The Characteristics of Railhead Contamination (T354)

Introduction

Low adhesion during the annual leaf fall season results in a significant cost and risk to the industry, including disruption to services, inactivated track circuits, and potential over-runs and collisions. On behalf of the Adhesion Working Group (AWG), RSSB instigated this project to improve understanding of low adhesion so that its management can be optimised, and thus reduce costs without compromising safety.

Aims

The objectives were to identify the potential for new or improved treatment or prevention methods for railhead leaf contamination, and to capture this knowledge by developing industry-supported Guidance Notes for the measurement and simulation of low adhesion conditions.

Methodology

A new approach to understanding leaf contamination was taken by investigating the bonding mechanisms between leaf and rail material. Practical and knowledge-based methods were used in the investigation, with laboratory and track-based trials to support theoretical developments. The theoretical research was based on obtaining a biochemical understanding of the interactions between leaf material and rail steel.

Findings

Prevention and Removal Methods

Laboratory and track trials focused on the effect of varying pH at the rail surface as a means of preventing or removing leaf films.

The results show that effective removal of an existing film demands different chemical conditions to those which are most effective in the prevention of film formation through pre-treatment of the rail. The properties of the leaf contamination are affected in different ways with different chemicals. In past trials, the effectiveness of chemicals in leaf film removal has produced variable results. The current findings are consistent with this experience. Consideration should be given to using leaf contamination softening chemicals in combination with other treatments rather than as stand-alone methods of removal.
A number of chemicals have been tested including pH buffers, CitraClean HD (HD), Orange Cleanse (OC), Sodium Percarbonate (SP) and NatraSolve (NAT). The tests indicated that leaf films which do form give less coverage of the rail surface and are softened by the presence of higher pH levels at the rail head prior to creation of a leaf film. These results suggest that there could be benefits of using chemicals in a preventative role. Slowing the rate of leaf contamination formation could potentially provide extended times between treatments. The fact that softer films form in the presence of preventative chemicals means that less effort should be required to remove them, which will be beneficial to existing treatment methods.

**Measurement and Simulation**

The fundamental study of leaf film properties has identified suitable methods for measuring and simulating railhead leaf contamination.

Adhesion measurements and monitoring are useful for assessing conditions after low adhesion incidents, during trials of new treatment methods and for monitoring the system (e.g. on a route basis). This project has brought together knowledge of adhesion levels under a range of conditions and related these to the various measuring devices that are available.

In order to achieve consistent conditions during trials and/or to enable comparison of adhesion levels under different conditions, a number of techniques have been assessed for measuring the physical properties of railhead contamination (e.g. hardness, shear strength, moisture level etc). Results from measuring leaf film properties with these devices support historical findings on film thickness, shear strength, etc. and extend the knowledge on how these properties vary with a range of conditions e.g. moisture level.

A range of testing requirements for low adhesion simulation including the assessment of contaminant removal techniques, friction modifiers, vehicle braking and traction performance, have been identified from industry users. A Guidance Note on Low Adhesion Simulation has been produced which includes advice on the issues surrounding low adhesion driver training, post incident investigation and track circuit operation.
Next Steps

Prevention and Removal Methods
These research findings provide a basis and direction for further investigation of biochemical approaches to managing low adhesion.

Some of the methods developed for the analysis of leaf film could be applied to thin film contamination. This could be useful for understanding the “wet rail” condition and its role in adhesion incidents when there is no visible sign of leaf contamination.

It is recommended that Citra Clean, Natrasolve and lime be further tested for use on the operational railway. Prior to any tests on the operational railway, measurements should be made of the adhesion levels produced when using these products. A brake test would be a suitable method for checking the adhesion. Identification of any secondary effects on the railway infrastructure and the environment is also required prior to use on the operational railway.

The test site should be treated manually and thickness, hardness and coverage of any contamination should be monitored to assess the effectiveness of the treatment.

Discussion should be held with suppliers regarding appropriate equipment to automatically dispense any successful treatment chemicals. Consideration should also be given to the possibility of incorporating the identified treatments into the mitigation trains.

Chemical removal and preventative methods have been assessed on relatively thick contamination (circa 50 microns). Work should be conducted on very thin (10 microns or less) transparent residual layers to determine the effectiveness of the proposed chemicals in preventing and removing this thickness of contamination.

Whilst this research has identified a number of potential chemicals for preventing or removing leaf contamination, a greater understanding of the chemical action by which pH variation reduces leaf film would aid product choice and highlight ways of optimising this action. The hypotheses developed in the biochemistry work highlight the chemical actions which may be active in both leaf film removal and prevention treatments. Research on these chemical actions is recommended, focussing on how the period between rail treatments could be extended, and how the ability of the chemical to penetrate and attack an existing leaf film can be increased. Secondary effects of the treatments on the railway infrastructure, including the environmental impact, must also be considered.

Measurement and Simulation
It is recommended that the industry use the Guidance Note on Low Adhesion Measurement to aid selection of a suitable measurement method/Tribometer and to aid interpretation of results.

Skid Resistance Measurement
Any new or modified portable Tribometer should be assessed by measurement of adhesion on a range of contaminants and compared to the adhesion measured with a full-scale wheel on the same contaminants under the same conditions. If a new
portable Tribometer is to be developed, then the specifications drawn up in this work should be used as the basis for the new design.

The use of systems for monitoring wheel slip and slide activity and railhead contamination (e.g. track circuit monitoring) should continue to be explored as elements for use in an Adhesion Management System (RSSB project T540 Scoping and development of the Adhesion Management System).

Devices for measuring the properties of railhead contamination have been included in the Guidance Note on Low Adhesion Measurement. It is recommended that the methods (outlined in the Guidance Note) for assessing test or incident sites should be used for future investigations and to assist in monitoring simulated low adhesion conditions.

More Information

A detailed summary report “Characteristics of Railhead Leaf Contamination. Summary Report” can be found on the RSSB web site www.rssb.co.uk.

More detailed technical reports are also available on request to RSSB. These reports are as follows:
- Analysis of laboratory created railhead leaf films.
- Properties of leaf contamination.
- Biochemistry of railhead leaf film.
- Analysis of real leaf film samples.
- Removal/prevention of railhead leaf films.
- Wheel-Rail Low Adhesion Measurement.
- Wheel-Rail Low Adhesion Simulation.

A copy of the Guidance Note for wheel–rail low adhesion simulation and Guidance Note for Low Adhesion Measurement will be published by RSSB on the Railway Group Standards (RGS) website www.rgsonline.co.uk, as part of the Railway Group Standards (RGS) catalogue.

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