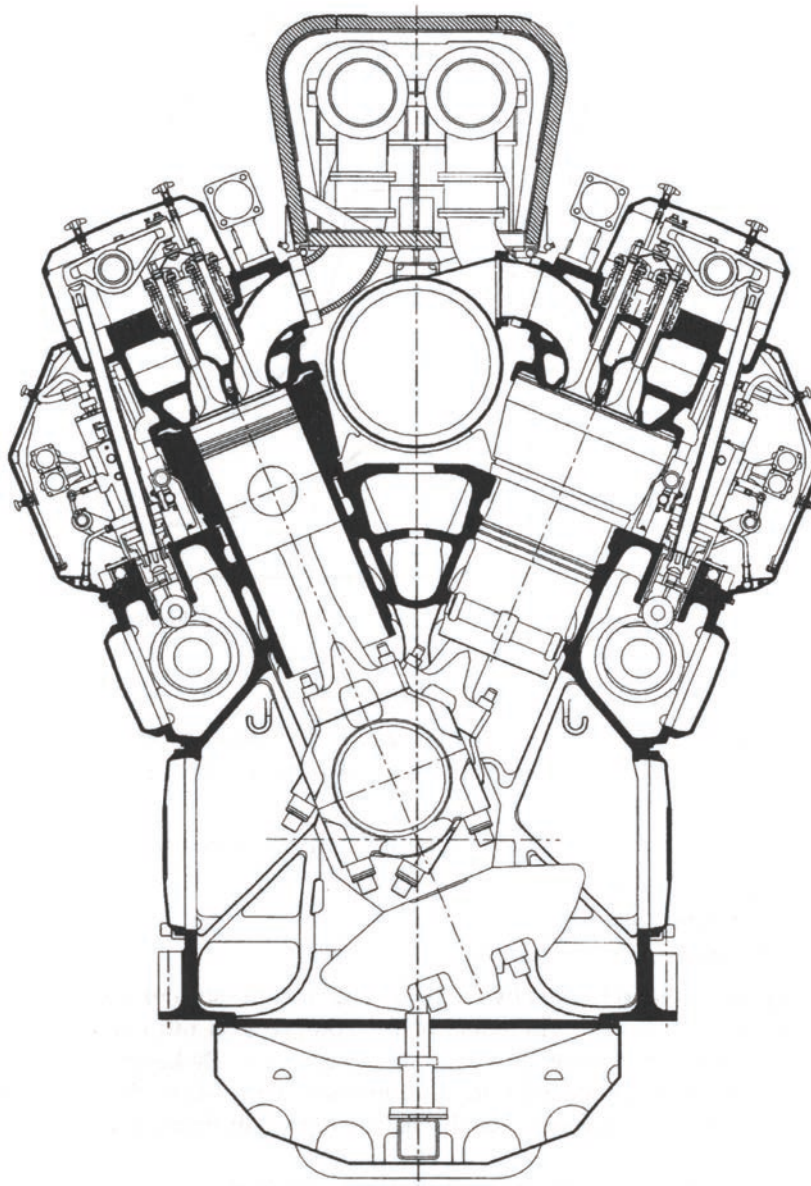

Figure 10. Wärtsilä NSD W46 four stroke engine cross section
(Courtesy of Wärtsilä NSD)

The Diesel Cycle

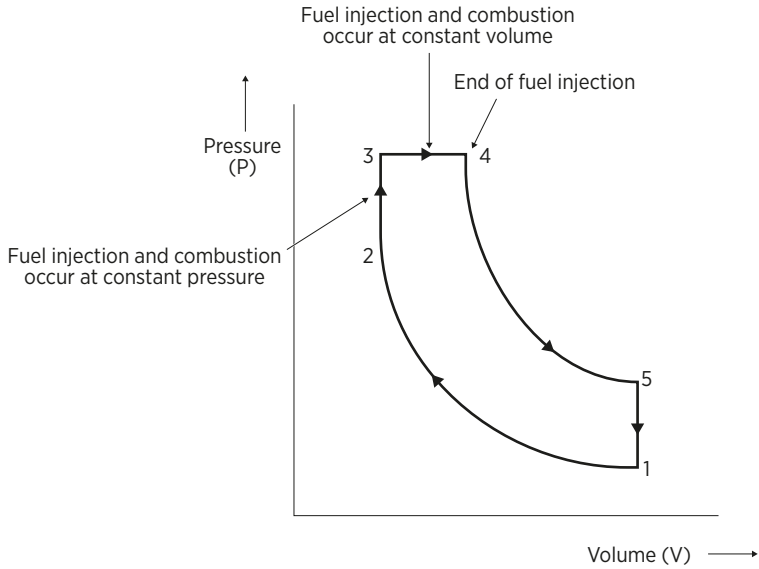

Figure 11. Diesel cycle

All two and four stroke engines work on the 'dual cycle', which is a combination of the Otto and Diesel cycles. The area of the diagram represents the work done per cycle.

The thermal efficiency of the above cycle depends on three ratios:

1. Compression ratio $r_v = V_1/V_2$
2. Pressure ratio $r_p = P_3/P_2$
3. Cut-off ratio $r_c = V_4/V_3$

The compression ratio is fixed by engine design (i.e. the stroke) and cannot be adjusted by the engineer. The effect of the compression ratio is to produce high pressure in the cylinder at the end of compression. By keeping the rings, liners and valves in good condition, the compression pressure will be kept at a maximum. The high pressure results in the high temperature required for efficient combustion.

The pressure ratio is determined by the point of fuel injection. Injection normally occurs about 20° before top dead centre to 20° after top dead centre. If the point of fuel injection is retarded, i.e. occurs later, the peak pressure will be reduced. If the point of fuel injection is advanced, the

peak pressure will be increased. High peak pressure should be avoided due to the increased mechanical stresses it puts on the running gear.

The cut-off ratio is determined by the quantity of fuel injected into the cylinder, i.e. by the position of the fuel lever.

Although a high compression ratio and peak pressure will produce a high efficiency, in practice thermal efficiency is also influenced by other factors, such as fuel quality, which may affect the rate of heat release and therefore the efficiency of the turbocharging system.

2 Main Propulsion Machinery – Operation and Maintenance

2.1 General

This chapter covers the operation and maintenance of main propulsion machinery, but should not replace the manuals issued by the engine manufacturer. These manuals will contain detailed information on maintenance procedures, with exploded drawings, lists of parts that may require renewing and any special tool requirements.

When preparing to overhaul an engine component, the maintenance manual should be studied in advance. This is particularly important if there are new engineers on board who may not have performed the task before. It is always useful to get all tools ready prior to commencing overhaul.

It is vital to ensure that the engine cannot be started during overhaul. Ensure the starting air to the engine has been isolated and that the valves on the air receiver have been locked shut. The drain valve on the air line should be open to ensure the line is vented. All indicator cocks should also be open.

The turning gear should be engaged and in the locked position when working in the crankcase. If need be, the fuses should be removed from the turning gear. There are occasions when someone will be in the crankcase when turning the engine, such as when reassembling a crosshead bearing, and great care should always be taken. The main lubricating oil pumps should be isolated and the fuses removed.

2.2 Running gear

2.2.1 Cylinder heads

Cylinder heads, whether on a two or four stroke engine, are complicated castings. They have to house the inlet and exhaust valves, fuel injector, air start valve, relief valve and indicator cock, as well as incorporating cooling water passages.

Due to the complexity of the casting, care must be taken in the design and manufacture to ensure the fillets have good radii, inspection holes are well compensated and stud holes are bossed. Coolant flow within the head should be as smooth as possible, which is particularly important around high temperature zones such as the injector pocket and exhaust valve cages.

There has been a trend to reduce specific fuel oil consumption (sfoc). One of the factors involved has been to increase the combustion pressure. This results in increased mechanical stress on the cylinder head, as well as higher temperatures (see Figure 12).

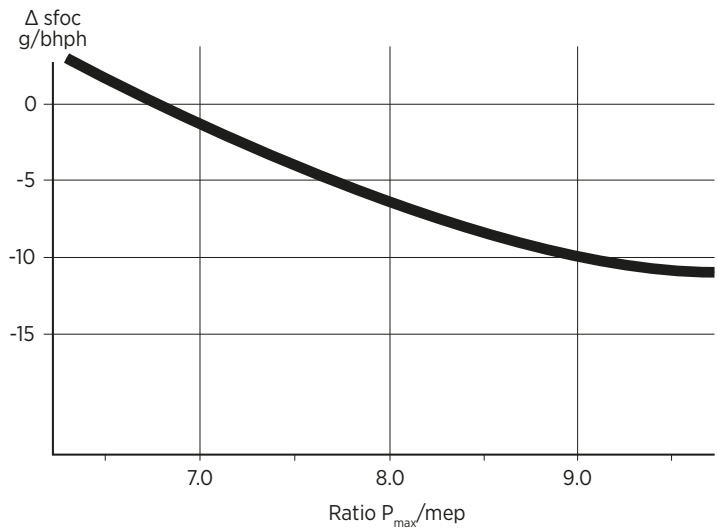

Figure 12. Influence of ratio P_{max}/mep on sfoc
(Courtesy of MAN-B&W Diesel)

It is preferable to manufacture the head from cast steel, but this can result in complications in casting. Cast steel does not flow as freely as cast iron