



Environmental product portfolio



KNORR-BREMSE



KNORR-BREMSE

ENVIRONMENTAL PRODUCT PORTFOLIO

Our contribution towards making mobility more environmentally friendly and energy-efficient

In recent years, climate change and environmental protection have taken on greater relevance for the commercial vehicle and rail vehicle sectors. In response, Knorr-Bremse has for many years been giving top priority to developing fuel-saving, emission-reducing technologies with solutions tailored to market needs.

Our product portfolio offers solutions that

- >> minimize energy consumption and enhance fuel efficiency,
- >> reduce atmospheric emissions,
- >> minimize noise emissions,
- >> protect the environment by using eco-friendly materials and manufacturing processes.

| ENERGY EFFICIENCY | PROTECTING RESOURCES AND REDUCING EMISSIONS | RAIL VEHICLE DIVISION |
|--|--|-----------------------------|
| <ul style="list-style-type: none"> • CFCB bogie-mounted block brakes • Compact brake calipers • Lightweight HVAC units, doors, brake discs • iCOM Assist (LEADER) driver assistance system • Driving and training simulators • iCOM Energy Metering • HVAC systems • IFE Generation 4 entrance system • Isobar brake pads • Aluminum brake discs | <ul style="list-style-type: none"> • Oil-free compressor with sound insulation • Flexpad Silent brake pad • LL composite brake block • Sanding systems with reduced sand use | |
| <ul style="list-style-type: none"> • Pneumatic disc brakes • Electronic air treatment • Aluminum compressor casing • Compressor with clutch • Electric screw compressor • Compressor with energy-saving system • Mechatronic transmission control • Shift module for dual clutch transmission • Tire pressure and temperature monitoring systems | <ul style="list-style-type: none"> • Electronic braking system (EBS) • Engine retarder • Genuine remanufactured products | COMMERCIAL VEHICLE DIVISION |

ENVIRONMENTAL PRODUCT PORTFOLIO

RAIL VEHICLE DIVISION

ENERGY EFFICIENCY



The **compact bogie-mounted block brake CFCB** makes it possible to reduce weight by up to 1,000 kg per freight car and is significantly more energy efficient than conventional brake equipment.



The **compact brake caliper** prevents disruptive noise and saves up to 120 kg per bogie, thus lowering the entire vehicle's noise levels and energy consumption.



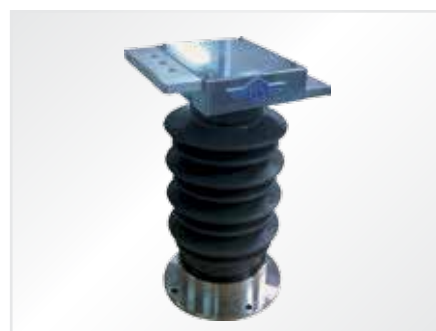
Lighter products such as the new models of our **HVAC units, doors or brake discs** contribute significantly to reducing energy consumption during operation.



The **iCOM Assist (LEADER) driver assistance system** supports drivers, enabling them to operate trains as energy-efficiently as possible, minimizing wear, and still arriving safely and punctually. iCOM Assist typically makes it possible to save 10% of energy costs.



Driving and training simulators contribute to driving efficiency and therefore to reducing the environmental impact.



iCOM Energy Metering measures the power consumption of trains and indicates savings potential, thus ensuring the most efficient operation possible.

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RAIL VEHICLE DIVISION

ENERGY-EFFICIENCY



Air conditioning units with integrated heat pump save 25% to 50% of energy compared to units without a heat pump.



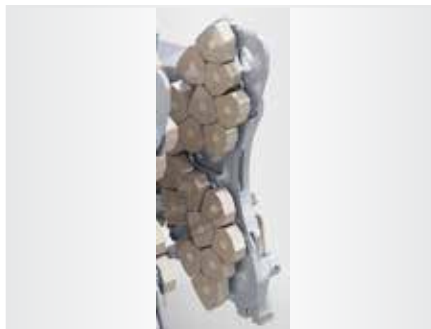
Special **HVAC** control systems adapt the supply of fresh air to the actual passenger numbers. If there are few passengers on board, the system reduces the inflow of outside air, reducing the amount requiring heating or cooling, and cutting energy consumption.



HVAC systems use excess braking energy to heat the air and reduce the additional amount of energy required for electrical heating.



The **IFE Generation 4 Entrance System** is 20% lighter and uses 25% less energy than its predecessor. New materials for the door leaves have improved levels of noise and heat insulation.



The **Isobar brake pad** is so effective it can cut the overall weight by up to 25% by reducing the number of brake discs and calipers required for each bogie. Isobar pads are also more durable and easier to replace than ones made with conventional materials.



The **aluminum brake** disc reduces the weight by up to 50% compared with conventional discs – saving considerable amounts of energy. The operating life of the discs and pads is also extended by up to a factor of three, and significantly less dust is generated.

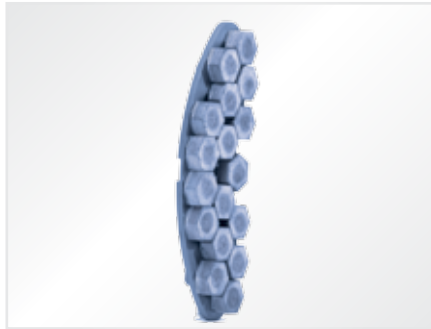
ENVIRONMENTAL PRODUCT PORTFOLIO

RAIL VEHICLE DIVISION

PROTECTING RESOURCES AND REDUCING EMISSIONS



The **oil-free compressor** operates without oil lubrication, which means that no oil reaches the environment or has to be disposed of. Its weight has been reduced, and it requires less energy and installation space. A sound-proofed capsule also significantly reduces noise levels.



The **Flexpad Silent high-performance brake pad** largely prevents typical train brake squeal, thus lowering noise emissions produced by rail traffic.



The **LL composite brake block** significantly lowers the rail noise of freight cars compared to conventional cast iron brake blocks. The same goes for the K pad, which is used for new freight cars. 10 years after the introduction of the first K pad, the second generation has now been launched, offering improved wheel wear.



New **sanding systems** reduce to a minimum the fine dust produced when braking rail vehicles, and also offer modern diagnostic options.

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COMMERCIAL VEHICLE DIVISION

ENERGY EFFICIENCY



The **SL7, SM7 and ST7 pneumatic disk brakes** help increase energy efficiency because they are considerably lighter than their predecessors. Eco-friendly chrome VI-free surface coatings avoid the use of critical materials.



The **EAC electronic air treatment unit** adapts to the driving situation, making it possible to save up to 1,300 liters of fuel per year.



The **aluminum compressor casing** reduces the weight by up to 35% compared with the previous model. The water cooling system incorporated in the cylinder also cuts the temperature by up to 50 °C. This reduces oil contamination, improves air quality and prolongs the operating life of the air drier cartridge.



The **compressor with clutch** automatically uncouples from the engine when the system is adequately supplied with air, thus lowering a truck's CO₂ emissions by about 2.5 tons per year.



The **electric screw compressor** saves energy by using the excess energy generated during engine overrun, thereby reducing a vehicle's diesel consumption by up to 1,700 liters a year.



Compressors equipped with an additional **energy saving system (ESS)** can lower fuel consumption even further.

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ENERGY EFFICIENCY



The **mechatronic transmission control system** reduces fuel consumption by ensuring that the engine is always running in the optimum operating range. The unit consists of an electronic control module, a pneumatic module and a sensor unit that registers the gear selected as well as the temperature and speed of the transmission.



The **shifting module for the dual clutch transmission** of a heavy-duty truck ensures rapid shifting without any interruption in the flow of power, which means added comfort for the driver and fuel savings for the fleet operator.



Tire pressure and temperature monitoring systems warn the driver if the pressure of the tires falls below a preset level or the temperature is too high. Such systems not only increase safety but also prevent excessive fuel consumption as a result of underinflated tires.

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PROTECTING RESOURCES AND REDUCING EMISSIONS



The **electronic braking system (EBS)** with wear harmonization uses sensors to monitor wear levels of individual wheel brakes. During braking, the axles with the thickest pads are braked more heavily, making maximum use of the brake pads and saving resources.



The **engine retarder** ensures the vehicle maintains a constant speed on downhill gradients independently of the engine load and speed. It controls the exhaust mass flow and plays an important role in reducing wear and tear on the service brake.



Genuine remanufactured products from Knorr-Bremse such as spring brake actuators, EBS components, electronic air treatment units, compressors or oil separation cartridges are qualitatively and functionally equivalent to newly-manufactured products, differing only in terms of the length of their service life. Remanufacturing is the best type of recycling, as it involves reusing entire products rather than just raw materials. Despite the cost of returning, disassembling, cleaning and testing the parts, up to 75% of the CO₂ emissions generated by manufacturing a new product can be saved.