The Drive & Control Company

Rexroth
Bosch Group

Reliable and efficient components and systems for rail vehicles

Focusing on costs over the entire life cycle

Global rail transport covers billions of kilometers a year – moving people and freight efficiently, often in the harshest climatic conditions. The goals are safety, energy efficiency, and lowering emissions. With tailor-made components and systems Rexroth helps manufacturers and transport operators lower the life cycle costs of rail vehicles and equipment.

RAMS – four key parameters
Rail operators take a decades-long view as that is how long rail vehicles remain in operation. Total Cost of Ownership (TCO) over the entire life cycle is what counts. In addition to energy costs, four key parameters are crucial: reliability, availability, maintainability, and safety, or RAMS for short. Rexroth's electrical, hydraulic and electro-hydraulic components and system solutions demonstrate these qualities daily, in thousands of rail vehicles, worldwide.

Improved energy efficiency – reduced emissions
Minimizing electricity and fuel consumption is increasingly important. For instance, new limitations for exhaust emissions have come into force with Stage IIIB and TIER 4 Final, requiring fundamental changes in engine technology for diesel-powered vehicles.

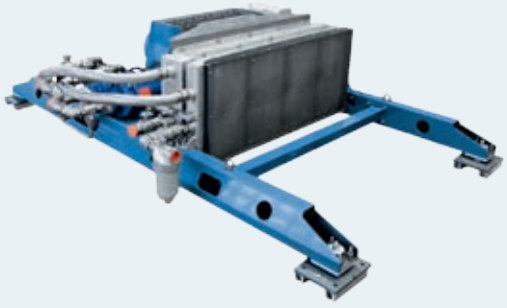
A key player in this are cooling systems that deliver precise temperature regulation on demand. Demand-oriented cooling reduces fuel consumption of diesel engines, and consequently exhaust gas emissions. As a system partner for the entire cooling system assembly, Rexroth incorporates its engineering expertise into the rail vehicle and takes into consideration the overall system – including retrofitting new engines in older vehicles.

Global partner throughout the life cycle
Rexroth has been a multi-technology system partner for over 50 years in the rail industry. Hydraulics, electrical drive and control technology, and mechanical systems combined with experienced specialists that know the market, provide the best possible technical and economic solution. This process incorporates extensive experience in industrial applications, mobile equipment and automotive applications. Beginning with an encompassing system knowledge, this process links tried and true quality management with a secure long-term spare part supply management chain. Bosch Rexroth has a presence in over 80 countries, and is ready, willing and able to act locally and perform globally.

Solutions for rail vehicles

The technologies available for rail transport are evolving rapidly, such as networking of individual modules within the vehicles and the railroad systems. Lower operating costs and reduced emissions combined with maximum safety and reliability are reducing life cycle costs. Manufacturers have to adapt these new opportunities into approval-ready rail vehicle designs faster than ever before. With its tailor-made components and system solutions, Rexroth helps manufacturers and operators of rail vehicles achieve these goals.

Hydrostatic auxiliary drives
The right output power in the right place: with its extensive range of hydraulic pumps and hydraulic motors Rexroth provides a virtually unlimited selection of fans, compressors and generator drives. The components, which are finely scalable in terms of their operation and output power, can be integrated into confined spaces, and are ideal for the limited design areas found in rail vehicles.



Cooling systems
Increasingly stringent regulations for permissible emissions from rail vehicles apply virtually throughout the world. Rexroth's complete cooling systems with electrically or hydrostatically driven fans, help designs remain below the permissible limit values, and increase energy efficiency.


Source: Vossloh

Hydrostatic traction drives
Specialized railroad vehicles have to maintain extremely low speeds while smoothly and steadily moving loads weighing several tons. Rexroth's hydrostatic traction drives carry out these tasks adroitly and efficiently. As the world's largest supplier of equipment for mobile work machinery, Rexroth offers you a combination of best-in-class components and integrated system solutions.

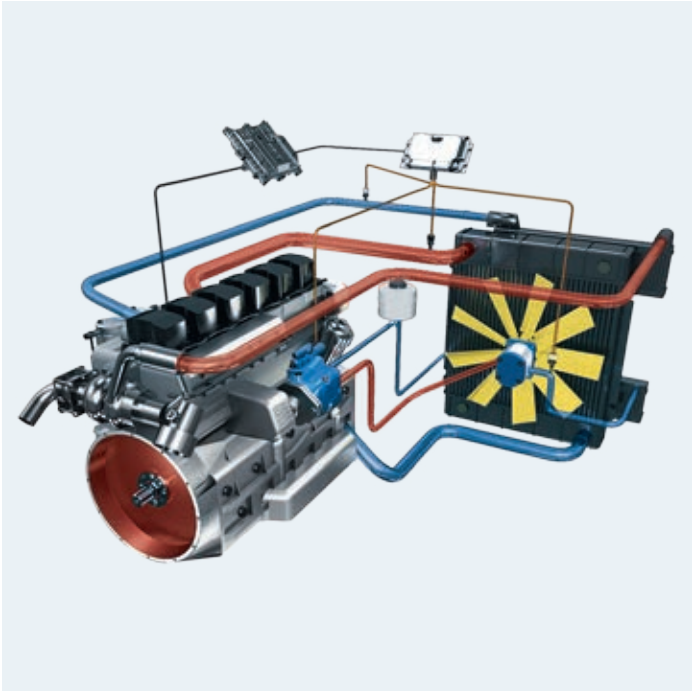
Hydraulics for railway maintenance of way machinery
Maintenance of way machines must be able to deliver powerful forces and provide accurate control processes. Rexroth has been collaborating with the manufacturers of railway maintenance machinery for decades. That is why Rexroth understands the special requirements involved, and implements them in tailor-made system solutions.

Auxiliary drives – intelligent solutions for efficiency

Fans, compressors or generator drives: with the widest range of hydraulic pumps and motors, Rexroth provides virtually unlimited opportunities for implementing the right output power at the right place. Its components are finely scalable in terms of their configuration and output power, and therefore a perfect fit for diesel-powered rail vehicles.

Modular construction for confined installation spaces
The limited installation space in rail vehicles make a modular arrangement indispensable. The components forming an auxiliary drive can be flexibly configured so that the best possible arrangement of the hydraulic components within the rail vehicle is achieved without sacrificing ease of maintenance.

Hydrostatic fan drives
Their job is to dissipate the heat generated by the engine's combustion as it arrives at the cooler, thereby ensuring the optimal engine and combustion temperature. Intelligently controlled fan systems facilitate compliance with the legal emissions guidelines and they also reduce fuel consumption. Controlled via sensors, they cool as required depending on the measured temperature, and they consequently also produce lasting reductions in operating costs.

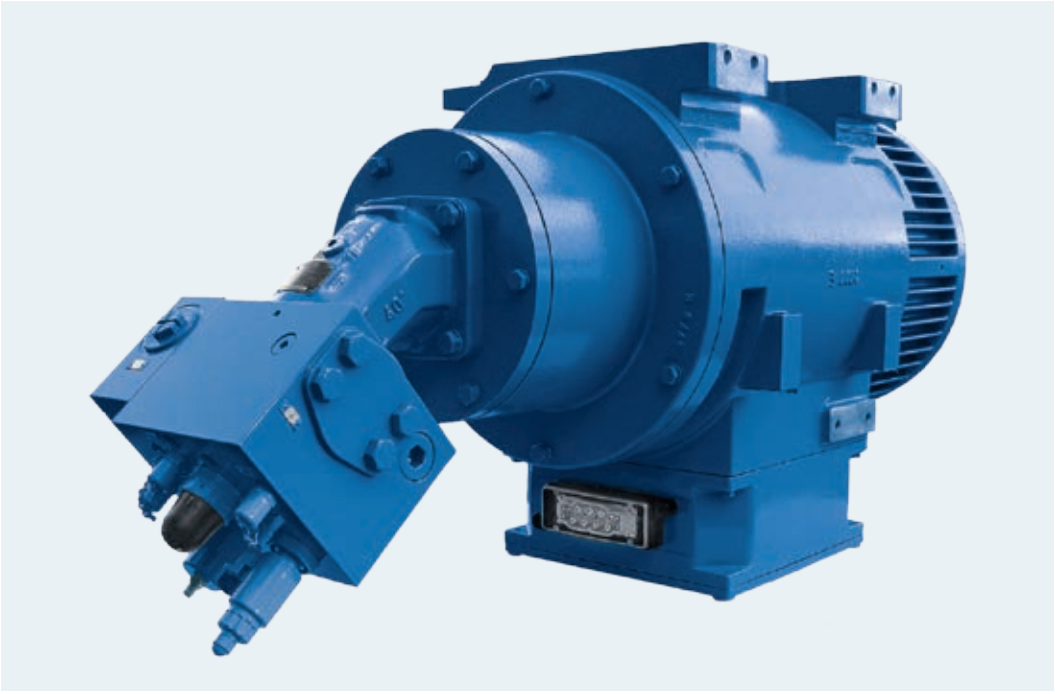


Due to their modular form of construction, hydrostatic fan drives also fit into confined installation spaces

Advantages of hydrostatic fan drives:

- The highest power density of all drive technologies enables savings to be made in terms of installation space and weight.
- Fan speed can be set to match demand levels, ambient temperature and air density. This reduces the noise of the fan as well as fuel consumption.
- The pre-cooling function adjusts the fan speed according to the ambient conditions and the increase in load of the diesel engine. The pre-cooling keeps the media which are to be cooled within a narrow temperature range in which the diesel engine operates for maximum efficiency in energy terms. In addition, a narrower temperature range also increases the service life of the coolers due to reduced thermal stresses.
- Stepless adjustment of fan speed is provided by means of pressure-controlled pumps, irrespective of the rotational speed of the combustion engine.
- Drive power of the fan fully adjustable.
- In the event of a cable break or power failure the electro-hydraulic pressure control automatically actuates the fail-safe function and provides maximum cooling power.
- Fan standstill and reverse function (reversal of the direction of rotation of the fan, for blow off) are possible options.

Whatever the demands placed on your rail vehicle – we supply the right components. In Rexroth quality.



▲ **A10VO variable displacement pump in swash plate design for hydrostatic drives in open loop circuit**

◀ **Hydrostatic generator drive illustrates the power density of hydraulics**

Compressor and generator drives

An extremely wide selection of axial piston units enables the required drive power to match exactly to the customer specification. The hydraulic motor's maximum output power available even when the diesel engine is at idle speed.

Advantages of hydrostatic auxiliary drives:

- The highest power density of all drive technologies enables savings to be made in terms of installation space and weight.
- Compressed air and electricity supply are available regardless of the speed of the diesel engine.
- Hydrostatic auxiliary drive can be enabled or switched off as required.
- The stand-by setting of the adjustable axial piston pump enables the power consumption to be minimized when the pump displacement is fully swiveled back. This prolongs the life time of the starter motor and the batteries.
- The displacement control of the axial piston pump enables the drive power to be aligned with the optimized overall level of efficiency – compared to a solution using flow control valves.

- **Fixed displacement motor in bent axis design for hydrostatic drives in open and closed loop circuit**

- **RC controller – programmable PLC control unit with CAN-bus interface**

- **Fixed displacement motor in swash plate design for hydrostatic drives in open and closed loop circuit**

- **BODAS temperature sensors for measuring the temperature of ambient air and charge-air as well as coolant and hydraulic oil**

- **Great filtration performance due to patented flow path, filtration of even the finest particles, and high dirt retention capacity**

- **Oil reservoir for hydraulic pump supply**

- **Pressure relief valve, direct operated, maximum operating pressure 630 bar**

- **Application-specific AFC20-based software (automatic fan control)**

Hydrostatic and electric driven cooling systems: energy-efficient and quiet

Fulfillment of environmental requirements from a technical and economic perspective: for decades Rexroth has been a system partner providing the engineering and manufacture of complete hydrostatically and electrically-driven cooling systems for rail vehicles. Rexroth rail experts satisfy those special requirements of energy efficiency, project-specific contingencies, and noise reduction.

▶ **Traction inverter cooling system**

Rexroth produces energy-efficient cooling systems, rail vehicle drive trains and auxiliary units based on a variety of technologies. Whether cooling diesel engines, transformers, traction drive systems, generators or converters, Rexroth specialists provide tailor-made solutions. They take advantage of all the opportunities offered by electrical and hydrostatic fan drive systems. A unique feature is the innovative patented fan control for variable-speed hydrostatic fan drives.

Complete system partner

The scope of the services which provided for the implementation of cooling systems ranges from modular assemblies and components to complete plug-and-play systems. Whether it is mounted under the roof or the floor, we customize each cooling system to the rail vehicle and the available installation space. An integrated approach is used to evaluate the cooling system as a whole. Using state-of-the-art software we simulate and optimize all fluid flow, or even complete vehicles. Our results are incorporated into the manufacturers' vehicle simulation results.

Innovative noise insulation systems

A reduction in noise emissions is an increasingly important requirement for rail vehicles, and consequently for their cooling systems. Rexroth has developed innovative sound insulation systems, thereby helping manufacturers meet current noise emission standards.

Hydrostatic traction drives: Precise and powerful

Maintaining extremely steady low speeds while generating superior driving force is no problem for Rexroth hydrostatic traction drives.

Rexroth provides both hydro-mechanical control (DA) and electronic (EP) control systems. This enables the customer to choose the right solution for his machine: hydro-mechanical control with no need for electronics and classic operational schemes, or EP control in which the drive-specific characteristics can be mapped into software, and via Rexroth RC (PLC) controllers provide single-source advanced system solutions in an integrated package.

Advantages of hydrostatic traction drives:

- The highest power density of all drive technologies enables savings to be made in terms of installation space and weight.
- Low investment costs.
- Wide controlability range.
- Jerk-free and precise travel control, even at very low speeds.
- High response.
- Simple, quick and jerk-free reversing, full torque in both directions of travel without reversing gearboxes.
- High efficiency level ensures that there is low heat build-up when working at high traction force and low speeds.
- Flexible installation configurations are possible due to the modular construction, and in particular, allowing optimization of the layout of the diesel engine in the machine.
- Customer specifications, such as, anti-slip, anti-slide control and ECO mode are easily accomplished.
- The large selection of control schemes allows easy integration into the customer's existing system.

- **A4VG variable displacement pump – for highly efficient operation in high-pressure applications up to 500 bar. All the elements for closed loop operation as a hydrostat, i.e. charge pump, are integrated**

- **A6VM variable displacement motor – designed for good efficiency during starting and slow-running operation in high-pressure applications up to 500 bar**

- **RC controller – programmable PLC control unit with CAN-bus interface**

- **Safety block for secure disabling of drive torque and power. Effectively prevents a variable displacement motor from building up any output torque**

Hydraulics for railway maintenance of way machinery: green light for operation around the clock

Whether the need is linear or rotary drives, the lifting of loads with a powerful hydraulic system, or precise positioning – Rexroth always has the right drive solution.

Source: Plasser & Theurer

With its complete and varied range of products Rexroth always has a great solution for nearly all applications. The optimal blend of hydraulic and electrical drives enables productivity to be maximized.

Advantages of hydraulic drives:

- Superior power density, force and torque levels combined with small installation space.
- Stepless adjustability of speed, torque, and power over a wide range.
- Travel under full load, full torque at zero speed.
- Small space requirements and modularity make ideal structural design adaptations to the existing installation space possible.
- High efficiency levels due to central drive systems and decentralized use of the hydraulic energy.
- Parallel operation of linear and rotary drive elements in one hydraulic system.
- Simple integration of the overload protection, and simple energy storage in the system.
- Equally well suited to rapid motion sequences and extremely slow precision movements.
- Complete system solutions for high levels of performance, even in harsh environments.

All components from one supplier – a selection from our product portfolio:

- **Pressure, flow-control, check and directional valves – direct and pilot operated valves with hydraulic or mechanical actuation**

- **Pumps and motors – for medium and high pressure applications**

- **Compact hydraulics – a very wide range of products: cartridge valves, integrated control blocks, load holding and motion control valves, compact modules, compact directional valves**

- **Complete portfolio from compact 1-axis controllers to intelligent motion logic for multi-axis applications**

- **Manifold assemblies as customer-specific integrated solutions. All the components are derived from the extensive range of standard valves**

- **Ranging from standard hydraulic power units to customer- or project-specific units**

- **Large hydraulic drives – complete system solutions for high power in harsh environments**

- **Accumulator for energy storage, shock and vibration absorption and for leakage or volume compensation**

Engineering and simulation: economical development and optimization of systems

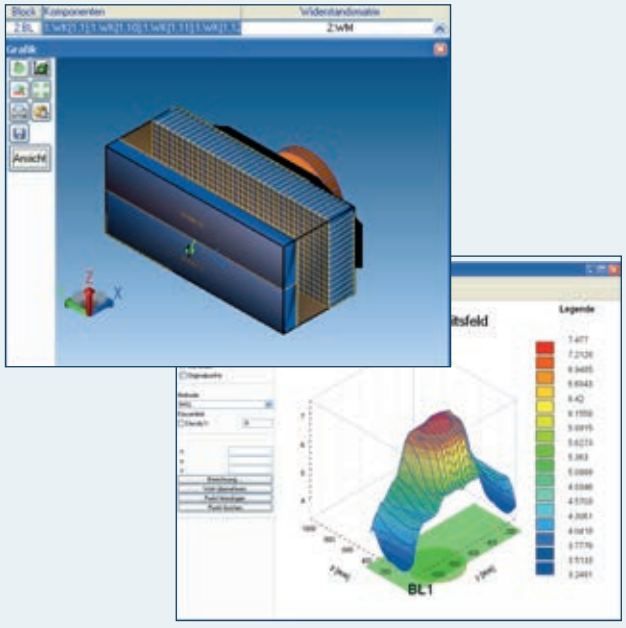
The increasing complexity of applications in rail vehicles requires the use of modern engineering methods. Even in the early phase of the development process, feasibility studies are needed as a basis to be used for defining the system and components. Rexroth provides simulations of entire drive systems for this purpose which evaluate at an early stage the interplay of the environment and the mechanical, hydraulic and electronic systems and the software.

More and more machine manufacturers are relying on simulation programs in order to speed up improvements and to reduce development time and costs. However, the programs that are available on the market often only depict sub-systems of the machines, and do not take account of the peculiarities of the fluid technology used.

Based on its worldwide applications experience in various industrial sectors, Rexroth has developed its own simulation programs which incorporate comprehensive component libraries and which consequently make detailed and reliable modeling of drive systems possible in a short period of time.

In the course of its joint planning and development with the machine manufacturers, Rexroth uses these simulation programs to verify the dynamics which customer applications can achieve during normal operation. Or in extreme and emergency situations such as power and component failures or emergency shut-downs, to verify the design of the drive component’s dimensioning and operating circumstances. Rexroth suggests control concepts for these applications, how to parameterize them.

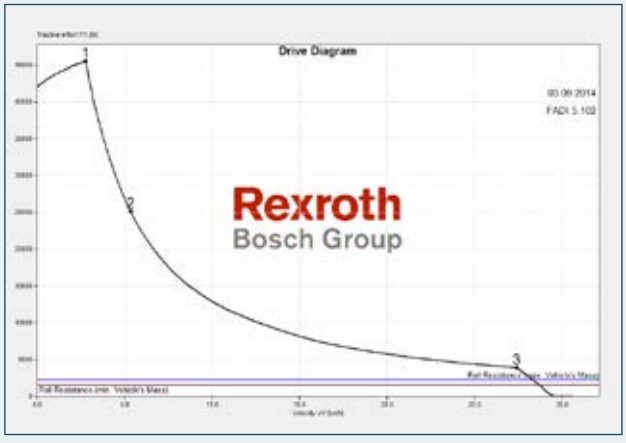
This preliminary “virtual commissioning” can replace costly real machine prototypes. Even extreme situations, which cannot be tested in reality due to machine and personal safety considerations, can be investigated. What's more, this means that it is possible to highlight potential problems prior to actual implementation, and to eliminate them with little effort. The simulation also provides access to all the desired measurements of the drive system and the machine, even those which are hard or impossible to ascertain in real machines.



Cooler fan design using CFD and KULI

Rexroth helps manufacturers to design customized cooling systems with the KULI software which originated in the automotive field. It uses measurement data from the individual components to simulate the various heat balances, making use of an extensive database relating to physical characteristics, cooling elements, and fans.

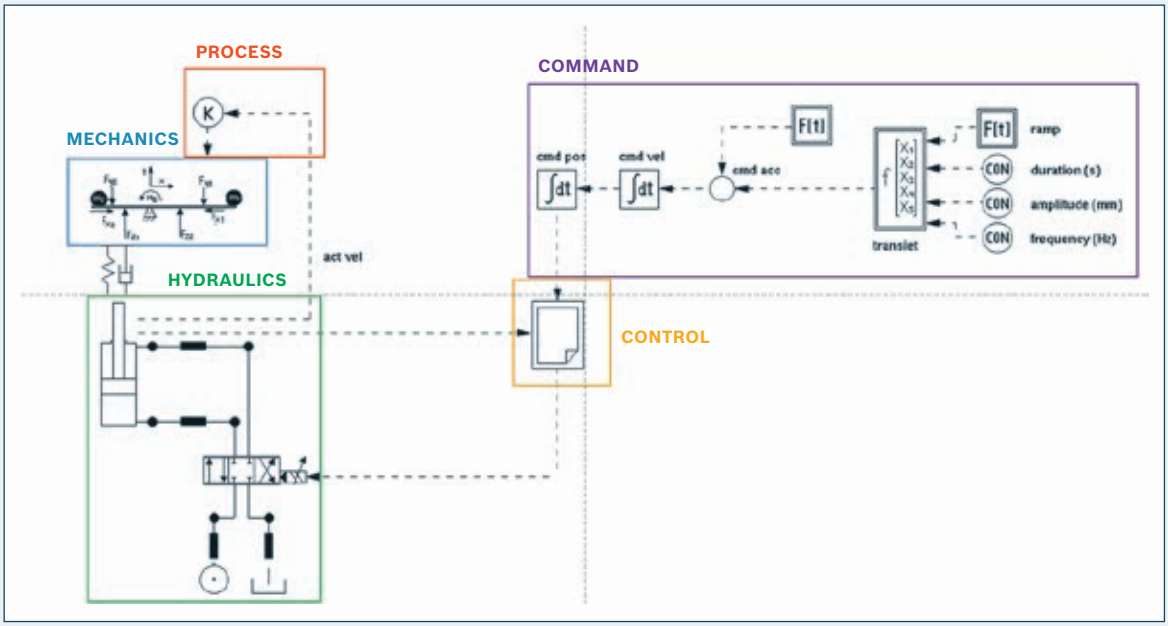
In addition, Rexroth combines these results with 3-D flow simulations on high-performance computers and determines complex heterogeneous flow distributions. This forms the basis for the detailed structuring of the cooling systems. Manufacturers can therefore dispense with laborious and time-consuming wind tunnel tests.



FADI traction drive design

When configuring hydrostatic traction drives, Rexroth calculates a travel diagram in order to draw quick and precise conclusions regarding the dimensioning of the required components. This involves plotting the traction force as a function of the travel velocity. Rexroth specialists use stored catalog data and efficiency characteristic diagrams for these calculations.

When doing this, Rexroth simultaneously takes account of several curves for various types of pump motor configuration in order to determine the optimal configuration for the rail vehicle.



Rapid Control Prototyping using Rexroth Simster
Rexroth Simster is a specially developed simulation environment which allows object-oriented modeling of mechanical, electrical and hydraulic systems, and also of the control programs, in other words rapid control prototyping.

In conjunction with Rexroth control systems, Rexroth Simster enables the simulation models to be transferred to standard control hardware without PLC programming. The new interface technology makes it possible to execute the functions written in C languages directly in the control system. This means that Rexroth speeds up rapid control prototyping and shortens the time-to-market.

Filter technology: Extended service lives and optimal protection

Having operating fluids in perfect condition at all times is an important precondition for the full functionality of the hydraulic solutions. It avoids expensive damage and machine down time. Rexroth's extensive portfolio of filters and offline filtration or purification systems for hydraulic applications ensures optimal operating conditions over the entire life cycle and reduces the TCO.

▲ **The Rexroth filter portfolio**
◀ **Inline filters – great filtration performance due to the special flow path**

From filter elements and complete filters to bypass filtration and recovery systems for fluids, the range of products contains precisely the right solution for just about every application. Innovative sensors and remote diagnostics provide the user with the means of monitoring quality, especially fluid purity, at any time. Condition monitoring systems signal when critical conditions are reached, enabling preventive service measures to be taken without having to schedule additional downtimes. Reliability is increased and costs reduced as a result.

The filter and purification systems can only do their job to optimum effect if they are precisely tailored to the specific medium and application. Trying to save costs can easily lead to considerable potential for damage. Contaminated fluid reduces the performance and precision of the hydraulic system. In many cases it leads to early wear of system components and to unscheduled downtime.

For the initial commissioning in particular, Rexroth recommends that hydraulic fluid be supplied to the hydraulic system through a suitable filter system and that the purity of the oil be checked at regular service intervals. Even minor investments in Rexroth filter technology will significantly reduce overall operating costs for the operator.

Rexroth Service: Your partner for maximum system availability throughout the entire lifecycle

You need to be able to trust the equipment reliability of your machines and systems. Every failure may result in large consequential costs for repair and even business income. A service partner who knows your application and is able to maximize production by working together is the goal. Rexroth is ideally suited to do just that. Rexroth offers more: custom-tailored services from a single source for all drive and control technologies for your systems.

Spare parts service:
the right parts in the right place
When repairs need to be carried out it is crucial to be able to obtain the correct spare parts without delay. This also applies in the case of older rail vehicles. Our experienced specialists are certain to find the solution in Rexroth's wide-ranging product portfolio – quickly and anywhere in the world.

Product overhaul:
made as good as new, fast and economically
Why wait until a system fails? It often makes sense to replace wear parts or defective components on a preventive basis at standard scheduled service intervals. By doing so you increase the availability of the rail vehicle at minimal expense.

Repair service:
factory reconditioned service
It doesn't always have to be a replacement. An economical repair is often possible, especially in the case of expensive components and modules – if you choose Rexroth as your partner. Our service workshops repair your components quickly.

Warranty: enhancing the security of your investment
Once the repair and maintenance work has been completed you receive a twelve-month new parts warranty for all the components.

New, economical and environmentally friendly:
Rexroth REMANufacturing for axial piston units
Rexroth's REMANufacturing program for axial piston units provides a fast and economical solution for overhauling used units. They should be replaced every 5 years or after about 32,000 operating hours.

The units are completely overhauled at our Horb and Elchingen plants in Germany: all the wear parts and valves are replaced with new components. The service life of REMAN units is the same as that of new units. And naturally carry a full new parts warranty.

In addition, the Rexroth REMAN program delivers the highest reliability because of 100 % functional tests on state-of-the-art test beds. They are readily available from our warehouse, to ensure minimal down time and access for railway customers.

Exchange units can be sent back to Rexroth as part of the deal, and after evaluation, a credit note will be forthcoming from Rexroth.

You can obtain detailed information at
www.boschrexroth.com/service

Partnerships which last for decades

Rail vehicles are operated over decades. Rexroth guarantees the supply of spare parts for just as long, and assists with the modernization of older vehicles by providing modern system solutions.

Availability for at least 30 years
Rexroth components for rail vehicles are derived from series production and are available for at least 30 years. Even after products are phased out, our tried and true obsolescence management system ensures that the right replacement parts are available. This means that you can rest assured that you will be able to maintain and repair your fleet of vehicles well into the future.

Modernization for a new lease on life
The basic design of the rail vehicle is often in such good condition that it is worthwhile installing a state-of-the-art replacement engine. We help operators to analyze their vehicles, and to identify their upgrade potential. Our specialists replace outdated components and modules with modern, more efficient versions. Operators achieve significant improvements in the performance of their vehicles in return for a definable level of expenditure.

Rexroth brings older vehicles right up to date in technological terms by thoroughly modernizing them. We undertake the analysis, project planning, and implementation of the retrofit process. We plan the overhaul after providing detailed advice about which measures are worthwhile. We then incorporate modern drive and control solutions and commission them. What is especially important is to look at the system as a whole. Consequently, even older vehicles are given a second lease on life with full, state-of-the-art performance capabilities.

Advantages:
- Transparency due to the professional and comprehensive advice provided, including profitability calculations.
- A responsible partner, starting from the analysis, through to the project planning and implementation.
- Maximum vehicle availability combined with reduced operating costs.

◀ **Rexroth retrofitted the cooling system of the diesel engine and the hydrostatic fan drive**

Your advantages

- ☑ Increased reliability
- ☑ Reduced emissions
- ☑ Improved profitability

The Drive & Control Company

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