PLASMA TRACK

Leading the way in rail track cleaning technology.

Viewpoint 2023

Rail Adhesion

PlasmaTrack \ \ Meeting the Challenge of Railhead Adhesion

Low rail adhesion caused by a compacted leaf layer and other contaminants has been an issue that has long affected network operations, with generations of low adhesion mitigation systems (LAMS) struggling to cope effectively.

The challenge of solving it in a more sustainable and commercially viable manner becomes more urgent with each passing year as legacy equipment ages and needs replacing.

The impact on timetables and passenger and freight operations not only has an economic cost (£355 million per annum for Network Rail alone, including remediation), but low railhead adhesion also has an impact on the future development of the railway. Uncertainty over the ability to reliably predict traction and braking conditions negatively impacts the new cab-based signalling technologies that have the potential to reduce space between trains and create additional network capacity. Low rail adhesion also casts doubt on the feasibility of running more sustainable and lighter rolling stock, which will also struggle in low adhesion environments.

Key takeaways

1
We can define summer braking conditions as 0.14μ

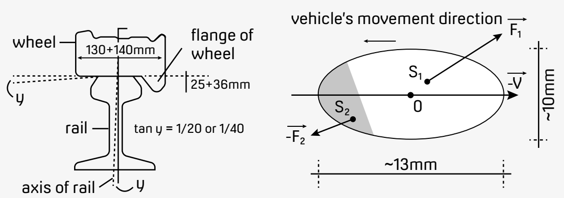
2
A wet leaf layer is proven to be more slippery than engine oil

3
To be effective, any LAMS system needs to return the railhead to 0.14μ or better

4
PlasmaTrack returns the railhead to >0.15μ

Defining summer running conditions

The active contact area between a train's wheel and the railhead is approximately the size of a thumbnail. As a result, even an 80-axle freight train has a total contact area smaller than an A4 sheet of paper, making the interaction between the two surfaces of critical importance.



The degree of 'slippage' between the two surfaces is measured using the coefficient of friction, with the higher number representing better traction. The following table briefly illustrates the coefficient of friction for commonly found railhead environments and train performance.

Raman spectroscopic analysis reveals that the wet leaf layer is composed of compound signatures including cellulose, cellulose acetate and tyrosine. This combination varies depending on localised vegetation but all compounds are compressed and hardened onto the railhead by repeated train movements, making them extremely difficult to remove. This results in what is often referred to as 'black railhead' or the 'third layer'.

Steel on steel	0.35μ
Summer running conditions (traction)	0.1-0.3μ
Summer running conditions (braking)	0.14μ
Engine oil	0.05μ
Leaf layer with moisture	0.02μ

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Further contamination – grease, fuel, water etc. – is also typically introduced onto the railhead as a consequence of normal operations throughout the year. While this does not form the compacted layer that leaf litter produces, to guarantee summer running conditions and timetabling it should be dealt with on an ongoing basis.

Why water jetting is no longer sustainable

In recent decades, water jetting has been the primary method of dealing with low railhead adhesion. However, an ageing fleet of vehicles is only serving to highlight the drawbacks of this approach.

Network Rail's water jetting fleet uses 200 million litres of water per year, enough to fill 80 Olympic-sized swimming pools. This is used to 'jet wash' the railhead at high pressure – 1000 litres of water per minute at a pressure of 1500 bars – with all this water carrying potentially toxic byproducts from the rail environment into the surrounding environment as both run-off and spray.

As well as the negative environmental impact, its sustainability is significantly impacted by the carbon costs of transporting the 200,000 tonnes of water required around the network, especially as the densest rail network in the south-east is also in the driest environment, meaning the water often must be brought in.

Water jetting is also switched off at specific infrastructures – crossings, points, platforms – resulting in distinct gaps in coverage over critical areas. Despite this, the onboard tanks still typically do not have capacity for the full route, necessitating the need to target certain areas and leave others untreated. Additionally, the process of introducing large volumes of water at high velocity into the trackside environment has a pronounced detrimental impact on both the static railway infrastructure and the application equipment itself. For example, wheel turning has to be factored into fleet maintenance schedules due to the accelerated erosive effects of the high-powered jets.

It is a solution that fails to provide 100% network coverage and suffers from high economic and environmental costs. There is a strong argument for it being a candidate for replacement rather than renewal.

Solving low railhead adhesion with PlasmaTrack

PlasmaTrack is a commercially viable and sustainable rail cleaning solution for the 21st century railway that has already been proven to return the railhead to summer braking conditions.

The system works by using plasma energy, already used for cleaning and sterilisation by many other industries. A high voltage, direct current is applied to a compressed gas which turns it into a plasma jet comprised of high energy electrons and ions. This is applied to the railhead at approximately 700°C, where it thermally ablates the compressed leaf layer and any other contaminants, returning the railhead to its original state and creating a sterile surface that additionally retards the return of the leaf layer.

It represents several critical advances over water jetting and other technologies. It is effective at up to 60mph, 50% faster than water jetting treatment vehicles. The equipment can be left running for the entire treatment route with safety protection built in should the service be slowed or brought to a stand, helping produce a projected 40% increase in treatment miles per vehicle.

RHTT (Rail Head Treatment Train) and MPV (Multi-Purpose Vehicle) units require no onboard consumables, as the nitrogen gas that is used to generate the plasma is simply stripped out of the surrounding air by the equipment, reducing service weight and emissions. It has no negative metallurgical effects on the railhead or impacts on any other rail infrastructure and is designed with sustainability in mind, providing a non-toxic solution with zero water table impact and overall lower fuel consumption per treatment mile.

PlasmaTrack \ \ at the Future Rail Technology Trials

The effectiveness of the PlasmaTrack solution was demonstrated during Network Rail's Future Rail Technology Trials. The equipment was mounted onboard a Balfour Beatty MPV equipped with WSP ready to conduct a 40mph test, but track conditions were so bad the MPV could not get above 20mph. The onboard team therefore asked if they could turn on the PlasmaTrack system before the vehicle reached the test zone. Despite being mounted in the usual water jetting position rather than its optimal position in front of the wheels, the MPV was able to get up to the 40mph target speed almost as soon as PlasmaTrack was turned on, proving that the system is effective and deployable.

Time for a viable alternative

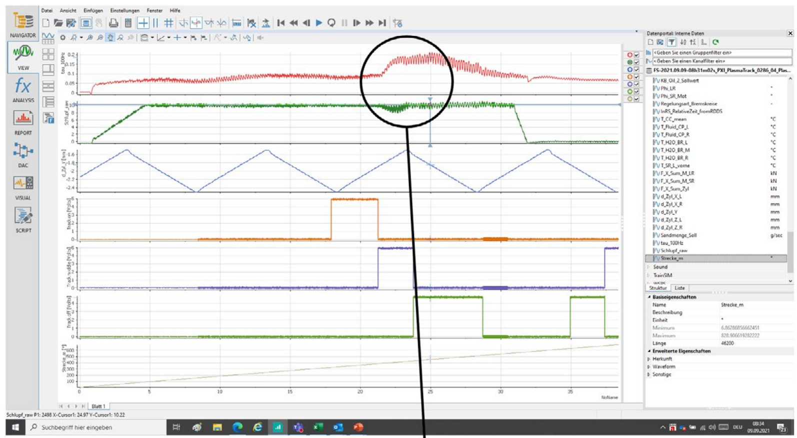
It is time to move on from legacy solutions to low rail adhesion and deploy a commercially viable and sustainable answer. PlasmaTrack, an innovation-driven technology addresses universal rail cleaning problems and has been developed specifically to return the coefficient of friction between the train and the railhead back to summer running conditions all year round.

PlasmaTrack will enable network operators to significantly increase current rail capacity, removing the need for autumn timetables and reducing the significant economic burden of penalties. A high-performing railhead that provides the consistent conditions necessary for new systems to operate in means the ability to confidently invest in

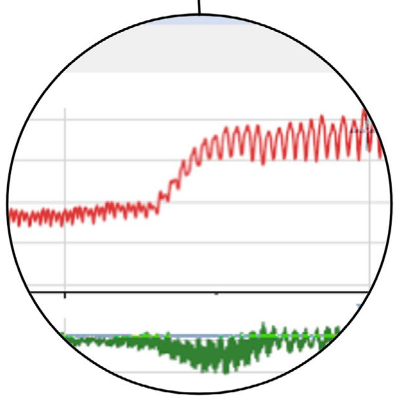
ATLAS rig tests

PlasmaTrack's effectiveness is already proven. During Knorr Bremse ATLAS Testing in 2021, plasma was applied to a railhead with a coefficient of friction of between 0.02-0.04μ, simulating the leaf layer conditions found during the autumn season. With a wheel load of 55kn, PlasmaTrack deployment resulted in a post-treatment coefficient of friction of >0.15μ, restoring the railhead in a single pass to a condition above and beyond what is necessary to ensure summer braking conditions.

Graphic output from ATLAS



Dynamic change in μ



Before > After