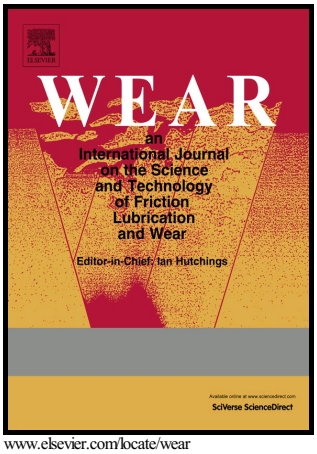

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The Low Adhesion Problem due to Leaf Contamination in the Wheel/Rail Contact: Bonding and Low Adhesion Mechanisms

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Abstract

Autumn leaves often cause low adhesion problems for train operations, leading to station overruns and signals passed at danger (SPADS). The aim of this paper was to review operational data and research methods to assess the current understanding of the problem and formulate hypotheses for the causes. Incident analysis showed the relatively high possibility of incidents between the hours of 05:00 – 10:00 and 20:00 – 24:00, suggesting the dew effect was important. This result corresponds to the knowledge that wet leaves in the contact area produce very low friction coefficients, below 0.1. Current mitigation methods, such as sanding, seem inadequate to remove the leaf films completely. To explain the bonding mechanism between the leaf film and the rail, a laboratory-based model and a field-based model were developed based on previous studies. Moreover, key parameters for a strong bond formation were identified, which are iron oxide, temperature, pressure and leaf material. The research gaps were identified by a paper grading method, and several hypotheses for bonding mechanisms and low adhesion mechanisms were proposed, such as sub- or super critical water and pectin gel.

Keywords: Low adhesion, Leaves, Pectin, Cellulose, Lignin, Railway, Wheel/Rail Contact

1. Introduction

Recently, railways have been re-evaluated as an eco-friendly method of transportation, which could achieve long-term sustainability due to their relatively low energy consumption and low carbon dioxide emissions [1, 2]. These characteristics are brought about by low rolling resistance due to the high stiffness of the wheel and rail. This leads to a relatively small contact area between the wheel and rail, resulting in a low dissipation of the driving energy by a friction force.

The tribological conditions between the wheel and rail are commonly expressed using three words, namely, friction, traction and adhesion. Friction is the tangential force transmitted between two objects which slide against one another. On the other hand, traction is the force transmitted between a driven cylinder rolling along a flat plane, further explanation can be found in [3]. The underlying friction level between two bodies of known materials will