

Special Report



Issue 11, November 2002

Silence on the curves

A Kassel tram travels quietly using a biodegradable lubricant

(by Gerd Trommer & Marianne Walz)



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To the managers in the KVG – the Kassel Transport Company – ensuring close links with their customers as well as maintaining a positive image among the inhabitants of Kassel are important concerns. Annoying, characteristic squealing noises caused by the trams were the reason for looking for possible ways of effective noise reduction. The use of traditional lubricants is extremely critical at the point where the curve squealing is generated, namely the friction surfaces between rail and wheel. They could have an inadmissible adverse effect upon traffic- and operational safety and cause pollution of the soil and the groundwater. The KVG used the Federal Government's promotional programme relating to the use of biogenous lubricants in order to try out a product developed specially to solve this problem of noise and environmental protection.

Trams have been running in Kassel for 125 years. Towards the beginning of the Eighties the Kassel city fathers decided upon offensive expansion of the public suburban passenger traffic service network. It grew by more than 50 per cent from 73 km in length to its current total of more than 115 km within the city and the area surrounding the capital of the Electorate of Hesse. The operator responsible is the KVG Aktiengesellschaft, a limited company owned by the city.

Motivated by the success of the development in 1995 of the VW site Baunatal, just under 10 km distant, the planners of the KVG incorporated further surrounding communities into the infrastructure with connecting rail lines. However, following commissioning of a new curved section through densely populated residential areas, the popularity and acceptance of the tramway came under threat: calls from residents complaining about noise pollution mounted up. Complaints were directed in particular against squealing noises on the curves. So the KVG began using lubricants and at that time quantities and soil

compatibility did not form part of the equation. At the same time, however, the KVG looked for a long-term solution in order to avoid polluting the soil and groundwater.

Discussion about curves with the consequences

The KVG was not the first company to analyse the problem. "Rail squealing" on curves has its main origin in the fact that the vehicle traverses wheel-rail-contact areas of varying lengths depending upon the radius. The distance is shorter on the inner rail than on the outer one. The inner and outer wheels, secured to axles, which are in practice rigid, equal out this difference by relative movements. They spin on the inside rail and slip on the outer – both things cause frictional noise. Particularly aggravating from the point of view of noise is the additional "cross-slipping", an axial movement.

Attempted solutions, which did not use lubricant, such as reducing noise emissions by mechanical damping, sound absorption and dissipation proved to be either impracticable or insufficient. In addition technical alterations to the design of the chassis for reducing the rotational differences, for example by independent wheel suspension and even coating the wheels with special non-abrasive plastic would have meant too high expenditure in costs. The experts therefore limited their problem solving to the search for a "intermediate agent", which surpasses the properties of the traditional products:

- the medium to be used should first and foremost be environmentally friendly, highly viscous, non dust-bonding and water-insoluble,
- it should noticeably reduce the frictional noises generated between rail and wheel,
- at the same time it must not lower the coefficient of friction to such an extent that the braking and acceleration behaviour of the vehicle are inadmissibly adversely affected or there could be risks of accidents to pedestrians and cyclists, and
- it must be able to be applied according to the situation and be controllable in the minimum dosage quantities.

Federal grants for those affected by pollution and noise

A special product made by their lubricant supplier Fuchs Lubritech, a subsidiary of the

Fuchs Petrolub AG, fulfils the stringent requirements. "Tram Silence" acts to reduce noise in the wheel-rail contact area, is applicable between –20 and 80 °C, is water-resistant as well as reducing corrosion and wear. Above all, however, the silver-grey paste has environmentally friendly properties. Manufactured from renewable raw materials based on vegetable oils it only penetrates into the upper soil layers and is biodegraded. After three weeks at the latest soil bacteria have degraded it oxidatively by more than 90 per cent into its non-toxic basic chemical components. Tram Silence has thereby a secure place on the positive list of non- or only slightly environmentally hazardous lubricants. On this positive list, compiled by the competent Federal authorities, are included only those products, which contain at least 50 per cent of renewable raw materials, are non or only slightly water-hazardous and which have degraded by at least 90 per cent after three weeks in the soil.

When compared with products based on mineral oils Tram Silence possesses similar to better utilisation properties. Additional costs are, however, incurred in changing over, in "re-oiling". Flushing of the equipment is necessary and new technology, if the existing technology is not "compatible" with biogenous lubricants. Low market penetration and consequently a higher manufacturing price have resulted from these and other disadvantages when compared with mineral lubricants.

Here a promotional programme run by the Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft (BMVEL) (Federal Ministry for Consumer Protection, Food and Agriculture) can offset a major part for the KVG. When those in charge at KVG learnt of the programme, which has been running since May 2000, they reacted promptly with their application. Approval came on 24.07.2001. The applicant's conclusive reasons had convinced the decision makers at the BMVEL. Although loss-lubrication, as used in this instance, is not exactly defined as a project qualifying for support, a grant of DM 80,000 followed. In this sum were included the additional expenditure arising from initially equipping or changing the plant over to biogenous lubricants. In addition to the financial boost for the environmentally friendly changeover the promotional package also contained scientific support.

The authors:

Dipl.-Ing. Gerd Trommer and Marianne Walz B.A. are freelance journalists with the registered editorial office of Gerd Trommer, Gernsheim.



Fig. 2: July 2002: Using the highly viscous biogenous "Tram Silence" the lubricant loss is only minimal. Photo 2-4: rgt

◀ Fig. 1: Drilling the holes in the rail for installing the filling equipment. Photo: KVG

Advice and intensive support during all stages of the project realisation. The Institut für fluidtechnische Antriebe und Steuerungen (IFAS) (Institute for Fluid Power Drives and Controls) at the RWTH (Rheinisch-Westfälische Technische Hochschule) in Aachen is responsible amongst other things, as part of the Federal Government's market penetration and promotional programme, for optimising rail head lubrication with the KVG.

Adventure on the railway tracks: the pilot project

The KVG installed pilot equipment for optimising rail head lubrication in the vicinity of the "Heinrich-Plett-Straße" and "Oberkaufungen, Gesamtschule" stops amongst other places. The pasty substance is applied from below through holes drilled in the rail head (Fig. 1) onto the rail running surface (Fig. 2). In order to use the promotional money as well as the biogenous buffer fluid as economically and effectively as possible, the rail engineers, together with the IFAS, began by working out a test plan. A pump driven by an electric motor conveys the lubricant under pressure from the storage container through hoses to the drill holes. Those responsible at KVG and IFAS for the tests were principally interested in the consumption of the medium depending upon the effects of different factors. They varied the distance between the drill holes as well as their position in the rail head, measured and compared temperature, humidity and traffic

frequency over the rails. In addition they noted the behaviour of the distribution system and its effects. They evaluated their results from the point of view of "as much as possible". While at the Heinrich-Plett-Straße a time-dependent control proved to be practicable, in Kaufungen (Fig.3) a control based upon tram frequency is better. The operation of the test equipment, which has been running under test since 22nd May 2002, has been consistently environmentally friendly. The pumps operate with a saving on resources, obtaining energy from a photovoltaic unit, mounted in a fixed position above the overhead line. In order that when it rains the falling water can replace biogenous grease, a rain sensor works directly alongside the solar cells (Fig. 4). Data, for example about the level in the lubricant container, the rain sensor or pump malfunctions are sent from the control system to the control centre.



Fig. 3: The filling equipment for the noise reducing medium at the "Kaufungen, Gesamtschule" stop is installed at ground level between the rails.

The programme and the product name and a bonus for the environment

From the test results, which have so far been obtained, it is clear that the use of Tram Silence on the curves not only reduces annoying traffic noise but also permanently reduces the pollution burden on the soil and the groundwater. Of the, according to IFAS, theoretically possible savings in lubricants of 90 per cent, the people in Kassel have realised just under 80 per cent in the test run with the grease filling equipment. In spite of the currently higher specific prices for the biogenous medium, the absolute expenditure is thus a lot lower. In addition fourth fifths less represent an important result, for throughout Germany and worldwide the pollution problem with lubricants remains an explosive one.

According to information from the BMVEL about half the more than 1 million tonnes of lubricants used annually in Germany are released through leakages or technical reasons. Of these a third, that is approximately 160,000 tonnes, are of mineral origin, i.e. water hazardous or poisonous. A litre of mineral oil seeping into low layers of the earth will contaminate a thousand times the amount of groundwater.

Limiting the use of mineral oil in the lubricant sector wherever possible is, therefore, a matter of safeguarding the future and of reason. Those in positions of responsibility with the KVG are certain that in this sense, even without the Federal promotional programme, they have mobilised all possible activities and means. At the moment one of these equipment units costs around EURO 23,000. In all they should be used at 40 locations. It is the objective of the users at KVG that the bio-lubricants, which are expensive when compared with mineral oils, shall attain better penetration of the market. They are convinced that heightened public awareness of the environment will bring about greater

acceptance, more outlets and, therefore, also more favourable prices. The users at the KVG are certain that they will also be used in other comparable transport undertakings. They want to get together with them to set up purchasing alliances and for this purpose to make use of, for example, e-commerce and electronic communications' media. In this way a higher number of units and more favourable prices could be achieved for buffer fluid containers and filling equipment.



Fig. 4: Solar equipment and rain sensors at the Plettstraße stop provide the "green" energy for operating the pumps as well ensuring that when it rains this water replaces the lubricant.

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