Conditioning rail heads reduces noise and wear

Unpleasant noises often occur when trams negotiate tight curves in their tracks. It is possible to prevent that by conditioning the rail heads; but this must not be allowed to make either the tram operation or the road traffic less safe.

In recent years, tram and railway operators have been increasingly experimenting with the application of a separating agent to rail heads to counteract the annoying screeching noise made by their vehicles running through curves, and some have even gone as far as to make a regular practice out of it. If this particular noise is to be eliminated, what has to be done is to reduce or prevent the vibration excitation caused by the stick-slip effect between wheels and rails. This is achieved by reducing the difference between static friction and sliding friction. Products that possess this property are known as friction modifiers. Their function is to prevent the stick-slip effect between wheels and rails as far as possible and to do so for an extended period of time. If they manage that, they are called "conditioning agents". The results obtained show measurable successes in terms of reductions in wheel screeching in track curves.

1 Application in tram networks

With this aim in mind, a public-transport operator in Eastern Germany recently ordered a series of tram vehicles from Bombardier equipped with mobile spraying devices from REBS Zentralschmiertechnik for conditioning the rail heads. This operator hopes that with these vehicles it will be able to eliminate wheel screeching in curves throughout its entire network. The quantities of lubricant sprayed onto the rail head are distributed over a locally predefined area so as to guarantee the desired uniform friction coefficient.

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The quantity to be sprayed (Fig. 1) can be computed as follows:

Width of surface treated:	approx. 30 mm
Normal running speed in the curve:	30 km/h
Spraying duration:	8 s
Quantity per nozzle:	0.5 cm^3
Length of lubricant film:	approx. 67 m (8 s at 30 km/h)
Total area treated:	2 m^2
Film thickness (theoretical):	0.25 μm

The spraying process starts before the curve, and the spraying system spreads the predetermined quantity for a period of 6-8 seconds on the head of the rail on the inside of the curve. If the curves are longer, the spraying process is repeated. Mobile spray systems are efficient and operate dependably in combination with a control that releases the spray on the basis of recognition of a location or other parameters. It is also possible to determine the times at which spraying is to be activated. It is thus possible, for instance, to cut off the application in the event of rain, a rate of advance slower than a pre-set minimum or sand distribution triggered by emergency braking.

Each of the ordinances on operating such lubrication systems mounted on vehicles demands an official approval procedure. In 2012, the Dekra-Industrial of Halle has been commissioned to perform the necessary tests for such an approval procedure.

The public-transport operator in Essen (EVAG, Essener Verkehrs-AG) already has several years of experience with the use of mobile rail-head conditioning units in scheduled tram operations. Friction modifiers can be seen to be having an effect even after just one application. Up to five applications

Fig. 1: Measuring the quantities sprayed onto the rail head *(source of all figures: the author)*

Fig. 2: Measurements of the friction coefficient (parts of rubber tyres were used as the friction partner on the rail head)

have been found to have no deleterious effect on a tram's braking distance.

2 Brake tests for two-wheeled vehicles

It is very difficult to furnish evidence that the use of a rail-head conditioning system has no adverse effects for motorised traffic, given the physics of how two-wheeled vehicles move. A motorbike has only a narrow footprint of roughly 25 mm anyway, and this has to run over different materials (rails, asphalt, etc.), which causes various critical discontinuities, making them unsuitable for measurements. So DEKRA Automobil (the company that was actually entrusted with carrying out the special test procedure) recommended investigating friction values in accordance with VDI 2700. It applied an appropriate measuring technique that did, however need to be adapted for the test arrangements of "tyre/rails" and "tyre/asphalt". Measuring the friction value makes it possible to establish precisely what change occurs in the rail's grip when the lubricant is applied (Fig. 2).

The friction value determines what deceleration is possible. The aim is not to be able to brake when in contact with the rail but for the wheels not to be wetted with lubricant beyond a defined maximum amount. The braking test is then carried out once the motorbike has moved onto the neighbouring asphalt. The results of the running test are only reproducible within narrowly specified conditions and also depend on the test driver's driving behaviour. Both the test variants performed (measurements of friction values and braking tests) have advantages and disadvantages associated with them. It therefore makes sense and produces more meaningful results to combine the use of both of them.

The chosen friction modifier was the biodegradable Headlub. This is manufactured by a Swiss company called Igralub and has already been successfully used on rail heads all around the world.

Even after the friction modifier had been sprayed onto just one of the rails ten times over, the measured results were still within the permissible range for both the braking performances of trams and the friction value. The braking performance achieved with the motorbike tended (for the same number of spray applications) to be slightly better after the friction modifier had been rolled in by the tram wheels than beforehand.

Even when the friction modifier was applied directly to the tyre tread, the reduction in braking deceleration was only 13% compared with the reference measurement made to begin with (Figs. 3 and 4). The conclusion from this is that the use of a mobile spray system fastened to trams for conditioning the rail head with Headlub as a friction modifier does not constitute any sort of threat for other road users.

More recently, at the end of 2012, the Swiss Federal Office of Transport (SFOT/BAV) also granted an approval for BernMobil to perform rail-head conditioning using the same spray system and friction modifier on the basis of the measurements made.

Fig. 3: Test ride of a motorbike along the conditioned curved track

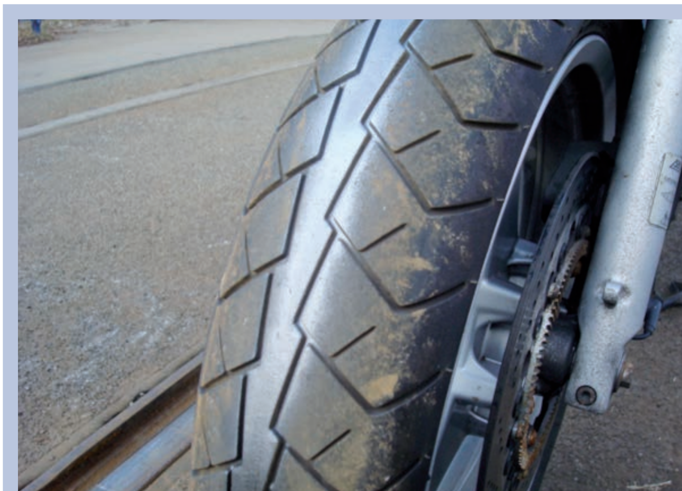

Fig. 4: Direct application of friction modifier to a motorbike tyre

Igralub is a company with worldwide know-how in the introduction of rail-head conditioning systems and acts as a total services provider both for implementing projects and for performing tests for official approval procedures.

3 Use at ProRail in a standard-gauge railway operation

Since 2009, ProRail in the Netherlands has been working on a new concept to reduce the noise caused by wheel/rail contact. In addition to reducing noise as a nuisance, bringing down its level also leads to less intense wear on the infrastructure as well as on the wheel sets of the railway vehicles. Prorail's project for wheel/rail conditioning does without any stationary equipment and moves the installation for applying the Headlub friction modifier onto trains. In this particular project, the constant adhesion of the wheels on the rail is measured by an electronic system while the vehicle is on the move, and the results are then analysed.

In order to guarantee safety in all operational circumstances, the trains equipped with rail-head conditioning also carry a case of measuring devices. These continuously monitor the amount applied. The parameters can be set from a central control room, and all important items of train information are available online. It is possible, amongst other things, to interrupt application if the friction value falls too low. The friction coefficient is derived from the current flowing in the traction motors and serves as an indicator of the occurrence of slippage. A sudden change in the current consumption is thus a reliable indicator of loss of wheel/rail contact. The lower limit is taken to be a friction coefficient (friction when moving off from a standing start) of 0.2. Below this value, no rail conditioning takes place with the application of the friction modifier. This ensures that there is adequate safety at all times. Conditioning is activated when the friction coefficient is between 0.2 and 0.4.

The experience collected in the field tests is thus generalised so that it becomes possible to forecast the applicability of rail-head conditioning and thus also its cost/benefit ratio. According to ProRail, a working party set up by the International Union of Railways (UIC) started to do clarification work on rail-head conditioning at the end of 2011. ProRail is going to chair the pilot studies and, along with experts and tribologists in Europe and China, is going to follow them in detail and to professionalise them further.

4 The IFM fleet-management system

Igralub is about to start supplying a new electronic fleet-management system (IFM) for trams for the entire control and monitoring of rail-head conditioning. IFM facilitates the successful implementation of rail-head conditioning. Its aims are not only to minimise or even eliminate screeching noises in curves but also to reduce the wear on wheels and rails and to improve safety. Depending on how the IFM's control functions are set, it is possible to monitor the use of a friction modifier all the time and to apply it in the way that is optimal for the whole fleet and its network of lines.

IFM is a system that is capable of operating via the web. It performs central monitoring of all the data that is relevant for rail-head conditioning and immediately communicates and executes all commands to make changes to installations and devices dependent on existing rail-head conditioning systems (as a consequence of the weather, changes in routes or short-term changes in timetables). It is possible to use a smartphone to optimise the use of rail-head conditioning and to issue commands from anywhere to systems affected by it onboard the vehicles or at stationary locations.

IFM is an operational lubricating system that monitors and controls all the important lubricating functions of rail-head conditioning. Its components are a computer with the appropriate software and specially developed sensors, which can simply be deployed in the appropriate places. This reduces the time-consuming checks and adjustments to existing lubricating systems onboard vehicles or on the rails. The Igralub Group has applied for a patent on the IFM.

Further information can be obtained from Igralub AG, Mainaustrasse 15, CH-8008 Zurich (Switzerland) or by contacting info@igralub.ch.