

Across the world's oceans without a care

2-stroke diesel marine engines with FIVA valves from Bosch Rexroth consume less fuel and operate with minimum emissions. The specially tailored maintenance program offered by Bosch Rexroth's Marine Service forms the basis for ensuing optimum performance is maintained cost-

efficiently throughout the entire life cycle. Owners, superintendents and crew members can draw on the five measures outlined below to make their ship operation even more profitable, simpler and safer.



Ships' engines must operate reliably around the clock. At the same time, however, they should also ensure the lowest possible emissions and minimum operating costs. This can only be achieved with optimum control of the fuel injection and exhaust gas outlet. Bosch Rexroth's hydraulic servo valve is designed to follow the performance curve of large 2-stroke diesel engines precisely, thus allowing fuel consumption and NOX emissions to be minimized. When it comes to ensuring reliable operation, another key aspect is optimum ease of handling: Bosch Rexroth's FIVA valve fulfills this requirement thanks to its integrated electronics. The complete valve can be replaced during a service call without adjustment. This significantly reduces failure times, unproductive layovers and ultimately maintenance costs. The total cost of ownership can be further reduced however by drawing on the special maintenance offered by Bosch Rexroth's Marine Service. Why is this the case? These are the reasons why:

WHY DO BREAKDOWNS HAPPEN AT SEA?

The best engine is only as good as its components. When shipping companies opt for FIVA valves from Bosch Rexroth, they know that they have chosen a robust and high-precision solution. Yet, like any hydraulic valve, this component does not remain wear-free either and also operates under harsh conditions. In extreme situations and where maintenance is deficient or neglected, spontaneous failures can also happen on occasion.

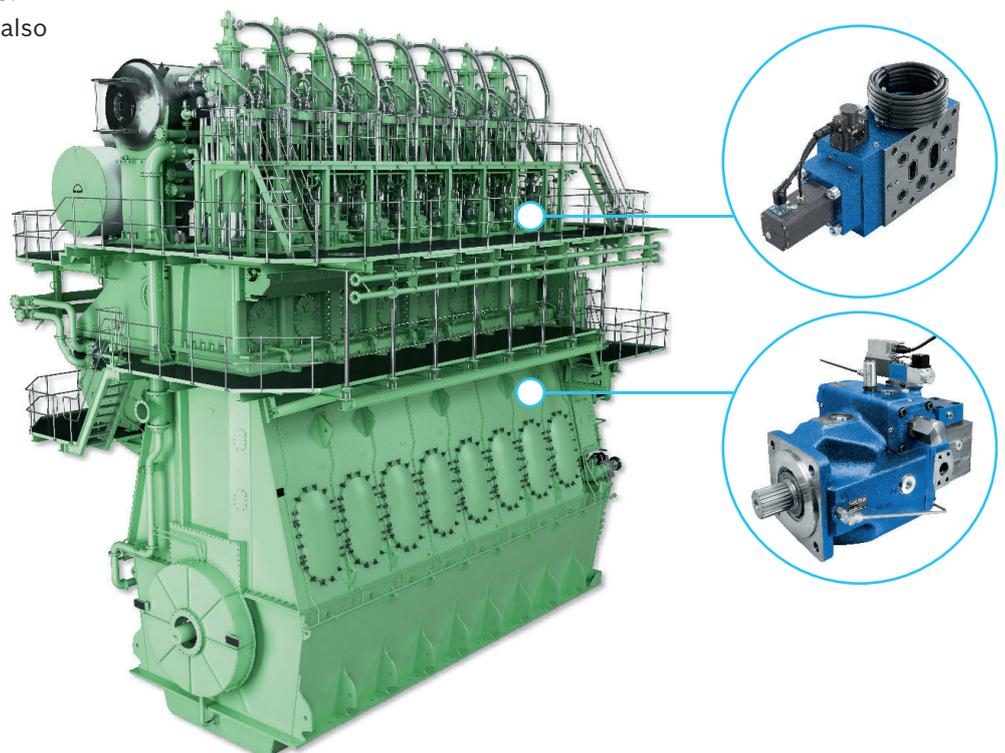
Cause 1: Overheating of the electronic controls

The temperature exerts an enormous influence on the life cycle of the electronics. If FIVA valves are used with a proportional valve as a pilot, electronics failures caused by overheating represent the most frequent cause of failure during operation. The reason for this is that the mechanical principle of operation requires high currents of up to 3.5 A. In contrast, the FIVA valve from Bosch Rexroth with servo pilot valve is controlled with just up to 0.03 A. Compared with proportional valves, considerably less waste heat is therefore generated, which together with the high temperatures and vibrations in the engine room loads the electronic controls and can lead to premature failure.

Cause 2: Contaminated engine oil

Control valves in marine diesel engines do not have their own hydraulic circuit, rather use engine oil, which is fed by the pump through a filter system. The problem with this is that if the oil cleanliness is inadequate, smaller particles can impair the precision of the pilot valve and main stage of the FIVA valve over time. If the particles are larger, clogging in the pilot valve can even cause malfunctions. Simple plug & play replacement of the pilot valve provided as a spare part can help here (see point 4).

- ▶ **2-stroke diesel engine with 8 cylinders, FIVA valve and Rexroth A4 axial pump.**



5 POINTS FOR RELIABLE ENGINE PERFORMANCE

The following five measures will help you to avoid unnecessary costs and ensure smooth and optimum operation:

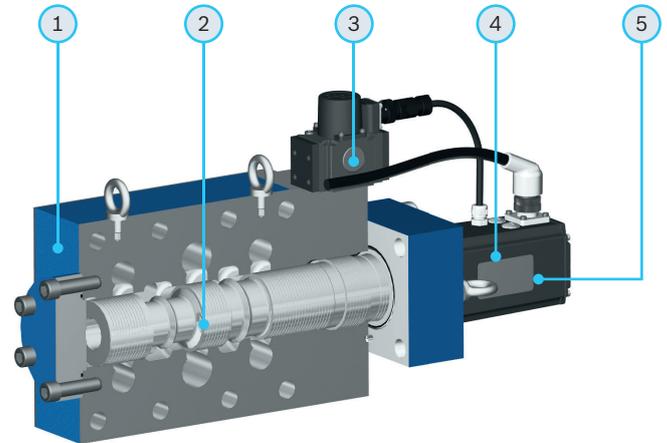
Point 1: Follow manufacturer's recommendation

The latest generation of FIVA valves from Bosch Rexroth is designed for more than 250 million load cycles. This corresponds to a running time of at least five years. The service letter issued by MAN B&W recommends an overhaul after this time. Replacement is prescribed every ten years owing to advanced wear. These maintenance intervals must be observed since they are a basic requirement for reliable performance. If the shipping company nevertheless risks spontaneous failures and no spares (plug and play in case of Rexroth) are available at the vessel, the ship can only continue its journey at a slower speed and may be delayed reaching the next port. In an absolute worst-case scenario, the ship becomes unable to maneuver owing to several simultaneous failures and therefore represents a hazard for people and the environment.

Point 2: Expert overhaul

Bosch Rexroth has developed a globally available service concept for the five-year overhaul and other maintenance work, which is fundamentally geared to quality and availability. The overhaul that is required after 32,000 operating hours (5 years) includes the following services:

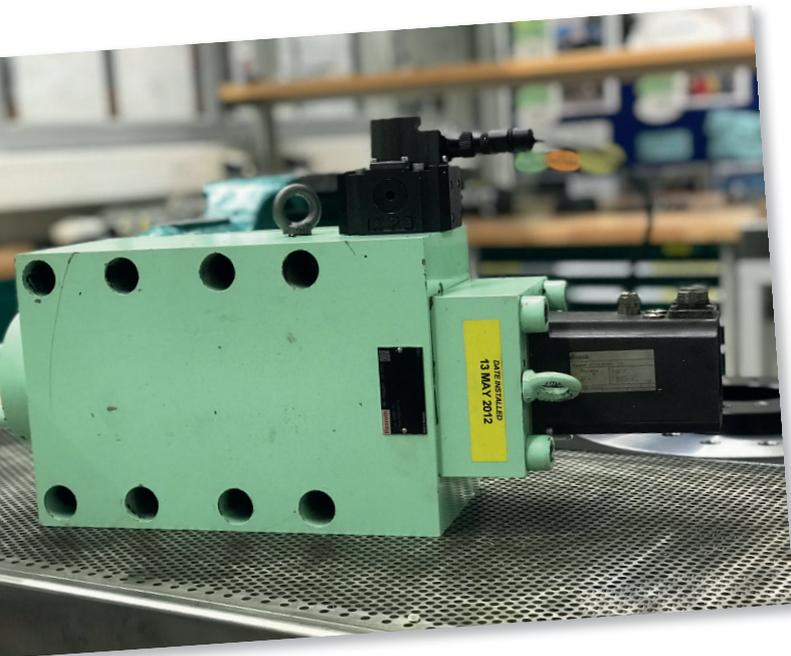
- ▶ 1. Incoming inspection on test bench
- ▶ 2. Dismantling and visual inspection of the parts
- ▶ 3. Detailed repair report
- ▶ 4. Follow-up work on main spool and housing (if required)
- ▶ 5. Replacement of pilot valve, position sensor and electronic controls
- ▶ 6. Replacement of all rubber gaskets
- ▶ 7. Adjustment of the valve in accordance with the factory specification including zero point setting
- ▶ 8. Corrosion protection / painting of housing



- ▲ **Ready for another 32,000 operating hours: Bosch Rexroth Service reworks the housing and main spools as part of the overhaul (1+2). Pilot valve, positional transducer and electronic controls (3+5) are refurbished.**

Thanks to their systematic approach, the service engineers resolve all relevant target/actual deviations and therefore ensure as-new performance and availability for another five years. The zero point calibration in accordance with the factory specification is especially important in this context. This can only be carried out by the Bosch Rexroth Service Center as they are the only ones with access to the vital production data. Omitting this zero point calibration would be almost negligent since the valve can then no longer operate precisely when opening and closing. The result is a loss of efficiency, increased exhaust emissions and risk of damage. In a worst-case scenario, critical overpressure can occur in the cylinder and the cylinder cover can become dislodged. (Cover lift)

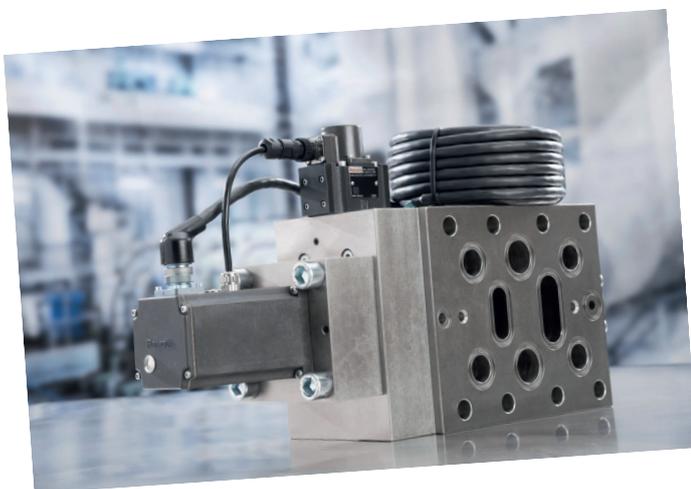
Components such as the pilot valve, positional transducer and electronic controls should also always be replaced to ensure reliable operation. Unfortunately, replacement of these important parts is commonly dispensed with for cost reasons.



▲ FIVA during overhaul by Rexroth Service.

Point 3: Replacement of FIVA valve

The main spools and housing of Rexroth's FIVA valves are produced in pairs to ensure minimum tolerances and optimum performance values. The level of wear is typically so advanced after 64,000 operating hours (10 years) that reworking within the framework of the tolerances is no longer possible. The complete valve is replaced in accordance with recommendations. The period of time spent in dry dock offers a good opportunity to replace less accurate or more error-prone valves for Rexroth FIVA valves. Thanks to Bosch Rexroth's global presence, the technical know-how is available to do just that.



▲ Dazzling performance: new FIVA prior to installation.

Point 4: Replacement of pilot valve on board

The recommended maintenance intervals are calculated under the assumption of regular maintenance and normal cleanliness of the oil. Spontaneous failures can also occur, however, with higher levels of contamination or overheating. Instead of replacing the entire FIVA valve straight away as part of the troubleshooting, it is sufficient to replace the pilot valve first. This can be handled by the on-board mechanic thanks to the closed control loop internally in the valve and the plug & play cable connection. The spare part that can be ordered from Bosch Rexroth weighs just 500 g, is mounted with four screws and can be connected to the FIVA valve without calibration and via a single connector. If this relatively simple measure still does not resolve the problem, there must be a different cause. Further analysis can then be performed from this point in order to provide the relevant information for Rexroth Service.

Point 5: Talking to Bosch Rexroth

Those who have neglected maintenance up to now or want to mitigate the cost and failure risk permanently using simple means will find a dedicated contact at Bosch Rexroth for every region. Spare parts, including pilot valves, are available globally, which means that a lot of work can also take place outside of dry dock on the high seas or in the harbor.

PREVENTION IS BETTER THAN CURE

No shipping company can afford unplanned layovers. Maintenance should therefore not be left to chance. Crew members are also happy if there are no failures or reductions in performance en route to the next port. The best way to avoid time losses, stress and unnecessary repairs is to perform expert preventive maintenance. In cooperation with Bosch Rexroth's Marine Service, owners and superintendents ensure optimum performance and availability, thus ensuring that the crew on board is capable of acting at any time – a good feeling and a win-win situation for all involved.

FIVE POINTS FOR OPTIMUM FIVA PERFORMANCE:

- ▶ 1. Compliance with service recommendations of the engine manufacturer
- ▶ 2. After five years: Overhaul by Bosch Rexroth for optimum performance and availability
- ▶ 3. After ten years: Replacement or opportunity to replace lower-performance valves
- ▶ 4. Original spare parts: Pilot valve for replacement on board as well as for troubleshooting (plug & play)
- ▶ 5. In the event of lapsed maintenance or problems with proportional valves: make contact with Rexroth Service globally (replacement possible in all major ports)

ABOUT THE FIVA VALVE FROM BOSCH REXROTH

The new generation of FIVA servo valves from Bosch Rexroth for 2-stroke diesel engines with up to 300 rpm (**F**uel **I**njection & **V**alve **A**ctivation) implements the respective injection profiles with optimum accuracy. Thanks to modern test methods, calculation and simulation techniques, internal friction of the main spool is up to 95 percent lower than usual. The reduced wear as a result allows a considerably longer life cycle with 250 million load cycles and minimum operation costs, which corresponds to at least five years of running time. A sandwich filter protects the FIVA pilot valve from contamination and damage during commissioning of the engine. This results in lower fuel consumption and minimum emission values, even under the most extreme conditions. What's more, the fail-safe philosophy prevents damage to the engine in case of a power failure. The most important advantages:

- ▶ Greater precision (fuel savings, emissions)
- ▶ Less wear (significantly reduced internal friction of the main spool)
- ▶ Higher availability / fewer unproductive layovers
- ▶ Service-friendliness: Pilot valve can be integrated and exchanged as a plug & play solution
- ▶ Lower maintenance costs / lower total cost of ownership

Authors:

Volker Tenhaeff
Senior Manager Service Sales Support
Bosch Rexroth AG

Luc Staub
Senior Area Manager Service
Bosch Rexroth AG