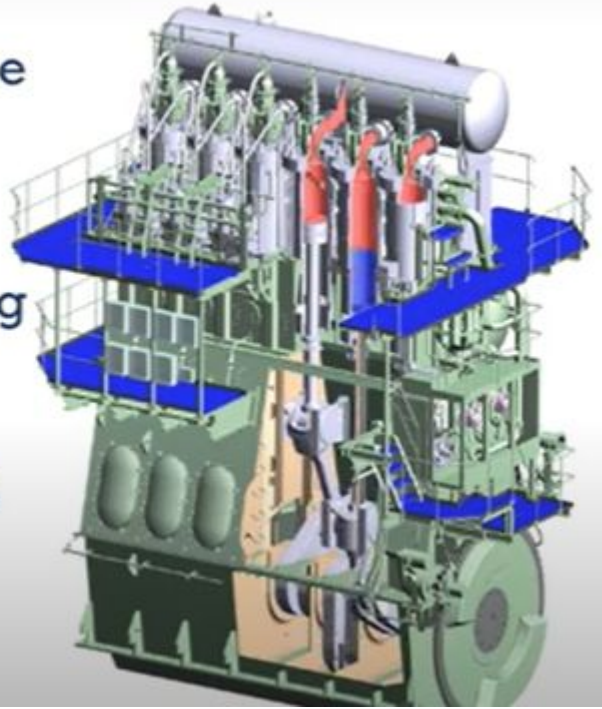
1. Two Stroke & Four Stroke
2. Fuel Used
3. Single Acting – Double Acting
4. Supercharged
5. CI Engine or SI Engine
6. Trunk Type Engine or Crosshead Engines
7. Single & Multi Cylinder Engine

- **Classification of Internal Combustion Engine:-**

8. W, V or X pattern of arrangement of the cylinders.
9. Main Propulsion use or Auxiliary engine use
10. Low, Medium and High Speed
11. Mean Piston Speed
12. Same direction or Reversible engines
13. Clockwise or Anti-clockwise

Advantages of Diesel Engine:-

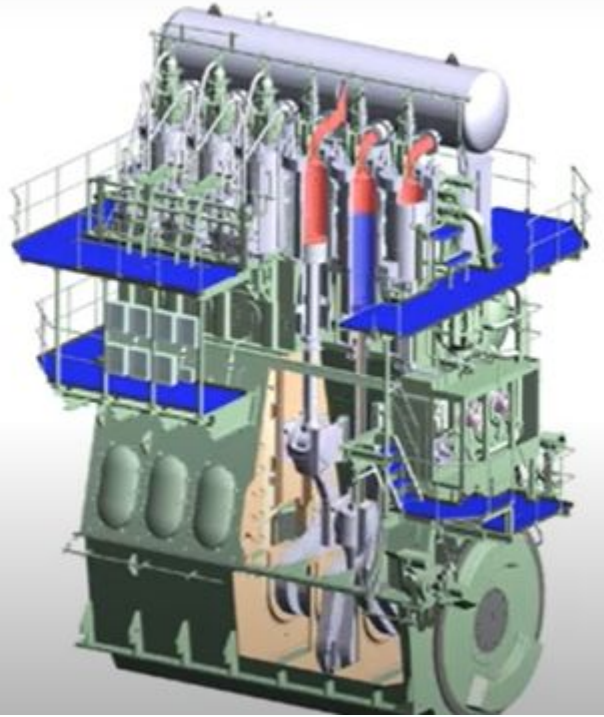
1. High efficiency & recovery of waste heat.
2. Increased maneuvering abilities.
3. Highest use of heat generated during combustion.
4. Increased time period before refueling.
5. Increased standby reliability.
6. Increased cargo carrying capacity.



VIDEOS

Disadvantages of Diesel Engine:-

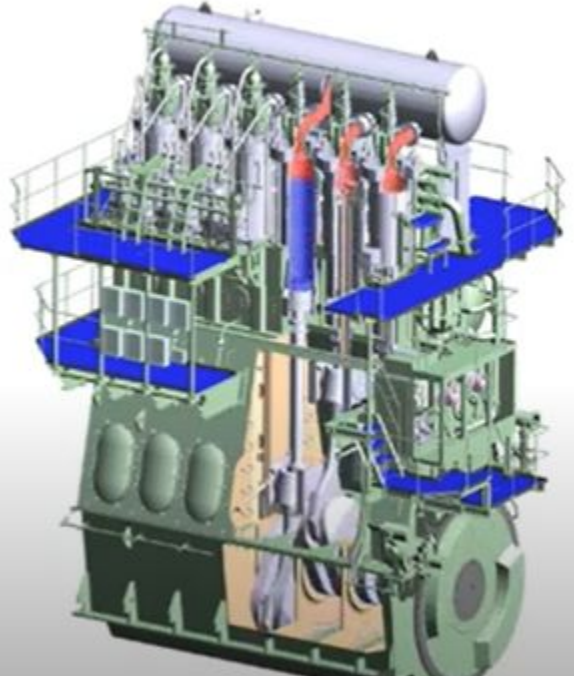
1. High capital cost, complicated design & construction.
2. High lube oil costs in medium & high speed engine.
3. High inertia loads due to reciprocating and rotating masses.
4. Pressures and temperatures are always varying in the system.
5. High idling speed of crankshaft and irregular rotation.



Components of Marine Diesel Engine (Marine Diesel Engine - Part 2)

Components of Marine Diesel Engine:-

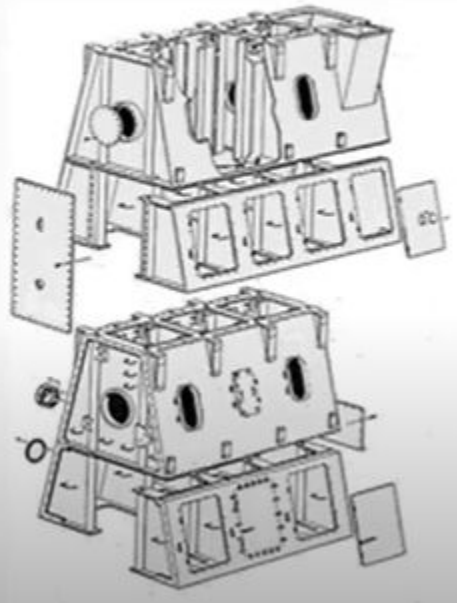
1. Bedplate
2. Frame Box
3. Crankshaft
4. Camshaft
5. Piston
6. Piston Rings
7. Liner
8. Connecting Rod
9. Cylinder Head
10. Inlet and Exhaust Valves
11. Turbocharger



1. Bedplate:-

- It works as a foundation block for the marine diesel engine.
- They are right at the same time strong & flexible to support weight and handle fluctuating forces produced by the engine.

2. Frame Box:-



- They support the cylinder block. It is separately fabricated structure mounted on top of the bedplate.
- They carry crosshead guides while supporting the cylinder block & are secured to the bedplate using bolts.

IDEOS

3. Crankshaft:-

- It is a key component of an engine transmitting cylinder power to the propeller shaft.
- It is subjected to high torsion & fluctuating bending and shear stress.

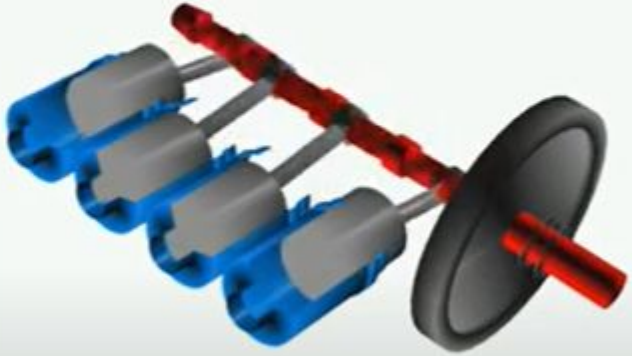
IDEOS

4. Camshaft:-

- It is control device which operates inlet valve, exhaust valve and fuel injector.
- It operates these valves with the help of cam follower, rocker arm and push rod.

5. Piston:-

- It is to convert the force of expanding gases during combustion process to mechanical energy.
- A piston can be called as the heart of an engine as it transform all that energy under fluctuating thermal & mechanical stress.

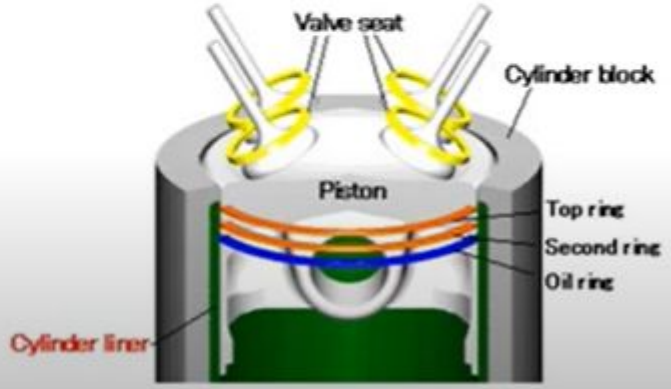


6. Piston Rings:-

- It provides sealing of combustion chamber by expending outwards. It also prevent the combustion gases leak or escape from the space in between cylinder head and piston crown.

7. Liner:-

- It is to provide durable and heat resistant combustion chamber.



IDEOS

8. Connecting Rod:-

- It does the function of transforming the reciprocating motion of a piston into rotary motion of crankshaft.
- It is fitted in between a crosshead & crankshaft in two stroke marine diesel engine, while in between gudgeon pin & crankshaft in four stroke engine.

IDEOS

9. Cylinder Head:-

- It is the top part of the combustion space; while supporting all necessary valves required for the operation such as inlet, exhaust, & fuel injector.

10. Inlet & Exhaust Valves:-

- The function of inlet valves in a four stroke marine diesel engine is to inject a charge of fresh air in the combustion space, while the work of exhaust valves all marine engines is to eject out all the byproduct of the combustion.
- Large two stroke marine diesel engine have only exhaust valves mounted on the cylinder head.

IDEOS

11. Turbocharger:-

- The function of a turbocharger is to increase the overall power & efficiency of an engine.
- It has two main parts:
  - Blower
  - Turbine

DEOS

Two Stroke Marine Diesel Engine (Marine Diesel Engine Part 3)

- **Two Stroke Cycle:-**

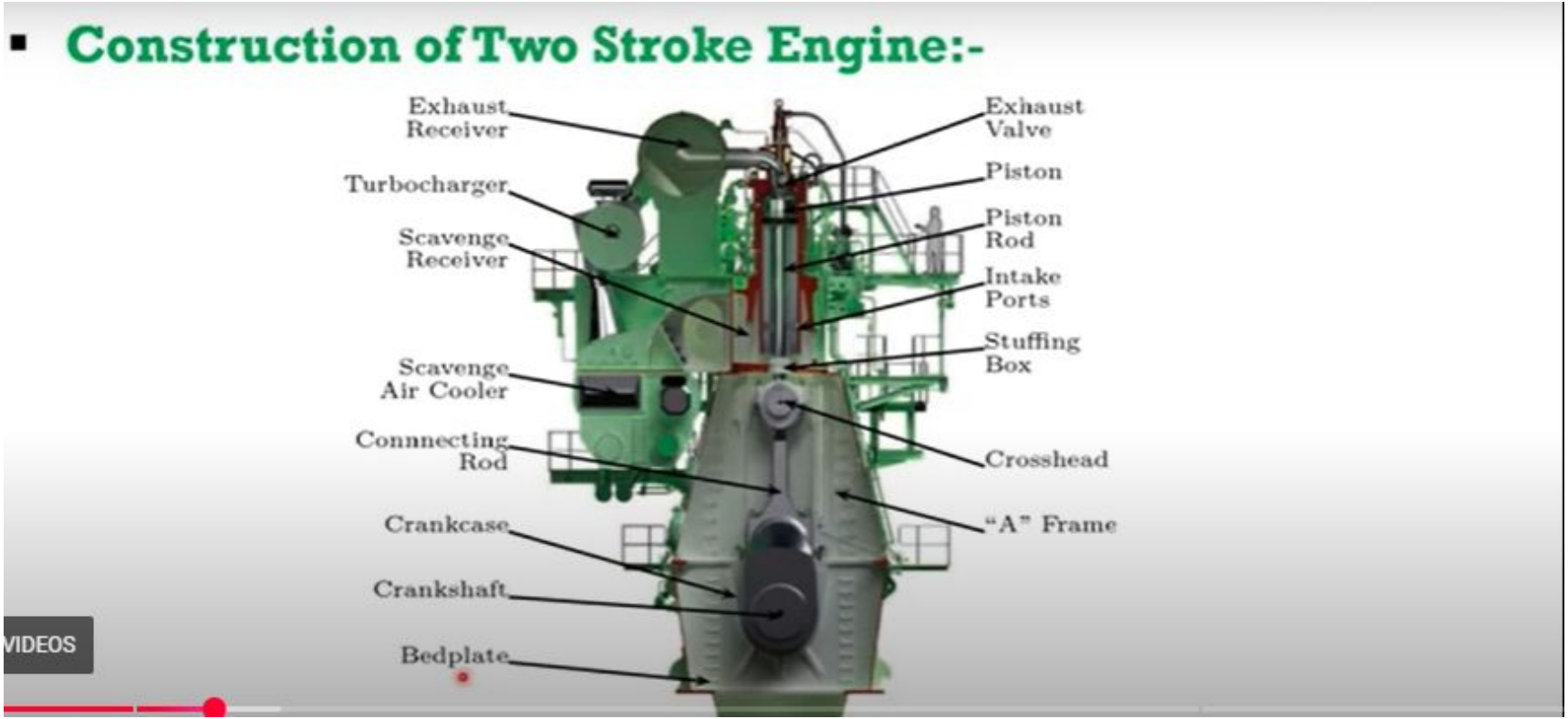
The cycle is completed in two stroke of the engine piston:

1. The Compression Stroke (Scavenging & Suction)

2. The Power Stroke (Expansion & Exhaust)

VIDEOS

Construction of Two Stroke Engine:-

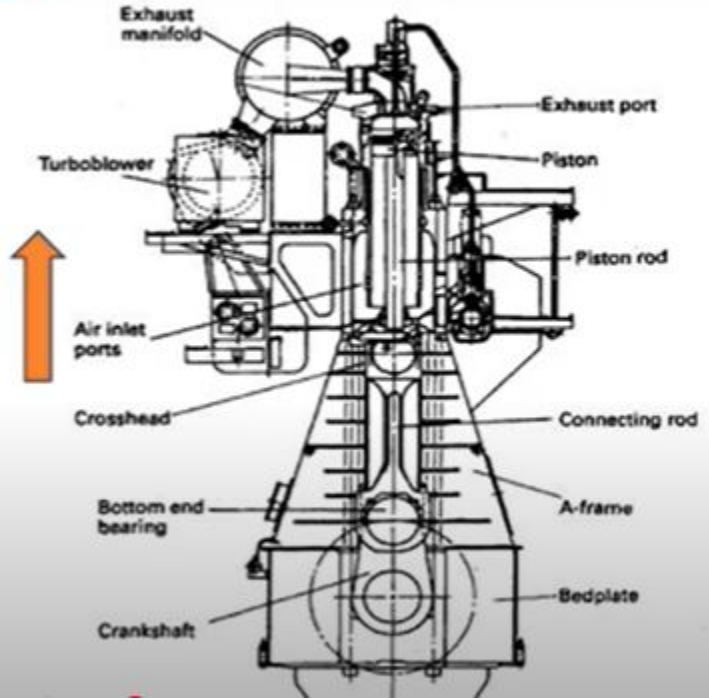


- **Working of Two Stroke Engine:-**

1. **Compression Stroke**

Air Pressure = 32 to 45 bar

Temperature = 650 to 800 deg.C

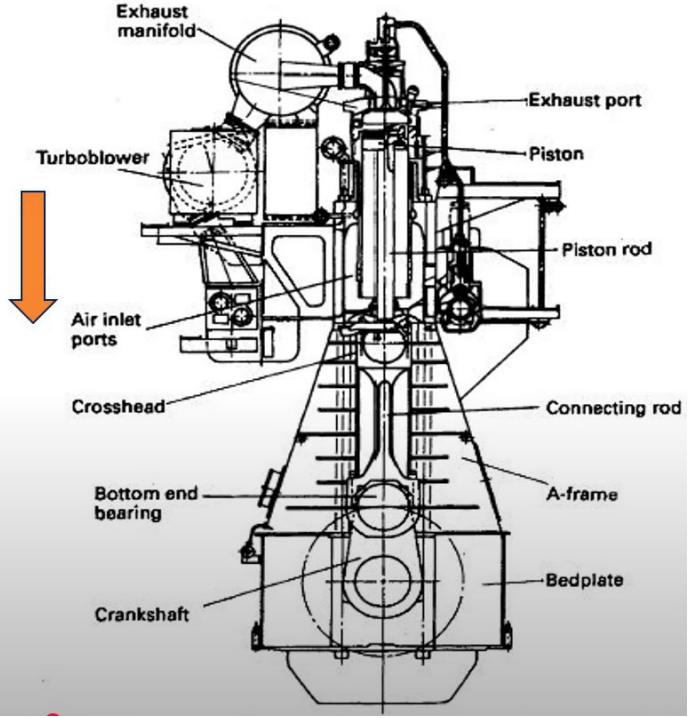


VIDEOS

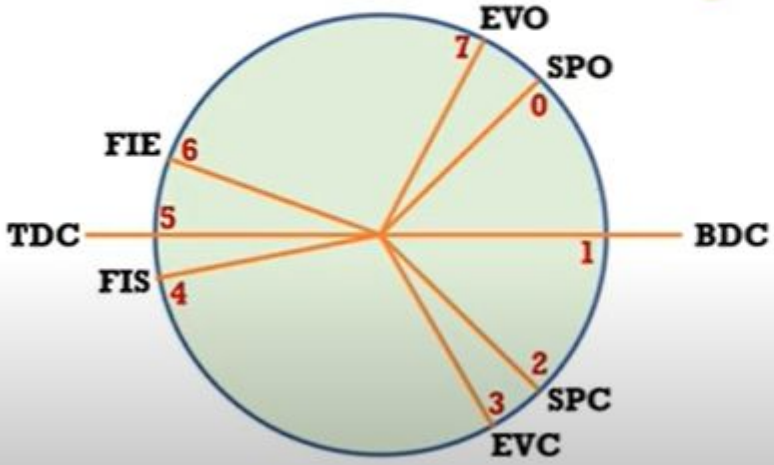
Working of Two Stroke Engine:-

2. Power Stroke

- The exhaust ports are uncovered at approximately 40 to 75 degrees of crank shaft rotation, just before BDC.
- Pressure in the cylinder falls to around 2 to 4 bar.
- Temperature is high due to the exhaust gases 250 to 500 deg.C.
- The exhaust ports are kept uncovered for approximately 118 to 130 deg. of crank rotation.
- The scavenge ports are kept open for 100 to 140 deg. of crank rotation.



Valve Timing Diagram of Two Stroke Engine:-



TDC – Top Dead Center

BDC – Bottom Dead Center

SPO – Scavenge Port Opens 42 deg. before BDC

SPC – Scavenge Port Closes 42 deg. after BDC

EVO – Exhaust Valve Opens 75 deg. before BDC

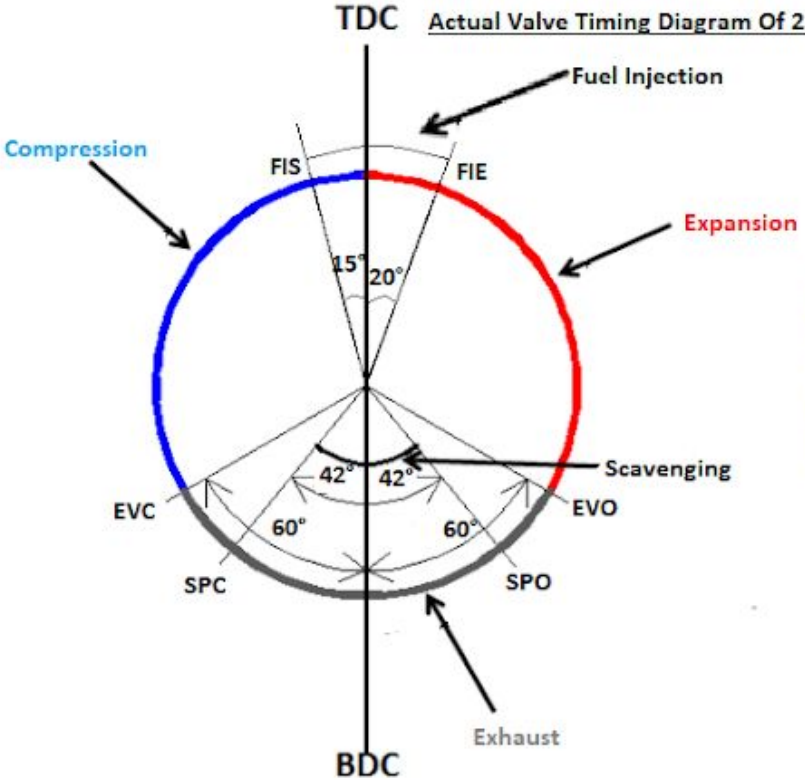
EVC – Exhaust Valve Closes 60 deg. after BDC

FIS – Fuel Injection Starts 16 deg. before TDC

FIE – Fuel Injection Ends 20 deg. after TDC

VIDEOS

Actual Valve Timing Diagram Of 2 Stroke Marine Diesel Engines



TDC- Top Dead Center
BDC- Bottom Dead Center
EVO- Exhaust Valve Open
EVC- Exhaust Valve Close
SPC- Scavenge Port Open
SPC- Scavenge port Close
FIS- Fuel Injection Start
FIE- Fuel Injection End

Four Stroke Diesel Engine - Marine Diesel Engine Part 4

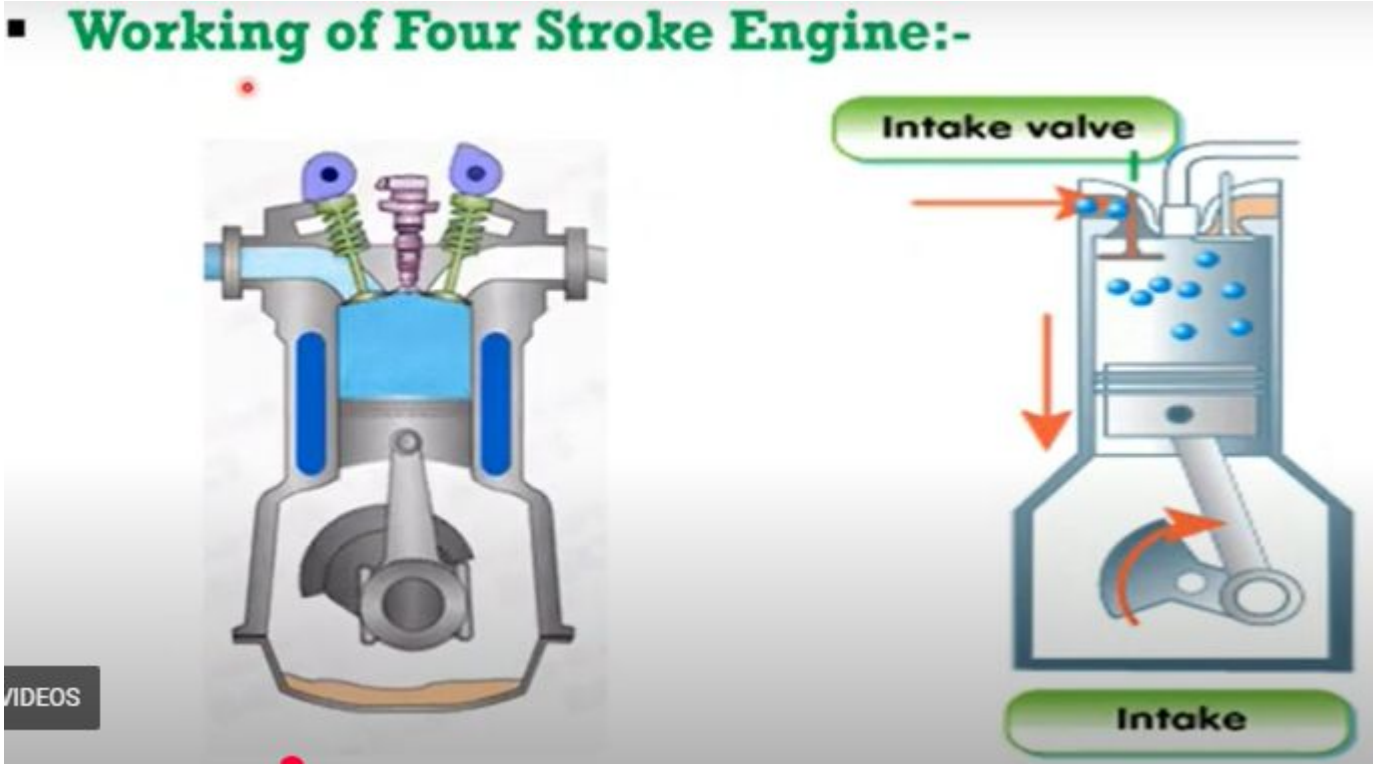
Four Stroke Cycle:-

The cycle is completed in four stroke of the piston:

1. Suction (induction) stroke
2. Compression stroke
3. Power (expansion) stroke
4. Exhaust stroke

IDEOS

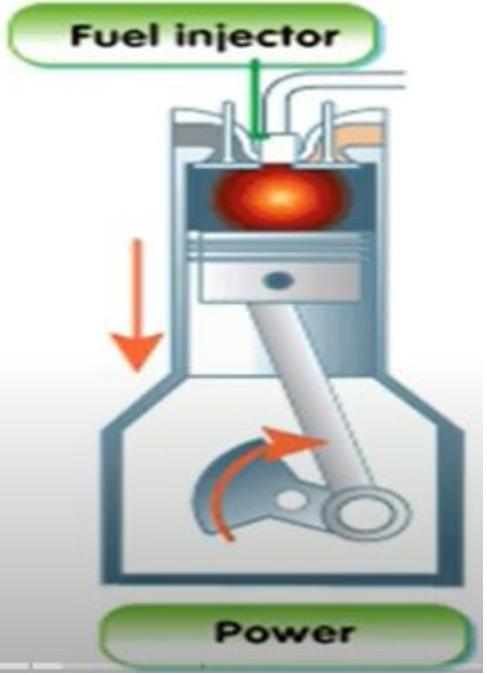
Working of Four Stroke Engine:-



Working of Four Stroke Engine:-

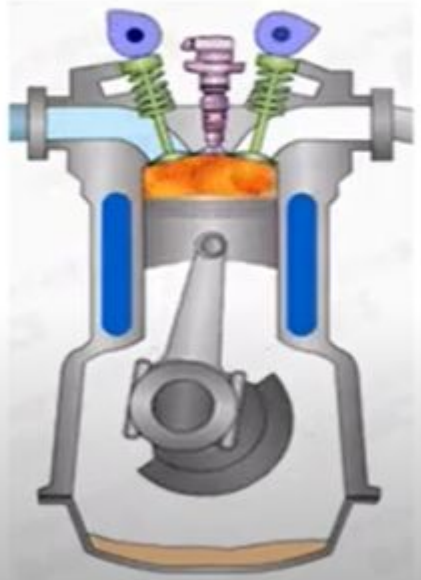
VIDEOS

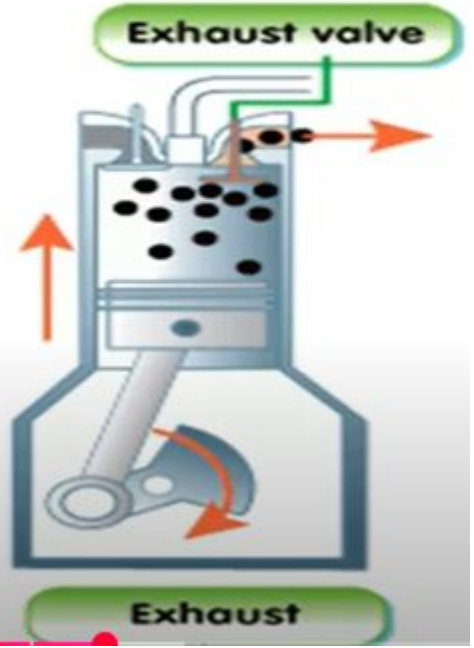
Working of Four Stroke Engine:-



VIDEOS

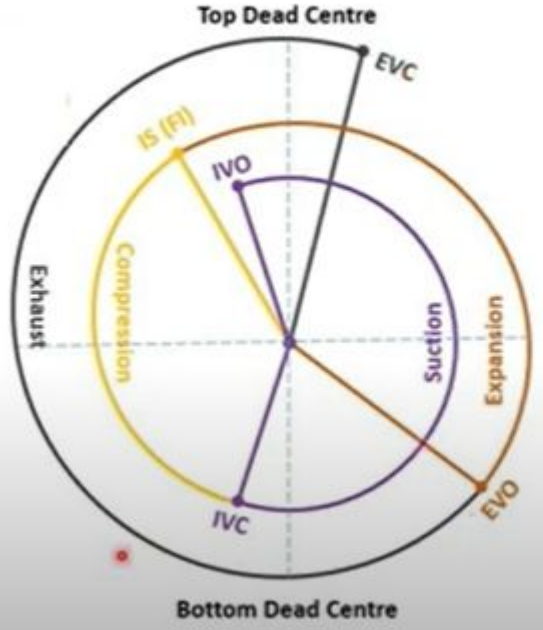
- **Working of Four Stroke Engine:-**





VIDEOS

Valve Timing Diagram of Four Stroke Engine:-



TDC – Top Dead Center

BDC – Bottom Dead Center

IVO – Inlet Valve Opens 20 deg. before TDC

IVC – Inlet Valve Closes 60 deg. after BDC

IS (FI) – Fuel Injection Starts 10 deg. before TDC

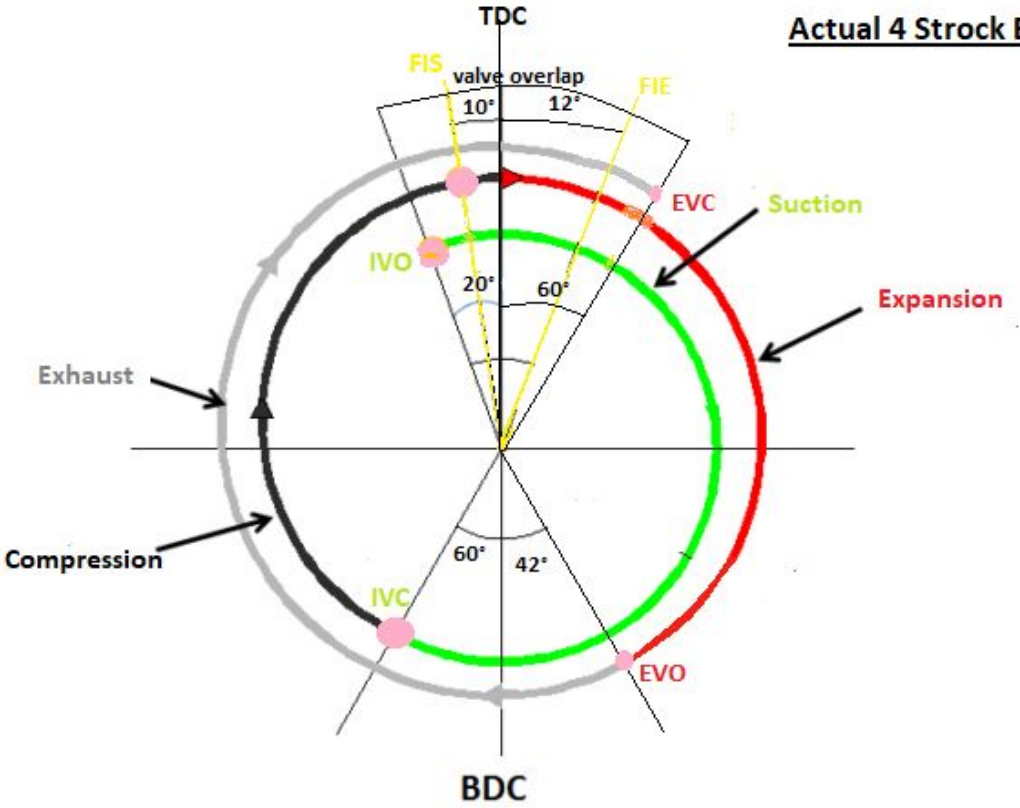
IE (FE) – Fuel Injection Ends 12 deg. after TDC

EVO – Exhaust Valve Opens 42 deg. before BDC

EVC – Exhaust Valve Closes 60 deg. after TDC

VIDEOS

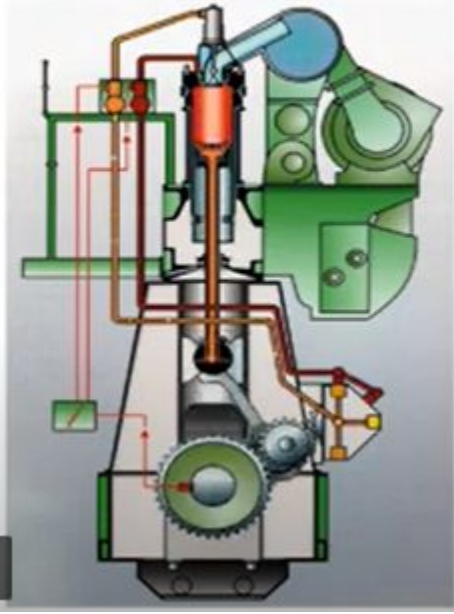
Actual 4 Strock Engine Valve Timing Diagram



TDC- Top Dead Center
BDC- Bottom Dead Center
IVO- Inlet Valve Open
IVC- Inlet valve Close
EVO- Exhaust Valve Open
EVC- Exhaust Valve Close
FIC- Fueloil Injection Starts
FIE- Fueloil Injection Ends

Air System (Scavenging Process) of Marine Diesel Engine - Marine Diesel Engine Part 5

Scavenging:-



"It is the process of removing exhaust gases from the cylinder after combustion and replenishing the cylinder with fresh air."

- Efficient scavenging is necessary for good combustion of fuel inside the engine cylinder.
- The passage of scavenge air will also assist cooling of the cylinder, piston and valves.

- **Satisfactory Scavenging Depends on:-**
  - Efficient evacuation of exhaust gases.
  - Exhaust ports or valves open before scavenge ports.
  - Scavenge ports close after the process of gas exchange.
  - Loss of fresh air through exhaust passage to be minimum.

- Importance of Scavenging:-
  - Overall efficiency.
  - Power output per unit weight.
  - Fuel consumption per unit power.
  - Incomplete scavenging results in poor combustion.
  - Lubricating oil contamination.
  - Wear piston rings and liner.
  - Mean temperature of cylinder high.

VIDEOS

- **Different Stages of Scavenging:-**
  - 1st Stage – Blow Down Period:
    - ✓ Sudden opening accelerates exhaust gases to exhaust manifold.
  - 2nd Stage – Scavenge Period:
    - ✓ Begins after scavenge ports open
    - ✓ Scavenge air sweeps gases out
    - ✓ Pressure difference between the scavenge trunking and exhaust manifold is important.
  - 3rd Stage - Effort made to contain air in the cylinder.

DEOS

Cross Flow Scavenging:-

Advantages:

- Low manufacturing cost.
- Good scavenging at low speed and part throttle.
- Low engine volume for the multi cylinder arrangement.

Disadvantages:

- Heavy piston with very high heat absorption.
- High tendency to knock.
- Poor scavenging at high speed and full throttle.
- Compulsory water cooling, difficulty in cooling piston crown.

- Loop Scavenging:-

Advantages:

- Low maintenance.
- The low surface area to the volume of the cylinder.
- Good scavenging at full throttle.
- Water cooling system not necessary.

Disadvantages:

- Poor scavenging at part throttle operation.
- Scavenging time is short.

Uni Flow Scavenging:-

Advantages:

- Extended time for valve operation.
- The possibility of mixing is reduced due to uniflow.
- Increase power output.
- Most efficient of all three methods.
- Good scavenging at all speed ranges and throttle position.
- Low fuel consumption compared to other scavenging types.

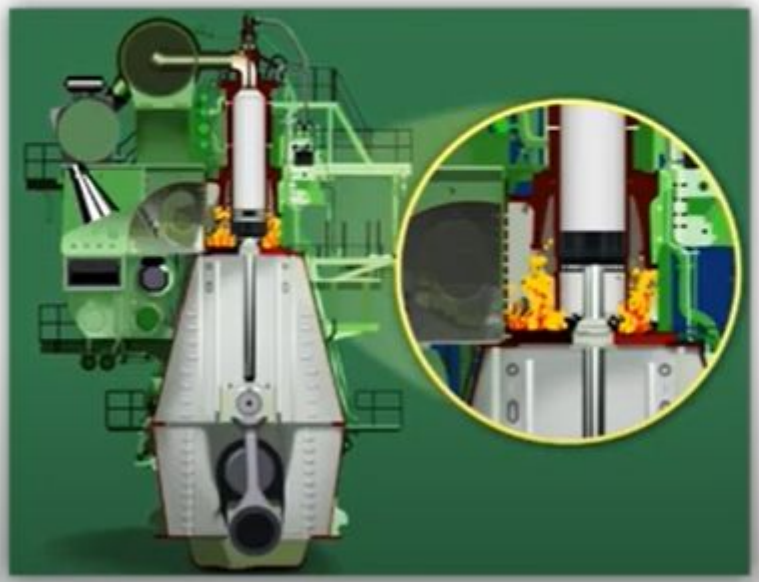
Disadvantages:

- Elaborate and costly construction.
- Difficulty in cooling the piston.

DEOS

Scavenge Fire - Marine Diesel Engine Part 6

- **Scavenge Fire:-**



- **Causes of scavenge fire**

1. Excessive wear of the liner.
2. The piston rings might be worn out or have loose ring grooves.
3. Broken piston rings or rings seized in the grooves.
4. Dirty scavenge space.
5. Poor combustion due to leaking fuel valves or improper timing.
6. Insufficient or excess cylinder lubrication.

- **Indications of scavenge fire**

1. Scavenge temperature will start increasing.
2. The turbochargers will start surging.
3. High exhaust temperature.
4. Loss of engine power and reduction in rpm. This happens because a back pressure is created under the piston space due to fire.
5. Smoke coming out of the scavenge drains.
6. The paint blisters will be formed on the scavenge doors due to high temperature but this will occur only in large fires and extreme cases.

- **Actions to be taken**

For Large Fires

1. Stop the engine immediately and engage turning gear, and keep engine rotating with turning gear.
2. Extinguish the fire with fixed fighting system for scavenge fire. This may be co2 system or a steam connection for smothering the fire.
3. In case fixed system is not available on very old ships an external cooling is provided to prevent distortion due to heat.
4. Once after confirming that the fire is extinguished. The scavenge space is allowed to cool down and later opened for inspection and cleaning of the scavenge space.

DEOS

- **Actions to be taken**

For Small Fires

1. Start reducing the engine rpm and reduce it to slow or dead slow.
2. Increase the cylinder lubrication of the affected unit. Special attention to be given for this as this does not feed the fire. In case of increase of fire do not increase the lubrication.
3. The fire can be due to leaky fuel valves, so lift up the pump of the affected unit.
4. Keep scavenge drain closed.
5. Keep monitoring the scavenge and exhaust temperatures and let the fire starve and wait for it to burn itself out.
6. After confirming that the fire is out start increasing the rpm slowly.
7. Keep monitoring the scavenge temperature for any signs of re-ignition.

MORE VIDEOS

Neptune

"Where knowledge has no boundaries"

Crankcase Explosion in Marine Diesel Engine

Crankcase Explosion in Marine Diesel Engine (Part 7)

- **What are the reasons of crankcase explosion ?**

1. The normal content of crankcase is air.
2. In this air there are oil droplets formed by the mechanical atomization of the oil as it sprayed from the edge of the bearing and other places and as it is thrown about and churned by the quickly moving parts.
3. If a hot spot occurs the oil particles in the neighborhood will evaporate.
4. This evaporation may cause the formation of a quantity of white condense oil mist in the cooler regions.

- **What are the reasons of crankcase explosion ?**

5. The continual generation of heat at hot spot vaporization may proceed a space until the ratio of vapor to air lies within the range of flammability.
6. If hot spot can provide the necessary heat for ignition of vapor, a primary explosion may occur.

- **Hot spot and why it occur ?**

1. It is an overheated part, sufficient to initiate combustion.
2. A hot spot occur due to the failure of lube oil to bearing, sprockets and similar parts.
3. Hot gas blowing past the pistons may provide spark sufficient to cause an explosion in the trunk type pistons engine.
4. Hot spot temperature: 280 °C to 400 °C above the L.O flash point.

- **How to know hot spot is there or not?**

1. By hand feel to crankcase door.
2. Irregular running of engine.
3. Abnormal noise in crankcase.
4. Bearing L.O temperature increase.
5. Alarm will operate when it reach at oil mist concentration 2.5 – 5%.
6. Smelling & appearance of the dense oil mist when open breather pipe, drain cock.

- **How to prevent the crankcase explosion?**

1. To minimize the formation of explosive mixture breather pipe or exhaust fan fitted on crankcase.
2. To prevent the formation of hot spot in the crankcase, the bearing should be in correct running clearance, lubricating oil should be adequately supplied to bearing , chain with sprocket wheels and other running parts.
3. The piston with rings and cylinders should be in safe working limits.
4. Good fitting and efficient locking of working parts.

- **crankcase safety devices:**

1. Breather pipe with flame trap
2. Crankcase exhaust fan
3. Oil mist detector
4. Crankcase relief doors
5. Bearing temperature sensor
6. L.O return temperature sensor
7. Routine test on used L.O for viscosity, flash point and contamination.

- **Preventive measure of crankcase explosion:**

1. There should be adequate cooling of the engine.
2. Proper purification and analysis of lube oil.
3. Lube oil filter to be changed over & cleaned as per schedule.
4. Ensure proper cylinder lubrication by checking the condition of piston, piston rings and liner through scavenge ports.
5. Clean scavenge space as per schedule & drain scavenges space regularly.
6. Maintain the stuffing box gland sealing in good condition.
7. All running gears maintenance & checks to be carried out.

IDEOS

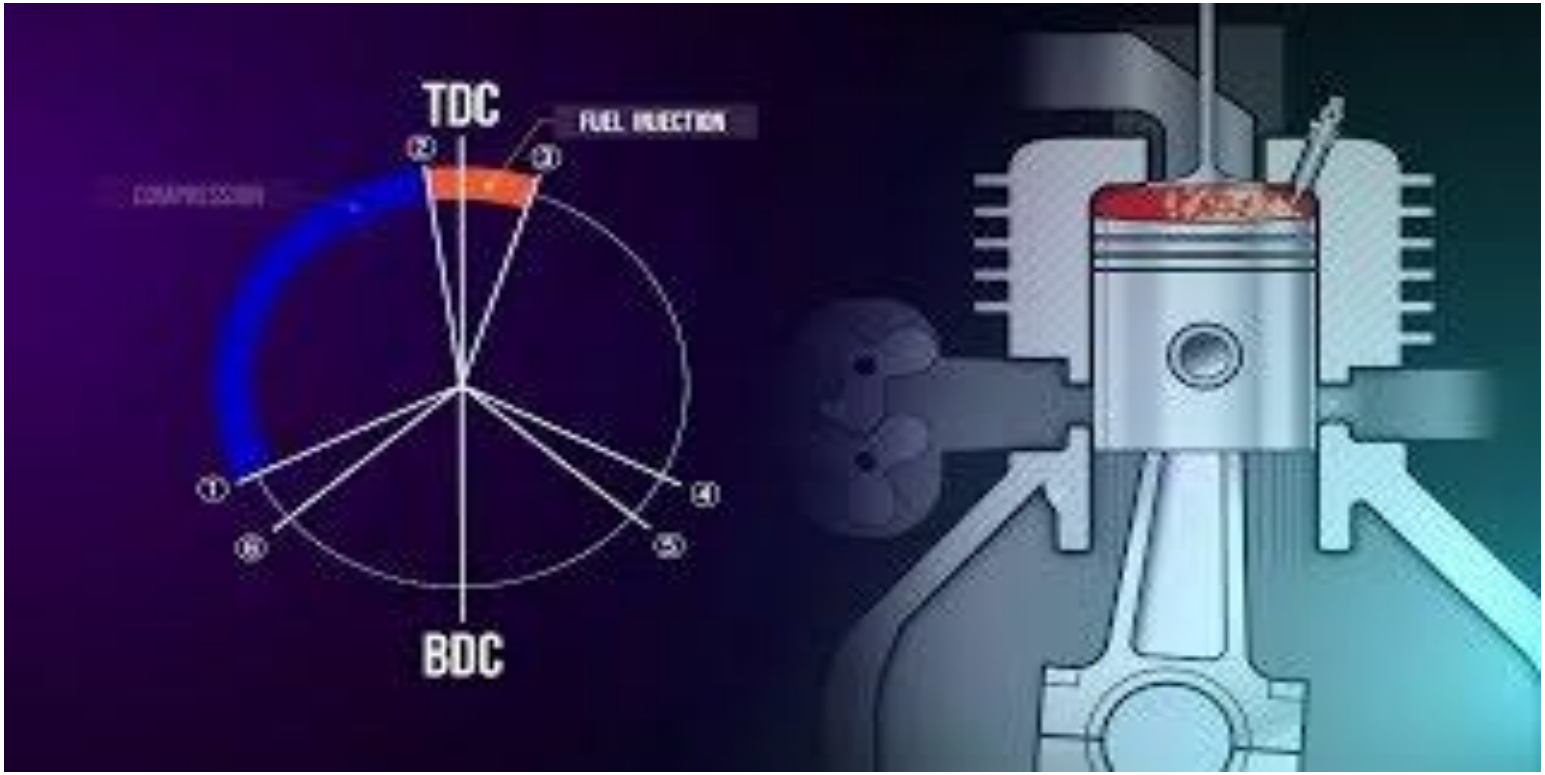
- **Preventive measure of crankcase explosion:**

9. All safety trips & alarms fitted on M/E to be tried out.
10. Proper watch on all running gears temperature & pressure to be maintained.
11. Blow through all sampling tubes of Oil Mist Detector regularly.
12. Zero adjustment & sensitivity of OMD to be checked regularly.
13. Check for oil leakage at crankcase explosion relief doors & check for the operation by hand.
14. Check flame trap for cleanliness.

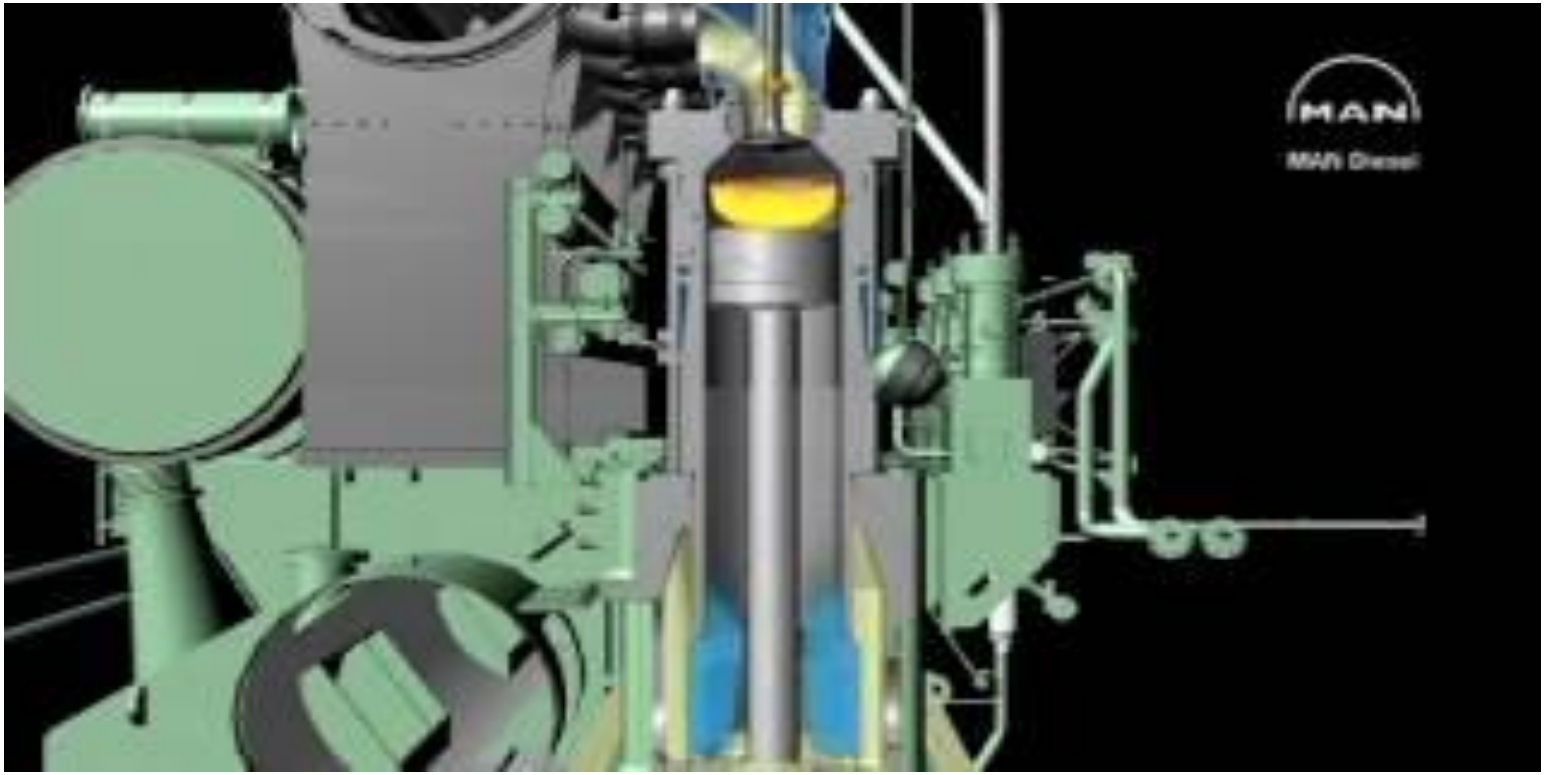
DEOS

Slow , Medium and High Speed Engines

2 Stroke Marine Diesel Engine MAN B&W: Operating Principle



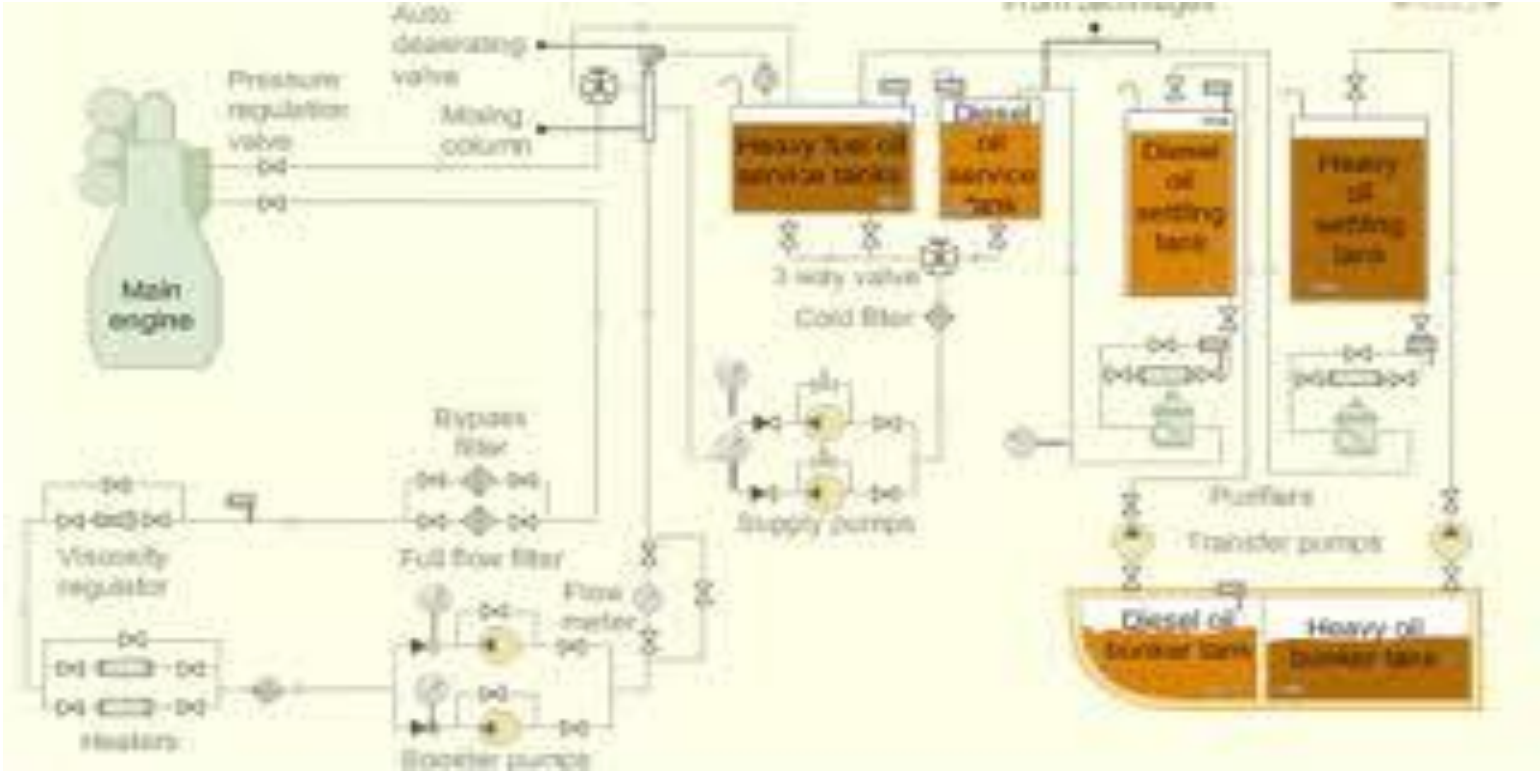
2 Stroke Diesel Engine Technology



Marine diesel engine MAN B&W MC/ME Engine- Construction and Principle

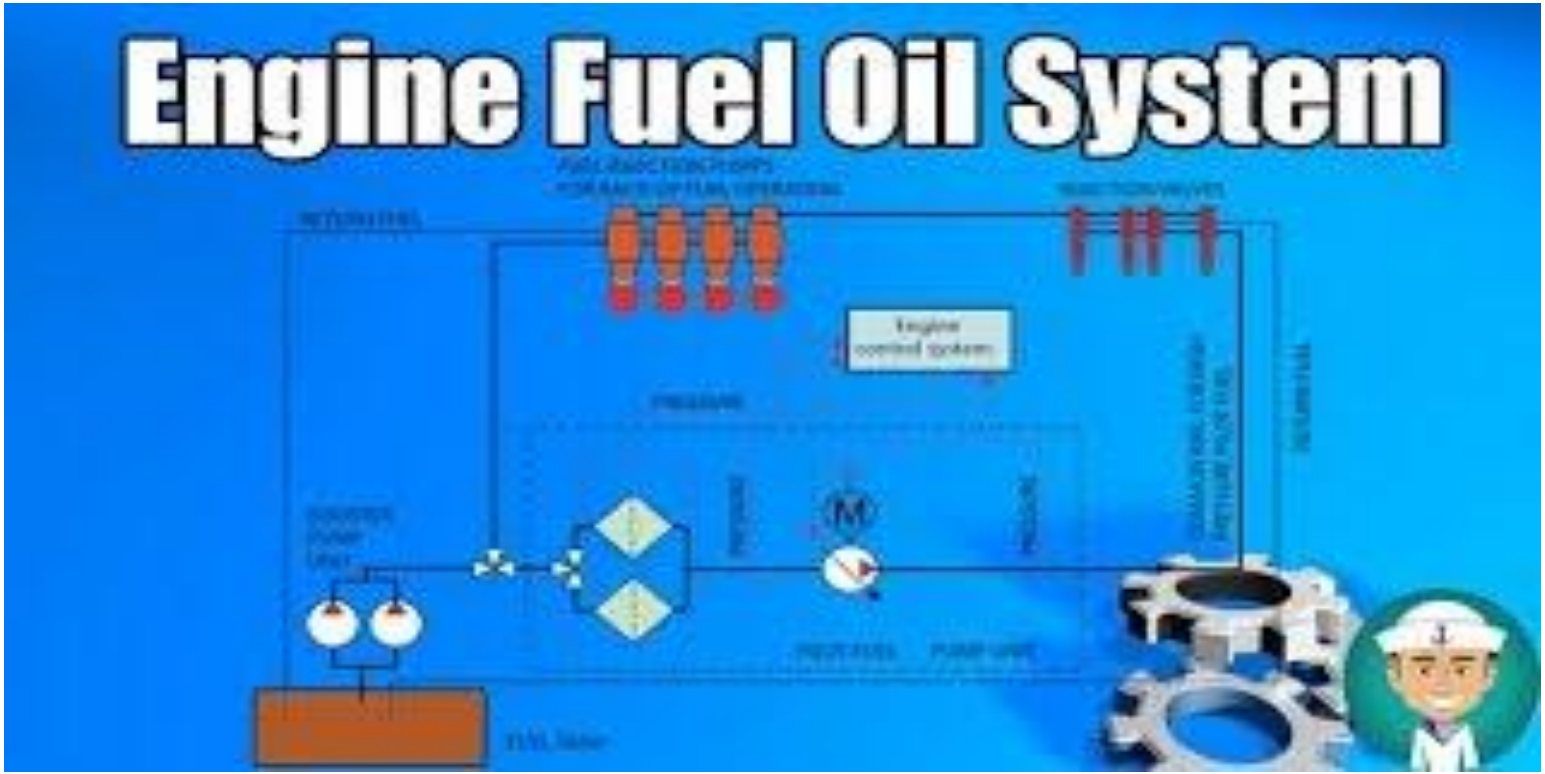
Marine Diesel Two Stroke Engine - How it Works!

Marine Engine Parts and Functions

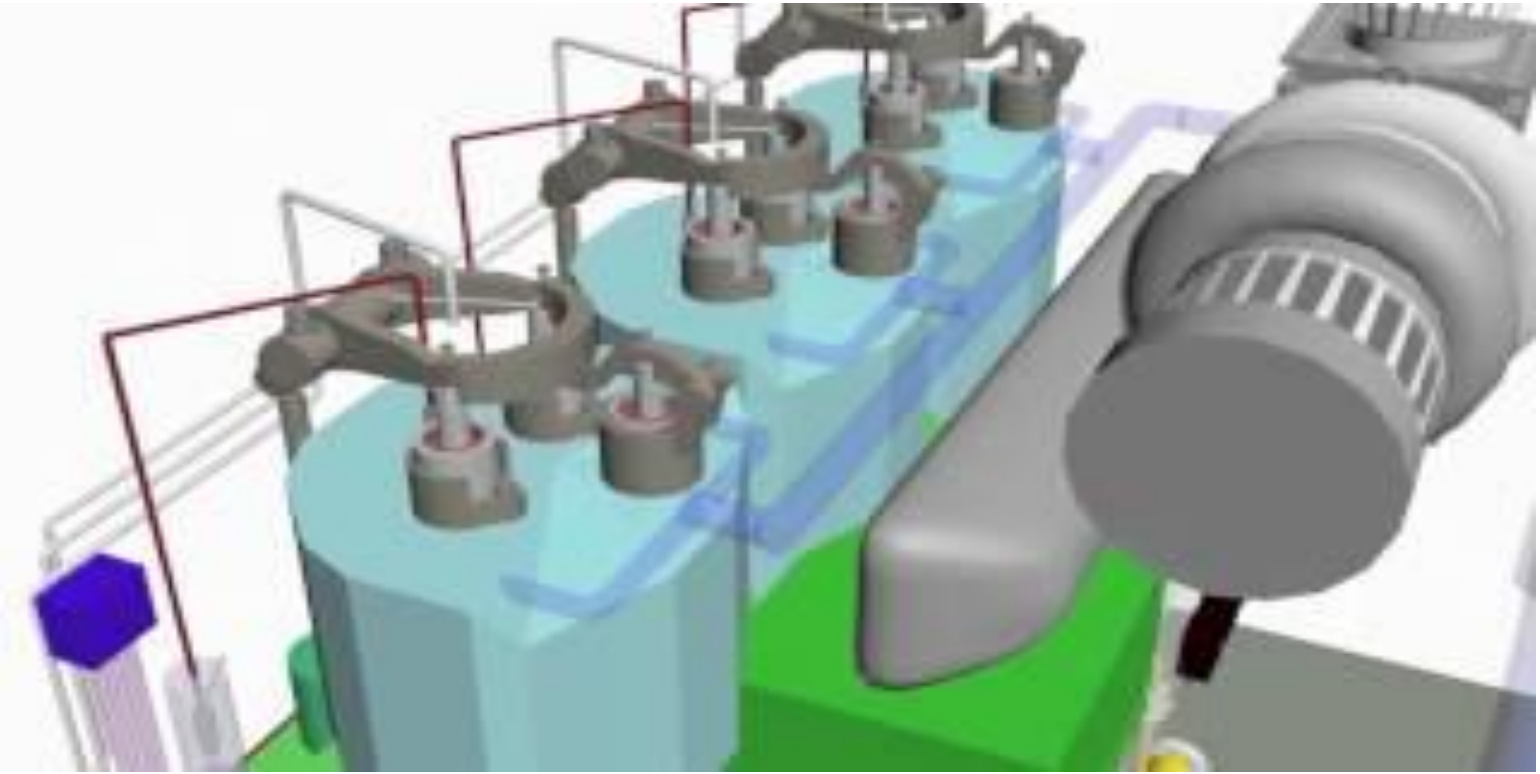


Fuel Oil System

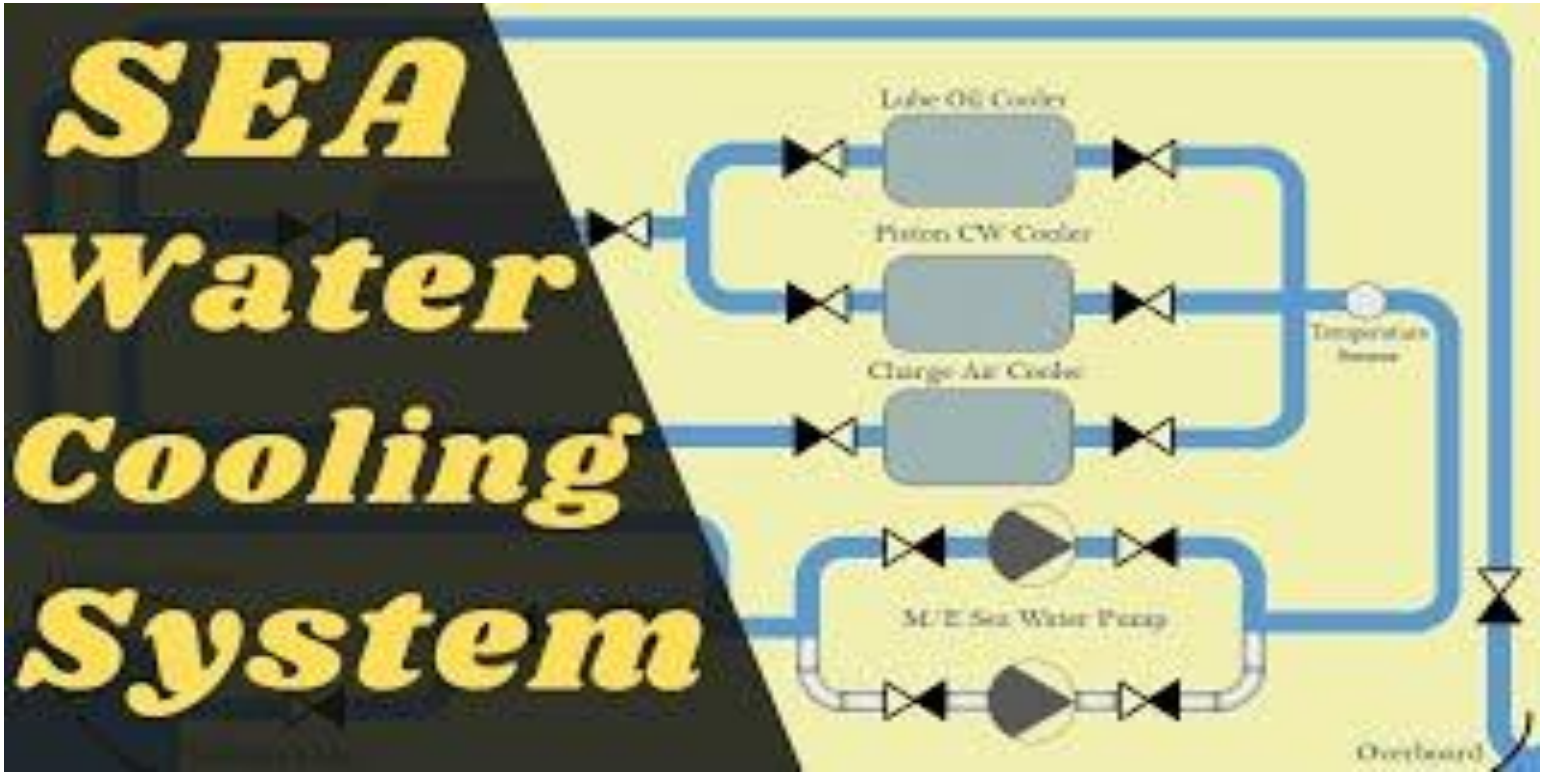
How The Main Engine Fuel Oil System Work | Fuel Oil System Animation



Engine Fuel Oil System

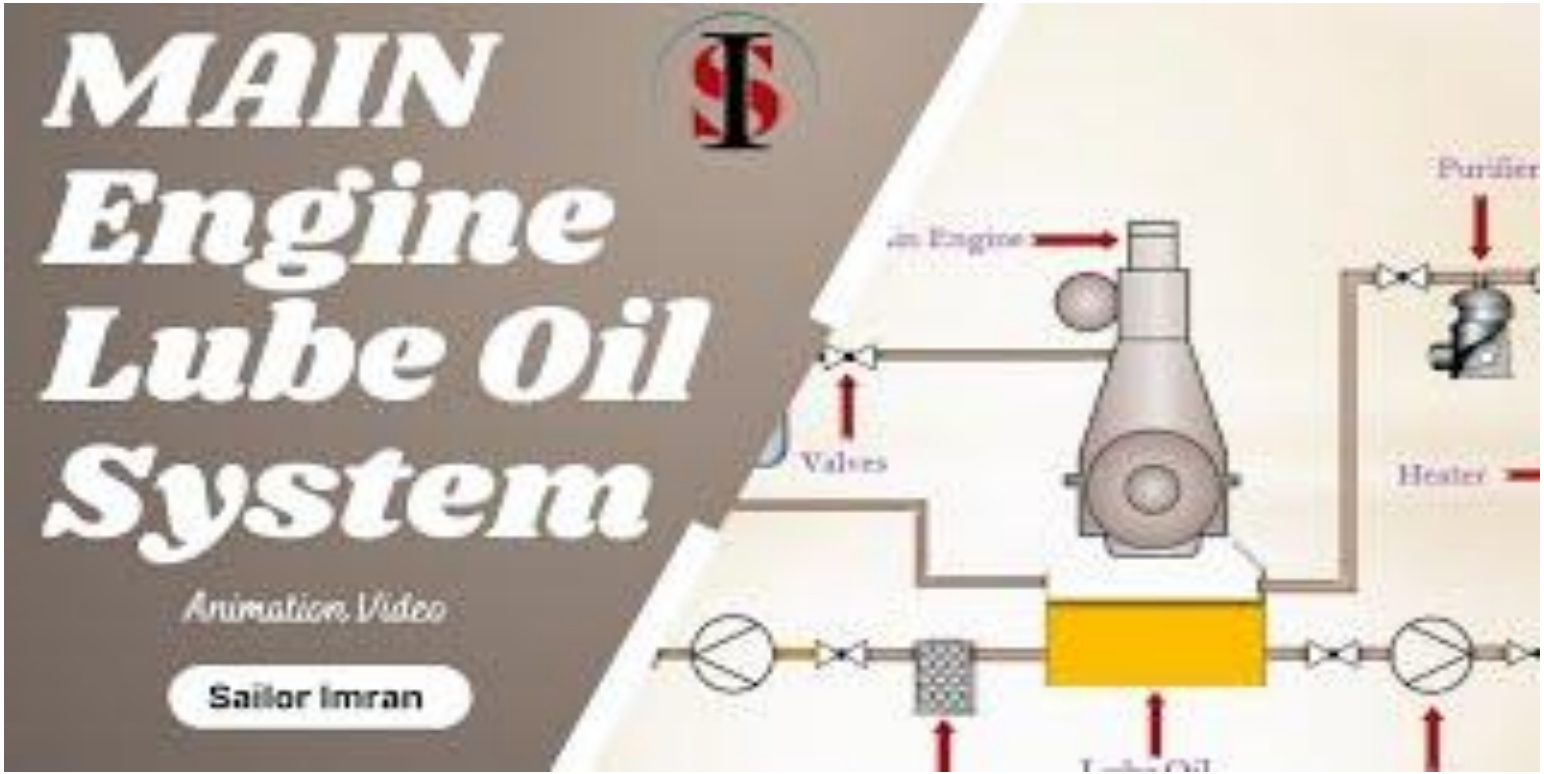


2 Stroke Diesel Engine (Jacket Cooling Water System) Marine Learning

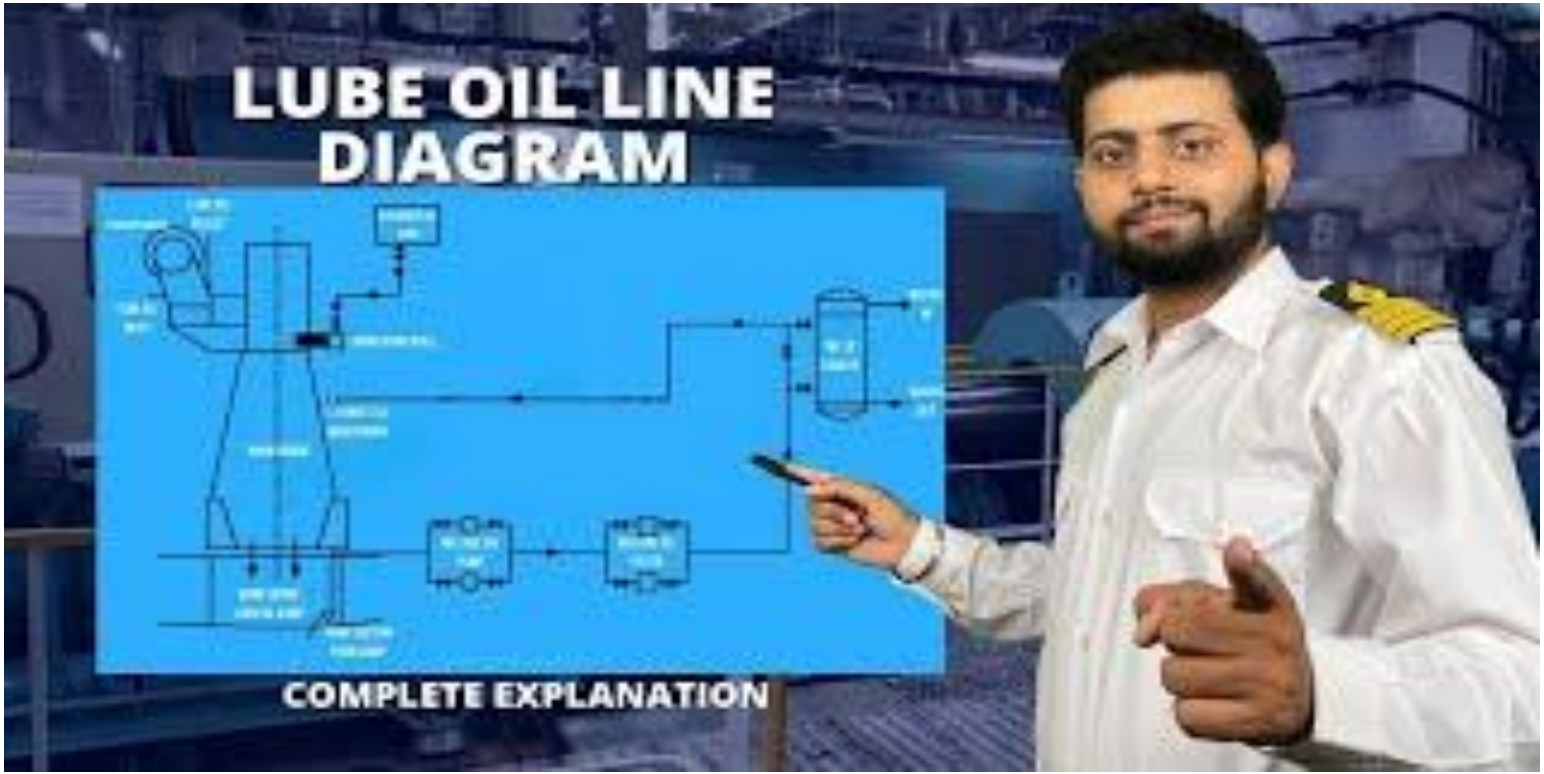


Main Engine Sea Water Cooling System Animation | Sea Water Cooling System Onboard

Marine LO System



Main Engine Lube Oil System Animation | Lubrication System Work



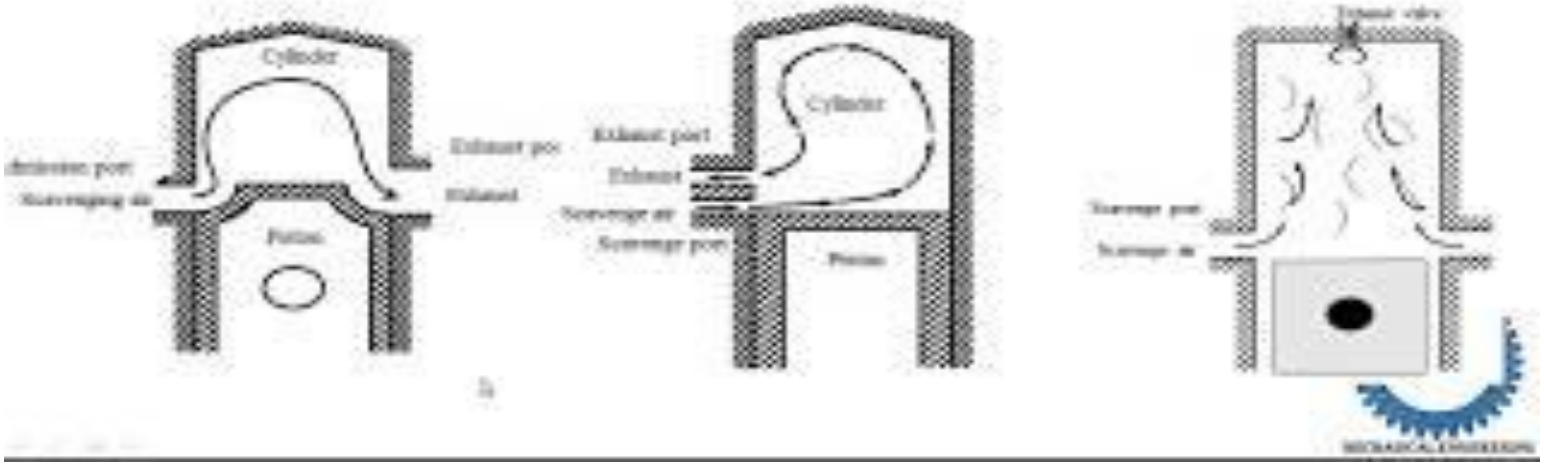
Main Engine Lube Oil Line Diagram

Starting Air System of Marine Diesel Engine Explained

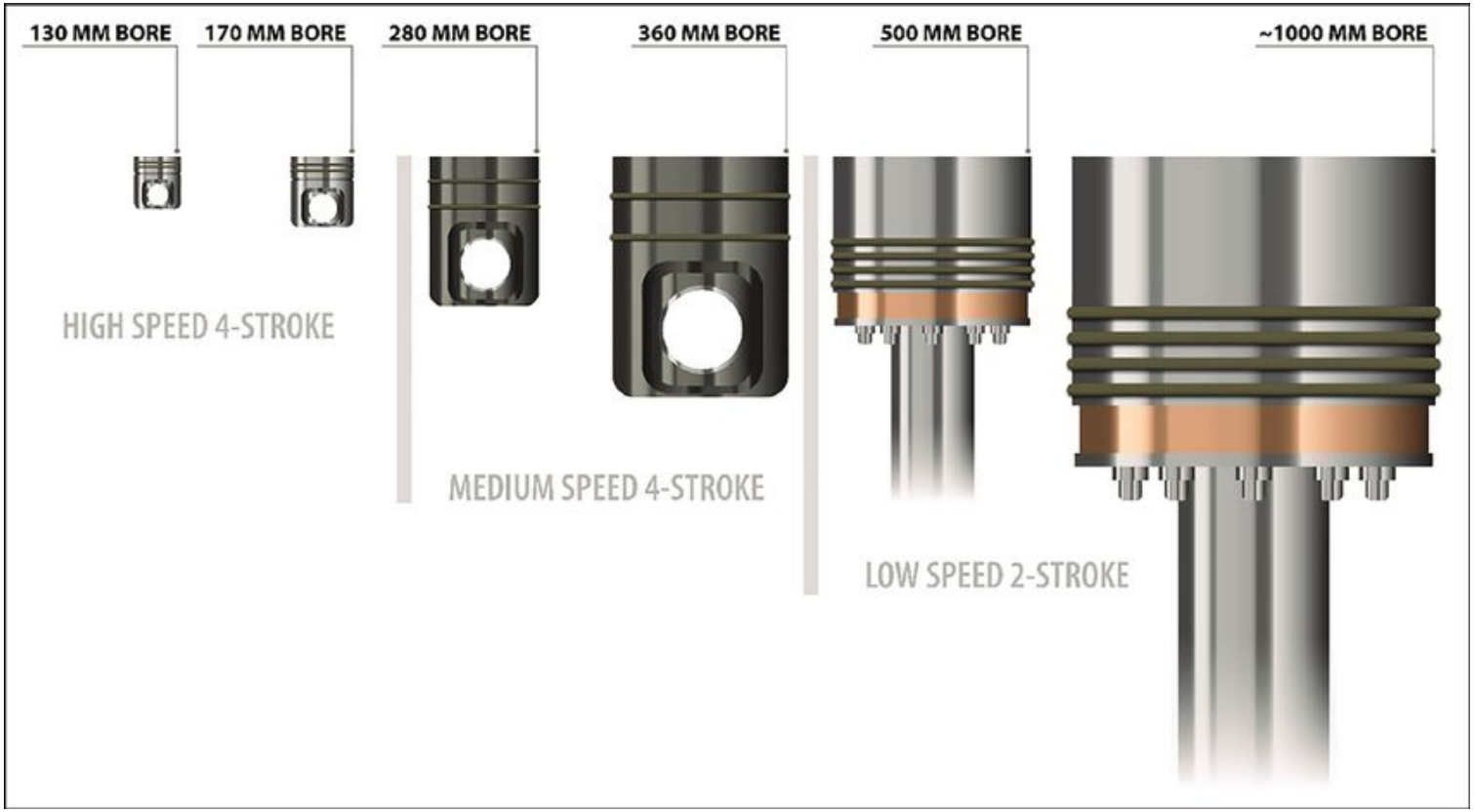
Engine Scavenging Modes Explained

Engine Scavenging Modes Explained

Method Of Scavenging



Method of Scavenging


130 MM BORE
170 MM BORE
280 MM BORE
360 MM BORE
500 MM BORE
~1000 MM BORE
HIGH SPEED 4-STROKE
MEDIUM SPEED 4-STROKE
LOW SPEED 2-STROKE