ENGINEERING ONBOARD

AEC1

Cycle of Operation

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THE DIESEL 4-STROKE CYCLE

INDUCTION: inlet valve open, piston descending, air charge being drawn in.

COMPRESSION: both valves close, piston rising compressing the air and adding heat.

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THE DIESEL 4-STROKE CYCLE

EXPANSION/POWER: fuel injected before piston reaches the top, combustion occurs forcing the piston down.

EXHAUST: before the piston reaches the bottom, the exhaust valve opens allowing the gases to exit - piston rise to remove any remaining gases.

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THE 2-STROKE CYCLE

Invention of the two-stroke cycle is attributed to Dugald Clerk a Scottish engineer who in 1881 patented his design, his engine having a separate charging cylinder.

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THE 2-STROKE CYCLE

UNIFLOW SCAVENGE

1. Compression
2. Power
3. Scavenge & Exhaust

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IN SUMMARY

The typical 2-stroke petrol engine is used for O/B engines/jet-skis/portable power sources - generators and pumps.
Large 2-stroke diesel engines are commonly used as the major prime mover in container ships and oil tankers.
In a vessel where high speed and fast manoeuvring is required then 4-stoke diesels are generally selected.

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BASIC TERMINOLOGY

Top Dead Centre: When the piston is at its uppermost point it is at top dead centre IDC.

Bottom Dead Centre: When the piston is at its lowest point, it is said to be at bottom dead centre. BDC.

Stroke: The vertical distance travelled by the piston between TDC & BDC is called the stroke.

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BASIC TERMINOLOGY

Swept volume: Is the volume swept or covered by the piston when moving in the cylinder from BDC to TDC, and equals the piston area x the stroke. Sometimes referred to as the Stroke or Displacement volume.

Clearance volume: The space left between the piston at IDC, and the cylinder head.

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COMPRESSION RATIO

On the compression stroke upwards - the difference between the initial volume of the cylinder and the final volume at the top of the compression stroke is known as the compression ratio.

Typical values are: 8-12 for SI engines and 12-24 for CI engines. Why are they higher in the diesel engine?

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ENGINE POWER

Rated in Horse Power (hp) or Kilowatts (KW)

hp x 0.746 = Kw
Example: 250 hp = 186.5 Kw

Kw x 1.34 = hp
Example: 1000 Kw = 1340 hp

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ENGINE PERFORMANCE - DEFINITIONS

The following performance definition are commonly used:

- Normal rated power - The highest power an engine is allowed to develop in continuous operation.
- Rated speed - The crankshaft rotational speed at which rated power is developed.
- Maximum rated power - The highest power an engine is allowed to develop for short periods of operation.

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THE INEFFECTIVE CRANKING ANGLE

This is the period at TDC and BDC when little or no movement of the piston occurs for a large movement of the crankshaft.

It allows, due to the natural design in all piston engines, both inlet and exhausts valve overlap to be achieved without loss of power and efficiency.

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FAULT FINDING

Use Trend Analysis' to check current engine performance against as new condition or fault finding - cylinder compression pressures, exhaust temperatures, oil condition, fuel flows.

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FAULT FINDING

- Black Smoke - lack of air or too much fuel - blocked air filters, poor vent, fouled turbo, defective fuel pump/injectors
- Blue smoke - burning oil - worn rings, tailed turbo-seals or valve guide seals.
- White Smoke - burning water in the cylinder - cracked block, leaking head gasket, failed wet liner seals.

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FAULT FINDING

Advanced timing (Bosch/Lucas) - caused by incorrect fuel pump set-up/damage to fuel pump coupling - Symptoms - Increased cylinder pressure but drop in exhaust temperature - typically head gasket tails.

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FAULT FINDING

Retard or late timing - same causes but this time - Symptoms - Decrease cylinder pressure but increase in exhaust temperature - typically drop in power, burning of exhaust valves, (vicious circling) - burn out turbo, glowing exhaust manifold potential funnel fire!

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Purposes of Air/Fuel Ratio

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AIR TO FUEL RATIO

Air-fuel ratio (AFR) is the mass ratio of air to a solid, liquid, or gaseous fuel present in a combustion process. If exactly enough air is provided to completely burn all of the fuel, the ratio is known as the stoichiometric mixture, often abbreviated to stoich or Lamba.
Both refer to the point at which the air and fuel mixture is perfect.

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AIR TO FUEL RATIO

For a petrol engine - it's just enough fuel to provide a nice, clean, and safe combustion with minimal emissions. This occurs when there are 14.7 parts of air to one part ot fuel, or an air/fuel ratio of 14.7:1. Divide the actual AFR by the stoichiometric ratio and you get the Lamba number, which will be I if they are both the same, greater than 1 if there is more air than ideal, or less than one if there is too much fuel.

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AIR TO FUEL RATIO

For a diesel engine the ideal ratio is 14.6: 1 but this varies with load and fuel quality if typically wrong it may cause: After burning is said to occur when the third phase of combustion extends over a long period. It may be caused by incorrect fuel grade, bad atomization, poor or excess penetration, incorrect fuel temperature, incorrect injection timing, insufficient air supply, or any combination of these.