Smart Rails

SKF lubrication systems for trams

SKF lubrication systems optimize tram operations

Rail wear and curve squealing: a constant issue for most tram operators. Squealing often occurs especially on curves in dry weather conditions and means a serious nuisance for nearby residents.

Typical reasons

- **Wheel flanges rubbing against the rail side. On unlubricated rails this gives rise to wear and tear and an annoying noise, known as 'wheel flange squeal'.**
- **On grooved rails the wheel back face also becomes a contact point, rubbing on the guard rail.**
- **Lateral and longitudinal movement of the wheels on the railhead together with the stick-slip effect also cause the wheels to vibrate. This gives rise to another nerve-racking noise: the high-frequency curve squeal, especially on the inner curve rail.**
- **The associated slip wave formation on the inner rails of the curve cause vibrations and wear.**

All running smoothly.

To reduce noise and wear, most tram companies rely on regular lubrication with grease or friction modifiers.

Some use an old tram as a lubricating wagon, others lubricate by hand. Neither is optimal, as they do not ensure continuous treatment of the rails. With manual lubrication there is generally too much or too little grease on the rails. This leads to environmental pollution, greater wear and unnecessary use of materials and labor.

So SKF offers stationary and mobile systems that can apply the optimal quantity of lubricant to the wheel-rail contact at defined regular intervals – with centralized control.

Automatic lubrication

Maintenance advantages

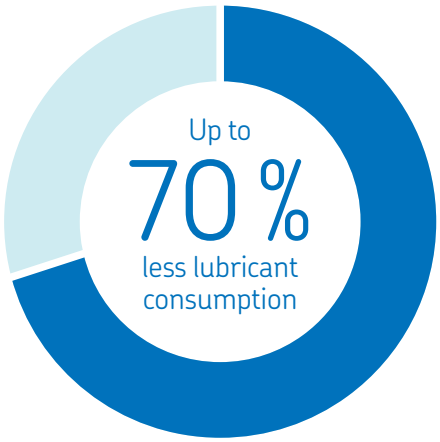
- Extended service life of wheels and of rails on curves
- Longer reprofiling intervals for wheel and rails
- Lower lubricant consumption
- Correct lubrication at all times

Advantages for operational processes

- More reliable equipment
- Less unplanned downtime
- Reduced energy and fuel consumption
- Better equipment productivity

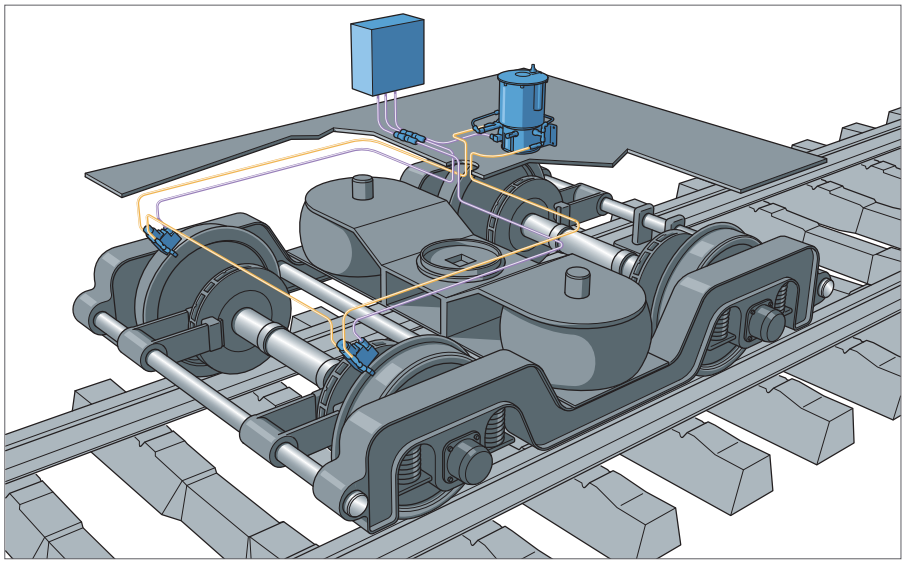
Advantages for health, safety and environmental protection

- No need to lubricate difficult-to-access curves manually
- Reduces the risk of derailments
- Lower noise level, no complaints from residents
- Eliminates over-lubrication

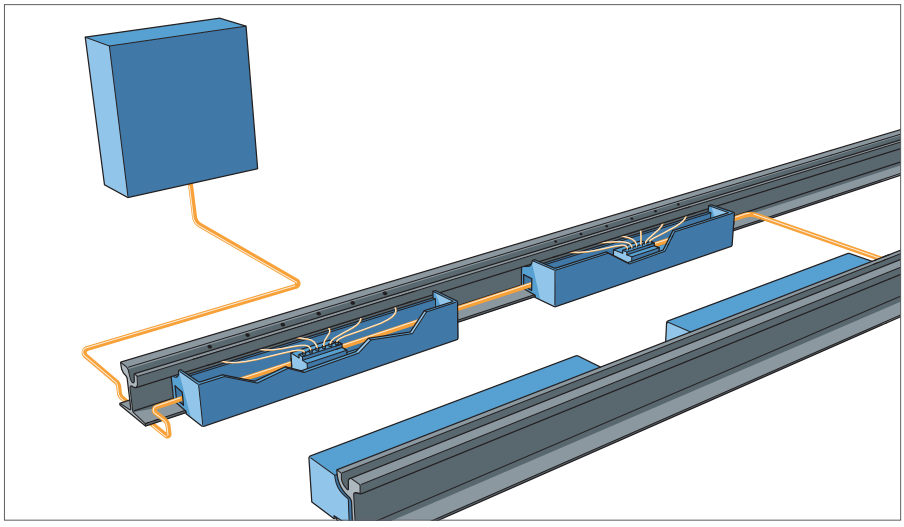


Lubrication systems – an overview

Mobile or stationary? Lubrication systems can get installed directly on the rails or on the trams.



Mobile lubrication system



Stationary lubrication system

Mobile lubrication systems

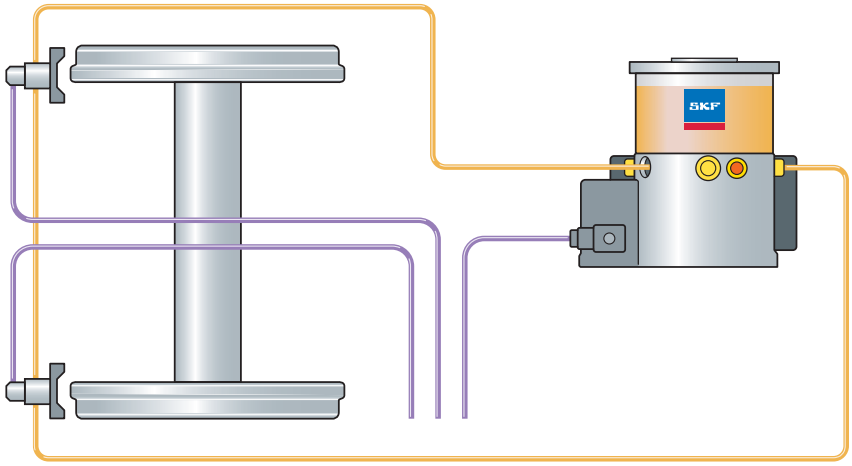
As a general rule mobile lubrication systems are fitted on the first axle of the leading tram car. Air and lubricant are fed from the lubricant container to the nozzle. All standard spray systems on the market use compressed air.

SKF however has developed a system that works without this expensive medium. Instead, electromagnetic SKF pumps squirt pre-set quantities of the lubricant onto the wheel flanges/ wheel treads. Just enough lubricant to do the job, minimize noise emissions and wear – without causing waste.

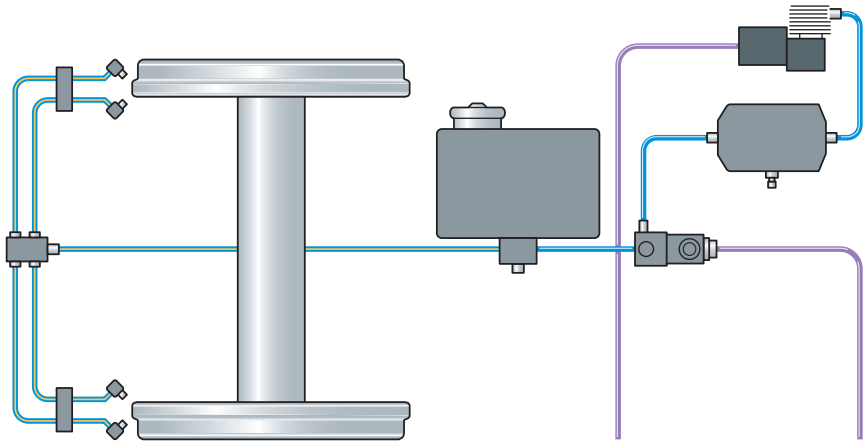
The electromagnetic pumps squirt a liquid grease onto the wheel flanges or a friction modifier onto the wheel tread drop by drop at high frequency (one squirt per second).

The advantages of airless vs. compressor solutions are:

- Only two components: one ring line pump and two electromagnetic pumps
- Lightweight, no compressed air or compressor system required
- No compressor noise
- Precise dosage: 30 mm^3 per squirt
- Simple to service
- No clumping or separation of lubricant



EasyRail Airless System



Spray system with compressor

Stationary lubrication systems

Stationary lubrication systems are installed directly in the track ahead of the noisy curve. Sensors detect arriving trams and release the lubrication. The tram wheels pick up the lubricant and spread it over for many metres along the curve. High-pressure, low-volume pumps effectively cover the rail with just enough lubricant, minimizing waste.

Since trams have lower axle loads than standard railway vehicles, lubricant distribution takes place here via lubricating channels drilled into the rails.

This has been standard practice for many years, in Europe at least.

As with mobile systems there is a distinction between grease and friction modifier here too:

Channels drilled to the gauge corners and through the guard rails are treated with grease, and channels drilled to the running surface with friction modifiers. There are two different lubrication methods:

Progressive automatic lubrication systems (PRO) and Single-Line automatic lubrication systems (SL)

Progressive systems (PRO) used to be the state of the art and have a useful role in certain operating conditions. However, in most cases SKF is recommending the operation of single-line systems (SL) because of their many advantages.

PRO

SL

Advantages of SL systems vs PRO:

- Exact lubricant metering
- No uncontrolled over-lubrication
- Amount applied per channel is very small, therefore transfer by wheels is better and almost waste-free
- A blockage in one lubricating channel does not result in failure of the entire system
- Cost-effective, combined gauge face and top-of-rail system layouts possible

Stationary or mobile?

Whether customers opt for a lubrication system on the rails or in the tram, the choice of lubrication method should depend on how and where it will be used, and cannot be answered off the cuff.

Our technicians decide on the best solution following site visits and discussions with the customers. They can investigate, for example, when noises occur and what sort of noises they are, the behaviour of the curves and where the friction is greatest.

Using data on the traffic volume and fleet, and taking customer wishes into account we develop an individual system – this is essential to allow for every feature of the route.

The issue of track lubrication should be included in considerations and planning as early as when tendering to build a new track – otherwise there is a risk of higher costs later.

SKF lubrication systems are among the most modern automatic lubrication systems in the industry. They can help tram operators to improve vehicle and track availability and reduce running costs.

Ulm's public utility company: New state of the art rail system

Ulm's public utility company (SWU) commissioned SKF to install 30 new lubricating systems on a new tramline and replace another 20 in an existing line. SKF's experts installed a system that applies a set quantity of 0.05 cm^3 per hole directly onto the gauge corner and guard rail side. A magnetic coupling coil registers each passing tram and sends a signal to the single-line system – triggering the lubrication. The channels are fed from a 10 kg reservoir including stirrer to prevent the lubricant clotting. At each lubrication point the technicians fitted twelve to 36 channels. With the low dosage the wheels transfer almost 100% of the lubricant. Wheels and rails are separated by the lubricating film. In addition, there is a railhead conditioning system that prevents the stick-slip effect and ensures the tram runs more quietly.

"We have far lower maintenance costs and it's easier to fill the reservoir. The lubricating and conditioning agent is applied more productively. Only a quarter of the material is needed per drill hole and it's delivered where it's required much more cleanly."

Eric Ziegler, Maintenance of rail system section, Ulm's public utility company.

RAIL NETWORK

20 km

TRAMS

22

Mainzer Mobilität: Old system refitted

Mainzer Mobilität (MM) replaced its obsolescent rail technology with a progressive system in stages. The system carries the lubricant from the pump to the metering device, which conveys it evenly to all drilled lubricating channels in the rails at a rate of 0.2 cm^3 per outlet – very slightly more than a drop of water.

When the route network was due to be extended, MM decided to incorporate SKF's new technology: the single-line system. Here too, the approaching tram triggers a lubrication cycle and the pump sends the lubricant to single-line metering device. These supply each lubricating channel with just 0.05 cm^3. There are now five progressive and three single-line systems installed on the network. Noise emissions have reduced significantly and servicing costs are lower. Previously, employees had to check the lubricating systems several times a week. Now, once a week is enough. In the long-term, MM wants to convert all the old systems to single-line technology.

"Compared to our old system we are now saving up to 70% on lubricant. We're very satisfied with the various systems and are hearing only positive feedback from our employees."

Kai Buhl, Infrastructure Management, Mainzer Mobilität

RAIL NETWORK

40 km

TRAMS

41

Kölner Verkehrs-Betriebe: A tailor-made solution for special requirements

"Previously some equipment had to be serviced twelve times a year by up to three technicians; maintenance costs have fallen drastically. And the service life of the pumps should also eventually be more than ten times longer."

Manfred Laubscher, foreman, Kölner Verkehrs-Betriebe

Over twenty years ago the Kölner Verkehrs-Betriebe (KVB) developed its own lubricating system based on the use of fluid grease. But recently the system had caused nothing but problems: with modern lubricants there were regular blockages in pump elements, and the servicing and maintenance costs were rising. So management decided on a new, central lubrication solution from SKF. KVB uses two types of pump units. An upright, standard pump aggregate is fitted in boxes next to the rails. However, urban planning prohibits use of these boxes in some locations. So, together with SKF the Cologne team developed a solution using horizontal pumps that are fitted in protective cases in the track system. Until now this model of pump has only been used in wind turbines, but with modifications it is the right solution for the needs of the KVB. The first lubricating system realized by SKF has now been working in Cologne for three years without being serviced or repaired.

RAIL NETWORK

198 km

TRAMS

382

Automatic lubricant metering systems make Gothenburg's trams quieter

Trams are a practical but also very loud means of transport. Squealing, especially on curves and in dry weather, can be reduced using special lubricant metering systems, writes Jens Goldenbohm, SKF Railway Industry Manager for lubrication technology.

Trams have been around for a long time and are increasingly popular. Many cities, especially in Europe, are expanding their network or even introducing trams for the first time.

However, the tram as a comfortable, environmentally-friendly means of transport does have one serious disadvantage: it can be very loud. And unlike mainline trains, trams run directly past residential areas in city centres; often they share the route with the bus.

Trams are usually louder than buses, and above all the squealing that is typical on curves is found to be particularly unpleasant. Until only a few decades ago, there was little awareness of noise in cities. 'Noise pollution' was an alien concept. But nowadays residents place great importance on having a peaceful neighbourhood, and politicians support them by passing noise control laws.

Trams are loud because the friction between wheel and rail gives rise to high-frequency oscillations, especially on curves, and this causes an unpleasant noise. In dry weather, friction is increased, and the squealing is particularly loud.

This annoying noise occurs above all on curves, because trams have rigid axles. As the outer wheel takes the curve, the inner wheel begins to slip on the railhead (both laterally and longitudinally), as it must cover a slightly shorter distance at the same speed. The slipping alternates rapidly with sticking (stick-slip effect), causing the wheel to oscillate. Then the sound radiated by the wheels is perceived as squealing.

Reduced friction

Lubricating the sliding surface reduces the friction and thus cuts the noise. So if rails on curved sections are lubricated, the tram is quieter as it passes over them.

Lubrication often takes place manually. Problematic areas are lubricated every two or three days. Lubrication can also be carried out using special vehicles. These pass along the track and apply lubricant to the rails as needed. There are also automatic systems for the wheel-rail contact area. SKF offers two forms of automatic metering system: an onboard system which is fitted on the vehicle, and a stationary system which is fitted on the track.

The stationary system consists of lubricating channels that are drilled into a 1.5 m stretch of the rails. The lubricant is pumped into the channels. Then the lubricating process is triggered by an inductive sensor that also determines the number of wheels. A vibration sensor may also be used instead of an inductive sensor, and this detects the oncoming tram.

The onboard system usually has special curve sensors. If the system detects a curve, it squirts the lubricant directly onto the wheel.

The quantity of lubricant must be precise because over-lubrication can lead to issues with braking and traction. In wet weather the system is often switched off – after all, lubricant is not required on wet rails.

In the jargon, lubricant is also called 'conditioning agent'. Its special chemical composition ensures that the rails do not become slippery. Friction is only reduced enough to prevent the stick-slip effect. Tiny solid particles in the lubricant, e.g. of aluminium or copper, guarantee the necessary traction and braking ability.

Combination of two systems

SKF's onboard and stationary lubrication systems have proven successful on the Gothenburg tram network. The two systems complement one another, and this is a great advantage in dry weather and on very tight curves.

The operator has equipped 28 trams (of a total of 200) with SKF onboard systems and in addition installed several stationary lubrication systems. The Göteborg tram network is due to be extended and we expect the operator to procure further SKF systems.

On some trams there are microphones and data gathering systems onboard to monitor noise levels. If a set noise limit is exceeded, the system sends an alarm to the route operator. Since installation of the SKF metering systems there have been 80% fewer alarms.

Although the lubricant is currently applied after a tram has passed through a set number of times, they are already considering switching to self-adjusting lubrication: this system monitors squealing and automatically adjusts lubricant output to cope with any changes in noise level.

City dwellers love the tram but hate its squealing. We want to ensure that they can enjoy the benefits of this environmentally-friendly means of transport without having to live with the disadvantages.

RAIL NETWORK

161 km

TRAMS

200

skf.com/lubrication

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