SULZER **RT-flex**

Sulzer RT-flex low-speed engines

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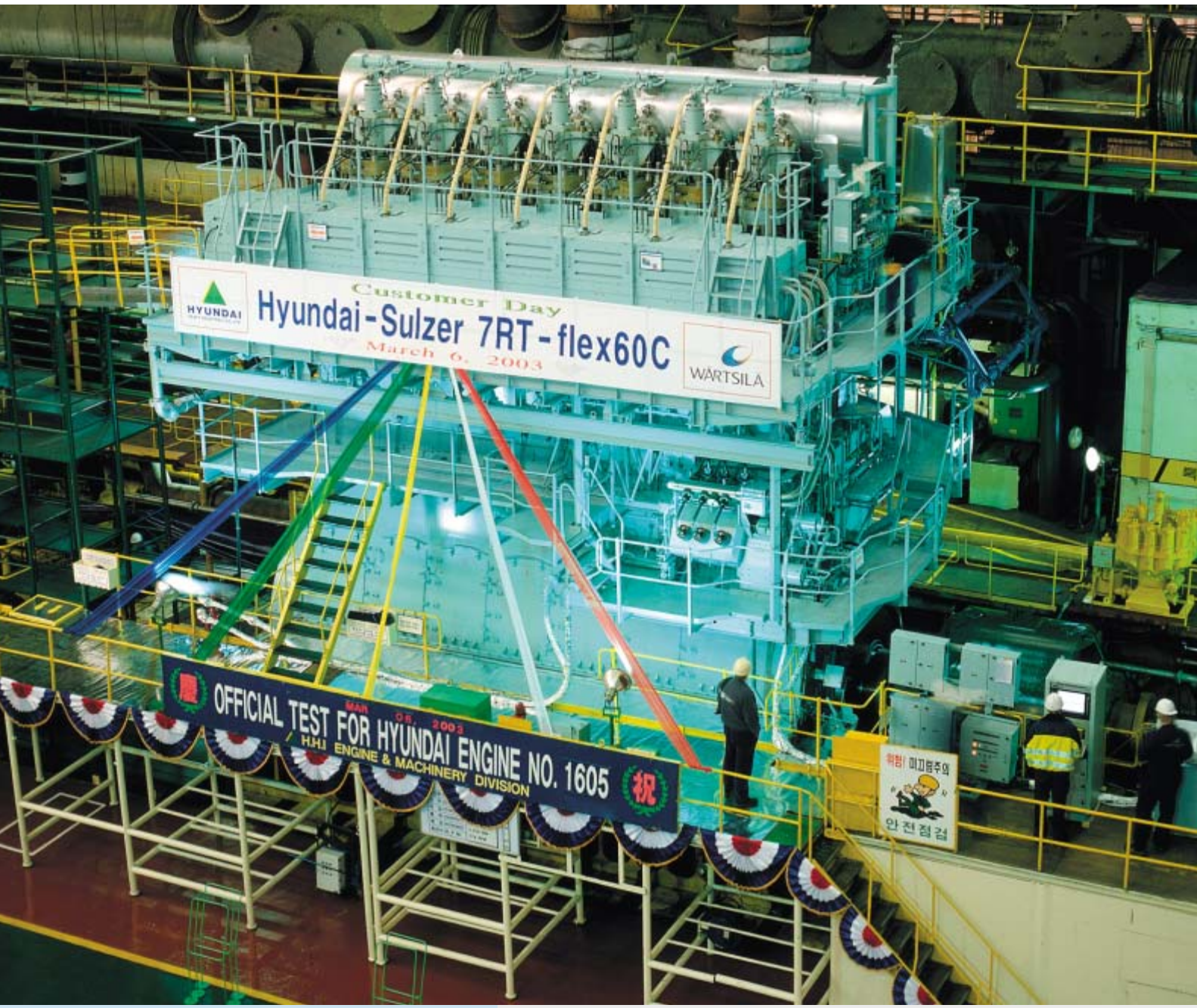
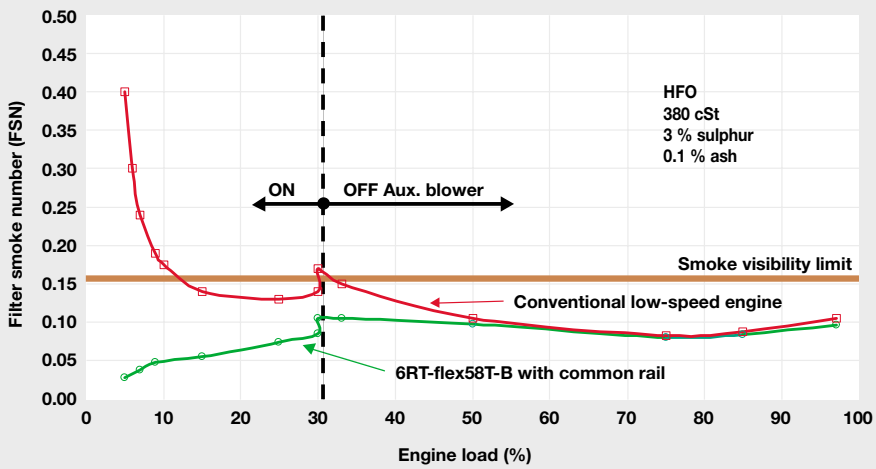


Sulzer 7RT-flex60C engine during shop test



Smoke measurements from the sea trials of the first Sulzer RT-flex engine demonstrate the smokeless operation of RT-flex engines compared with conventional low-speed engines

Innovation with confidence

The major steps in marine diesel technology have been few: the two-stroke engine cycle in about 1905, airless fuel injection in the 1930s, welded construction in the late 1940s, exhaust-gas turbocharging and the use of heavy fuel oil both in the 1950s, and 'superlongstrokes' in the 1980s. Each opened new possibilities for future development.

Now we have another major step - electronically-controlled common-rail fuel injection - introduced in SULZER® RT-flex engines. Although common-rail fuel injection is itself not new, the addition of integral electronic control allows full use to be made of the flexibility given by common-rail injection. This makes Sulzer RT-flex engines the most advanced low-speed marine engines available in the world today.

Development of the Sulzer RT-flex system began in 1993, and it was applied to a full-scale research engine in 1998. The first series-built engine, a Sulzer 6RT-flex58T-B of 11,275 kW, entered service in September 2001. The system has since been extended to engines from 500 to 960 mm cylinder bore.

Benefits of Sulzer RT-flex engines

Sulzer RT-flex engines have distinct benefits for shipowners.

Smokeless operation

A clearly visible benefit is smokeless operation at all ship speeds. The superior combustion performance with the common-rail system is achieved by maintaining the fuel injection pressure at the optimum level right across the engine speed range. In addition, the selective shut-off of single injectors and an optimised exhaust valve timing help to keep smoke emissions below the visible limit at very low speeds.

Sulzer RT-flex engines also comply more easily with the NO_X emission limit in Annex VI of the MARPOL 73/78 convention, with the best possible trade-off between fuel consumption and NO_X emissions at all loads.

Reduced running costs

Reduced running costs of Sulzer RT-flex engines come from reduced maintenance requirements and a lower part-load fuel consumption.

Maintenance costs become more predictable through better balanced operation and better retention of engine settings over many running hours. Excellent balance in power developed between the different engine cylinders and from cycle to cycle is provided by the common-rail system with its volumetric control. As engine settings are made electronically, the 'as-new' settings are retained so that engine performance such as fuel consumption does not deteriorate over time. The better running of the engine will also make for better prediction of maintenance timing and allows times between overhauls to be extended.

Lower running speeds

Precise control of injection, high injection pressures at low speed, and the sequential shut-off of injectors combine to give steady running at very low running speeds without smoking, down to 10-12% of nominal speed.

High reliability and redundancy

Particular attention has been given to making the RT-flex system reliable. The common-rail system concept also has inherent redundancy, adding to reliability and safety.

Redundancy is built in through multiple fuel and servo oil pumps, together with duplicated high-pressure fuel and servo-oil delivery pipes, and electronic systems. The multiple pumps have adequate redundancy for the engine to deliver full power with at least one fuel pump and one servo oil pump out of action, and only a proportional reduction in power should further pumps be out of action.

Key elements of the Sulzer RT-flex

World's biggest common rail

The Sulzer RT-flex concept brings common-rail fuel injection to the modern, large diesel engine. Current jerk-type fuel injection systems combine pressure generation, timing and metering in the injection pump with only limited flexibility to influence the variables. In contrast, the common-rail system separates the functions and gives far more flexibility. It has the distinctive features of precise volumetric fuel injection control, variable injection rate shaping, and free selection of injection pressure.

Well-proven fuel pumps

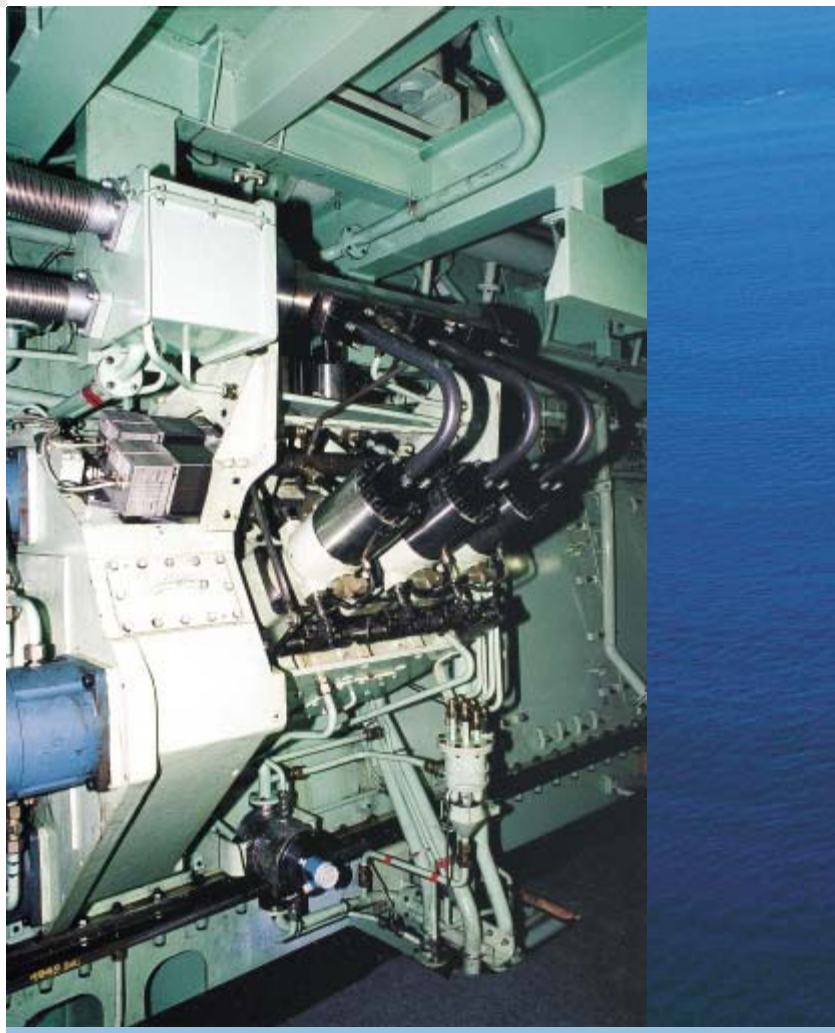
It employs high-efficiency fuel pumps based on the well-proven design of injection pumps used in Sulzer medium-speed engines. They run on multi-lobe cams to deliver adequate quantities of fuel to the common rail at the usual high pressure ready for injection. The common rail is, in effect, a manifold running the length of the engine just below the cylinder cover level. It provides a certain storage volume for the fuel oil, and has provision for damping dynamic pressure waves.

Electronic injection control

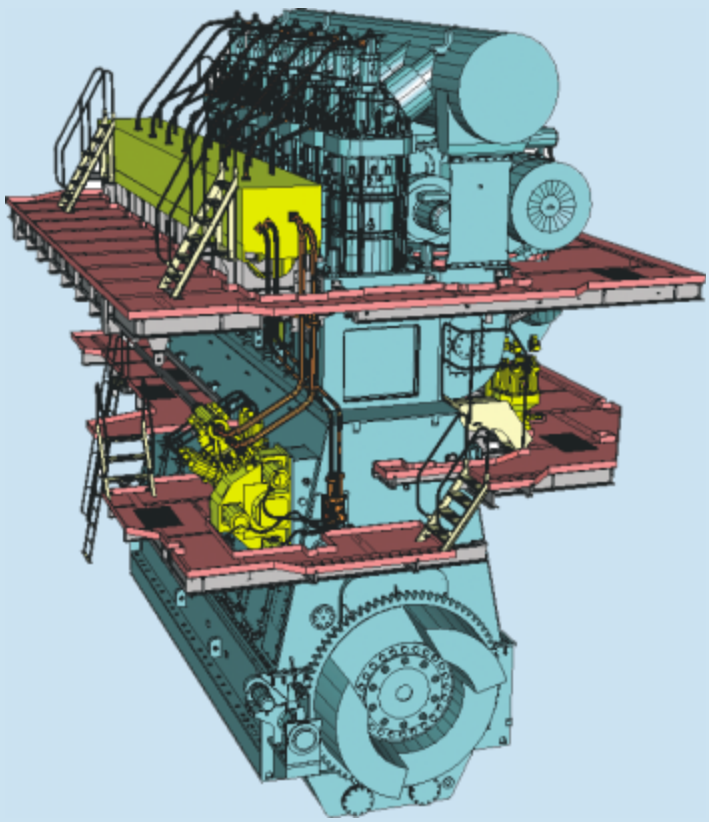
Fuel is delivered from the common rail through injection control units to standard fuel injection valves. The control unit for each engine cylinder regulates the timing of fuel injection, provides control of the volume of fuel injected, and sets the shape of the injection pattern. The three fuel injection valves in the respective cylinder cover are independently controlled so that they may be programmed to operate separately or in unison as necessary.

Ideal for heavy fuel oil

Sulzer RT-flex system is purpose-built for operation on standard grades of heavy fuel oil. For this reason, it incorporates certain design features not seen in other common-rail engines using middle-distillate diesel oils.

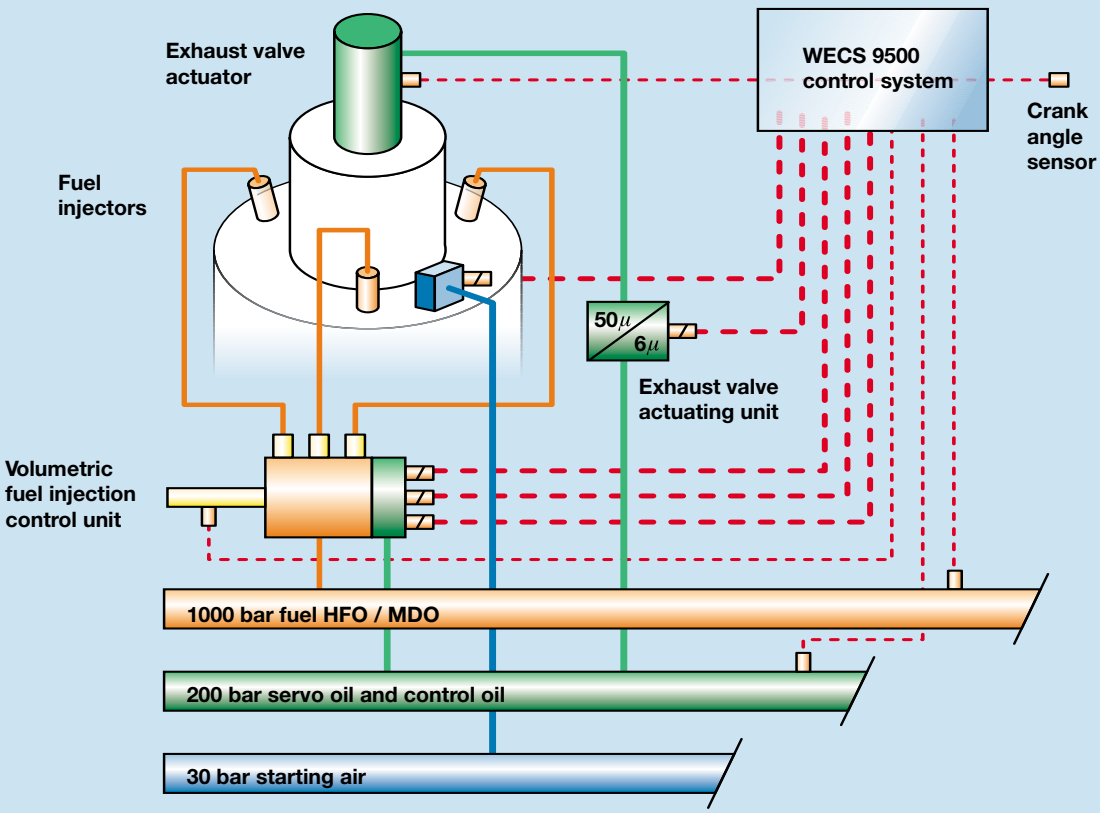


Supply unit of the 7RT-flex60C with fuel pumps on the right and the servo oil pumps on the left

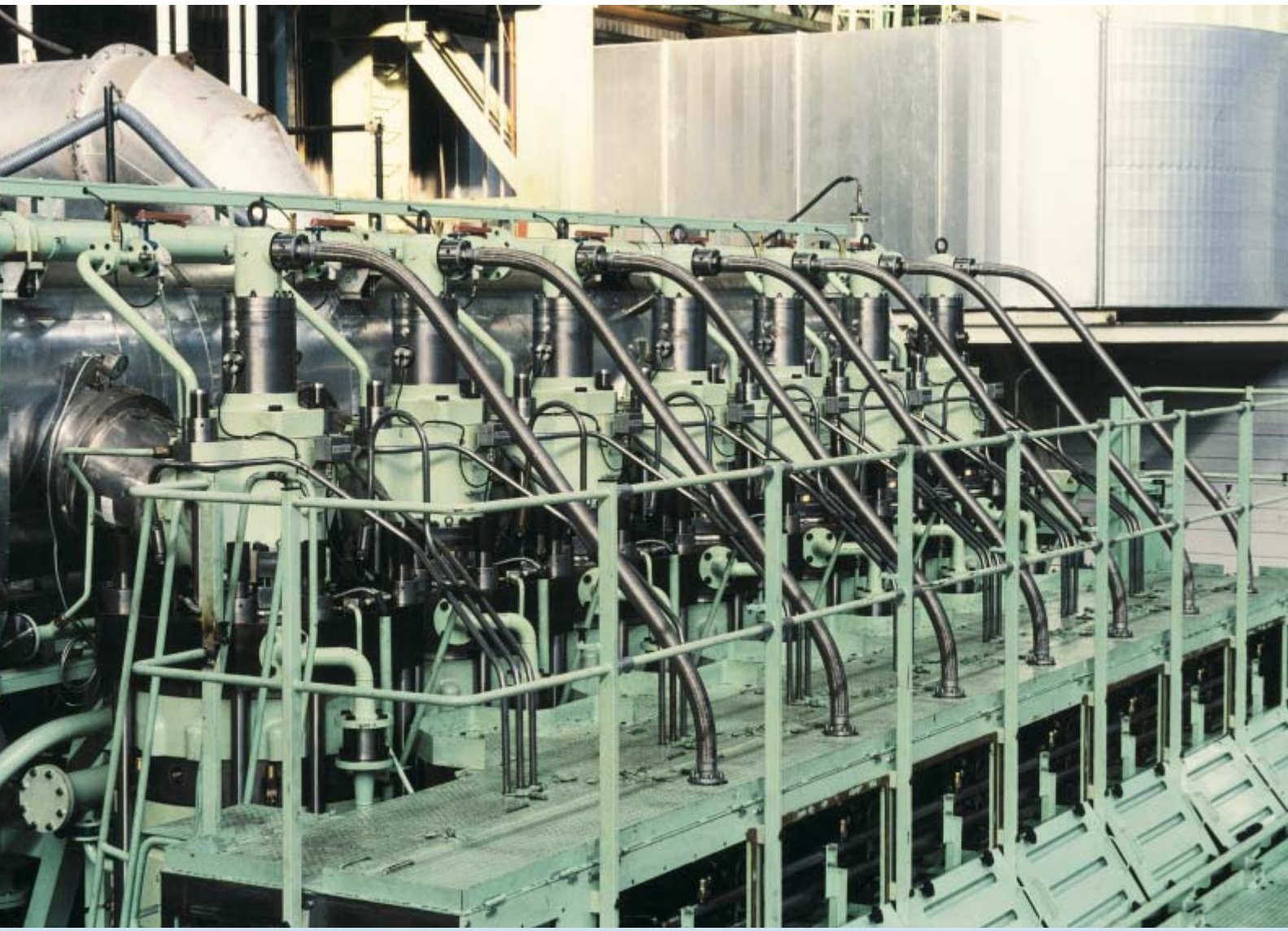


The main elements of the RT-flex system can be seen in yellow: the supply unit with fuel and servo oil pumps, the rail unit alongside the cylinders, and the servo oil filter on the other side.

"Gypsum Centennial" powered by the first Sulzer RT-flex engine



Sulzer RT-flex engines have electronically-controlled common-rail systems for fuel injection and exhaust valve actuation



Cylinder tops of the 7RT-flex60C with rail unit open at the side for access

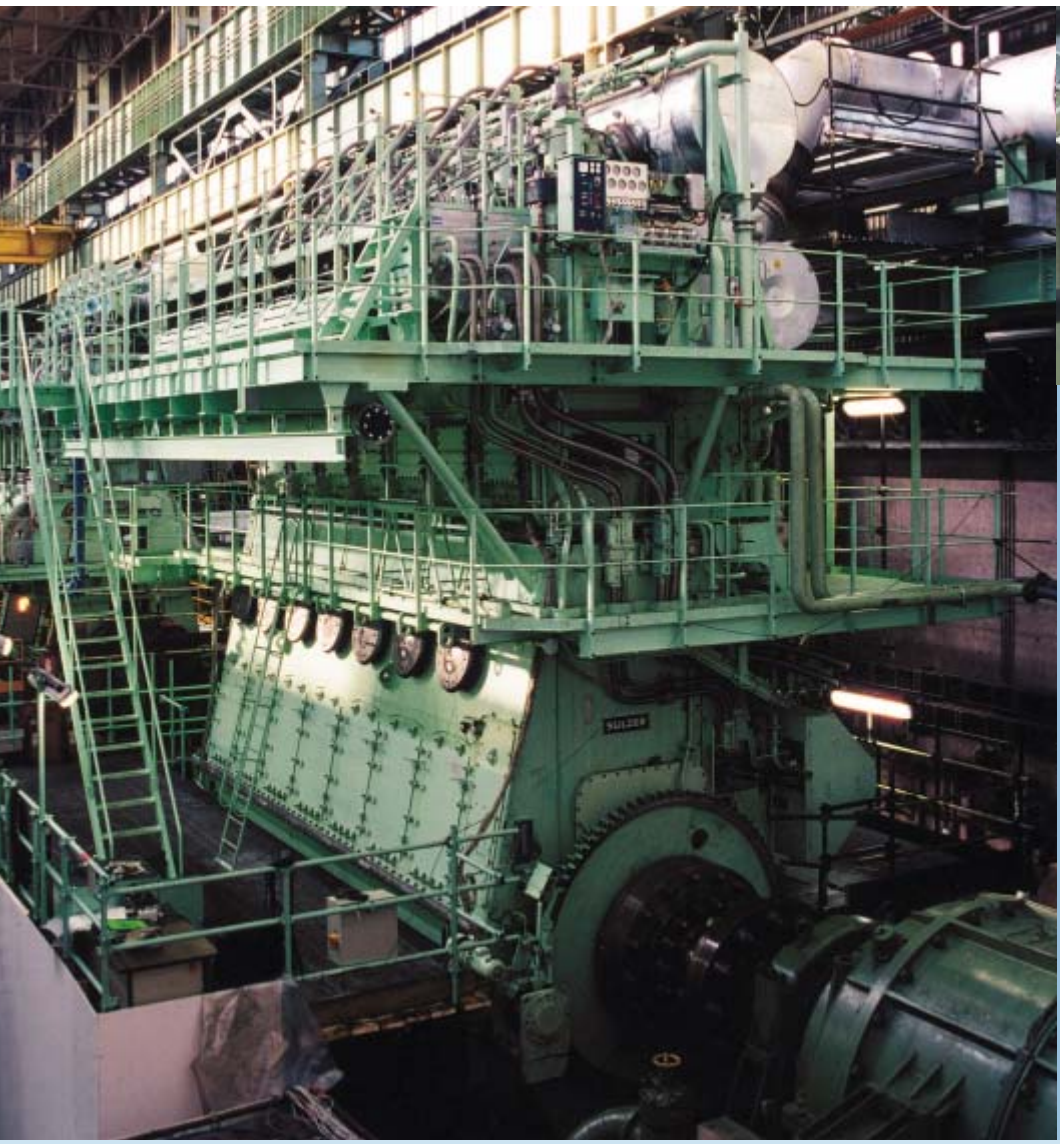
Exhaust valve actuation and servo oil systems

The Sulzer RT-flex system also includes exhaust valve actuation and starting air control. The exhaust valves are operated in much the same way as in existing Sulzer RTA engines with a hydraulic pushrod but with the actuating energy now coming from a servo oil rail at 200 bar pressure. The servo oil is supplied by high-pressure hydraulic pumps driven from the same gear drive as the fuel pumps. The electronically-controlled actuating unit for each cylinder gives full flexibility for valve opening and closing patterns. This unit utilises exactly the same rail valves as are used for controlling fuel injection.

Ease of installation

Although RT-flex engines can be called revolutionary, they are fully compatible with the RTA engines in relation to engine room installation and shipboard operation. This means that the main outline dimensions, foundations, key engine parameters, integration in ship automation and other interfaces of the RT-flex engines are identical with those of the corresponding RTA engines.

It should also be noted that at heart the RT-flex engines have the same structure, running gear and processes as the existing RTA-series engines. In addition, vital parts such as the fuel injectors and exhaust valves of the RT-flex are fully compatible with those of RTA engines.



Sulzer 7RT-flex60C engine during shop test

At the heart of the RT-flex system are quick-acting Sulzer Rail Valves

Flexible possibilities for future development

The Sulzer RT-flex concept provides the fully operational basis for a wide future development. Many improvements will be possible simply by software developments and thus could be easily retrofitted to existing RT-flex engines without hardware changes.

For example new patterns of fuel injection and exhaust valve operation could be introduced to optimise engine running for special 'modes' with priority given to lower NO_X emissions, lower fuel consumption, or greater waste heat recovery. It would thus be possible for ships' engineers to select their preference for their engine's operating criteria to suit their ship's prevailing requirements.

Another possibility is for future RT-flex engines to monitor their own condition and adjust key parameters automatically for the best engine performance. Many of the necessary condition monitoring systems are already in service with Sulzer diesel engines.

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