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Studying Solid Sticks for Friction Modification of the Tread Contact Using a Twin Disc Rig

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Abstract

This work studies the use of solid stick at tread contact conditions using twin disc rig. The solid stick was applied using a spring-loaded applicator. Three test types were proposed in assessing the effect of a solid stick on the traction of the wheel and rail. The traction-creepage tests were the first and these test could show how the traction changes across different slippage under the influence of the solid stick. The second test was the retentivity tests. This could determine how long the product would stay in the contact and maintain the desired traction level. The third test was the wear test, which investigated the mass loss of the specimens when the solid product was applied. The results showed that the solid products could reduce the dry traction to an intermediate traction level across various slippage and also significantly reduce the wear of the disc specimens. This work shows that the twin disc rig is suitable to be used to test solid stick products. The test conditions can also be adjusted when the solid stick is more lubricious in nature, such as those used for flange lubrication.

Keywords: Solid stick, Tread contact, Friction modification, Twin disc rig.

1 Introduction

Top-of-rail friction modifiers in liquid form are often used in railways, applied the the rail head via wayside applicators, to reduce wear and save energy by providing an intermediate level of friction in the wheel tread/rail head contact [1, 2]. Numerous studies have been published exploring the efficiency of the liquid products in terms of the retentivity of the product, traction-creepage behaviour and the wear [3]. Very few comprehensive studies have been performed on tread solid sticks, applied continuously to the tread via a spring-loaded on-board device, however. Therefore, this work aimed to perform tests that could show in more detail the efficiency of the solid sticks to assist in selecting the best product for a particular application.

2 Methods

The twin disc rig used in this project is shown in Figure 1. The figure also shows the solid stick applicator that was used to apply the solid product onto a disc specimen. The applicator is a spring-loaded system and the stick (cut into a 10 x10 mm2 cross sectional long cubic structure) was located at the tip of the applicator. When the trigger in Figure 1 (a) was released, the stick would engage at the disc and effectively transfer the product onto the disc specimen.

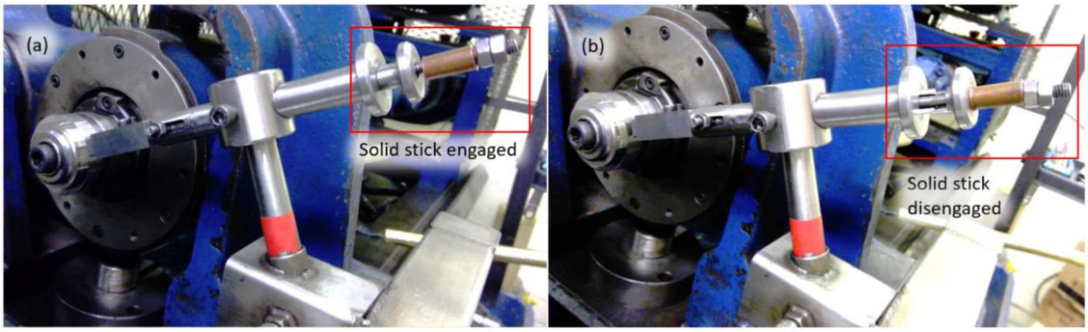

Figure 1: Solid stick applicator when (a) in contact with the wheel disc and (b) not in contact.

There were three test types proposed, which were the traction-creepage test (to study the traction level of the discs across a range of slip conditions when the product was in effect), the retentivity test (to study the time period when the product would last) and the wear test (to study the mass loss of the disc specimens when the product was in effect). These tests were performed on two solid stick products. The tests relied on the effective transfer of the solid product, which would require a minimum threshold application load. In this project, it was found that these products transferred effectively at 50N.

There were two test phases for a traction-creepage test, which are the discs conditioning phase and the testing phase. The slip in the disc conditioning phase was 0.2%. In the testing phase, the slip condition was reset to a new value to construct the traction-creepage graph. The contact pressure and the rotational speed were 900MPa and 400rpm respectively. The discs were run without any product application for the first 2000 cycles. From the 2000th cycle, the solid stick was engaged with the wheel disc (see Fig. 1) for 2000 cycles to allow product transfer equilibrium to be reached. The rig was then restarted from the 4000th cycle at the desired slip, which would be used to generate the traction-creepage graph. The test procedure is illustrated in Fig. 2(a). The slip conditions tested were 0.2, 0.4, 0.7, 1.0. 1.3, 2 and 5%. Each test condition was repeated two times.

The retentivity test generally had a similar concept to a traction-creepage test. The discs were run dry initially until the coefficient of traction reached 0.4. The solid stick was then engaged with the wheel disc for 200s. After the solid stick was disengaged from the contact, the discs were allowed to run until the coefficient of traction reached 0.4. The contact pressure was set at 1200MPa because the worst condition scenario was considered. Trains with heavier weight would normally negatively affect the efficiency of the product. The rotational speed and the slip condition was set at 400rpm and 1% slip respectively throughout the whole retentivity test. The test procedure is illustrated in Fig. 2(b).

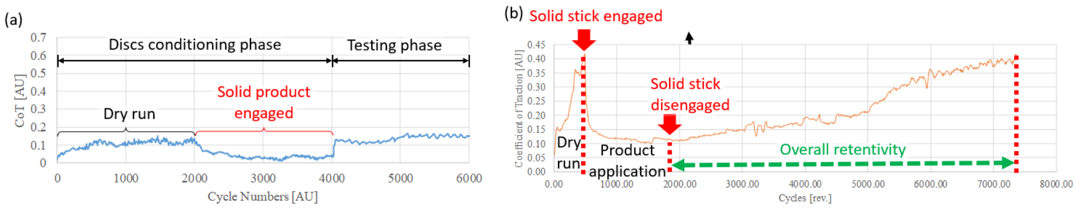

Figure 2: Test procedure for (a) traction-creepage tests and (b) retentivity tests.

Figure 3 shows the wear test procedure. A full wear test comprised of several individual wear tests. The weight of the discs was measured before and after each individual wear test to compute the discs wear rate. For each individual test. the solid stick engaged with the wheel disc throughout the test. The test was run at 1200MPa, 400rpm and 1% slip. The individual wear test was stopped if the coefficient of traction reached 0.4 or after 5000 cycles, whichever came first.

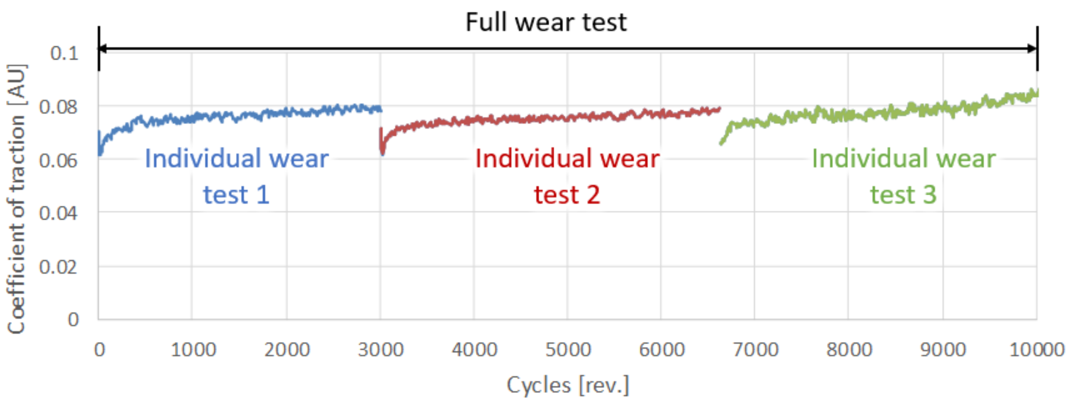

Figure 3: Test procedure for a full wear test.

3 Results

Figure 4(a) shows the comparison of traction-creepage graph between untreated discs and discs treated with the solid stick, which shows the solid stick product was successfully transferred to the discs and managed to reduce the coefficient of traction to an intermediate value. Figure 4(b) shows the retentivity of the solid sticks. Both products had similar retentivity at 7000 cycles before wearing off completely.

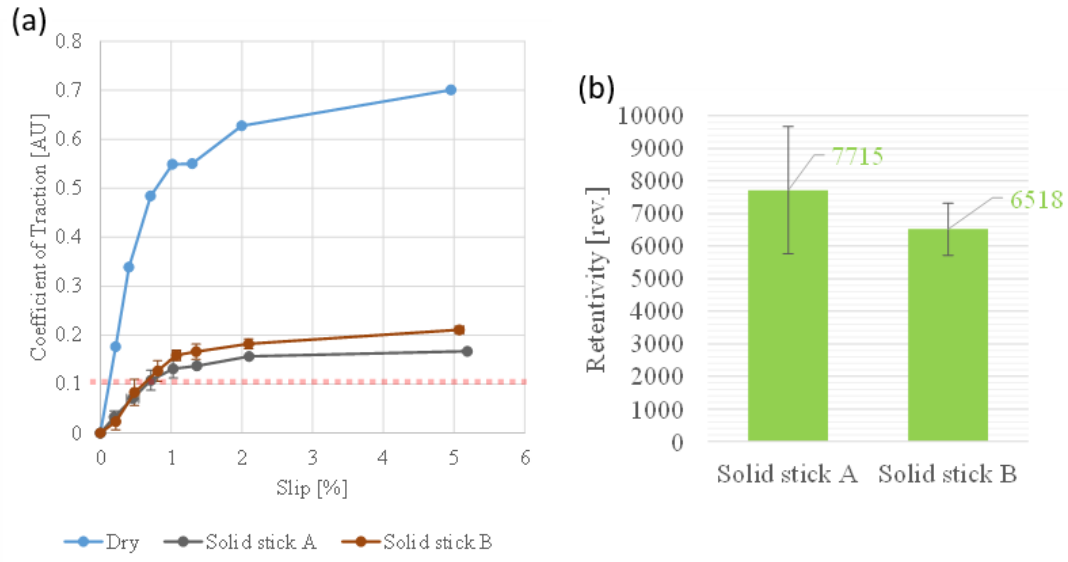

Figure 3: (a) Traction-creepage graph of treated and untreated discs and (b) retentivity of solid sticks.

Figure 5(a) and (b) show the comparison of disc wear rate for the rail and wheel discs when untreated and treated. As expected, treated discs had much lower disc wear rate.

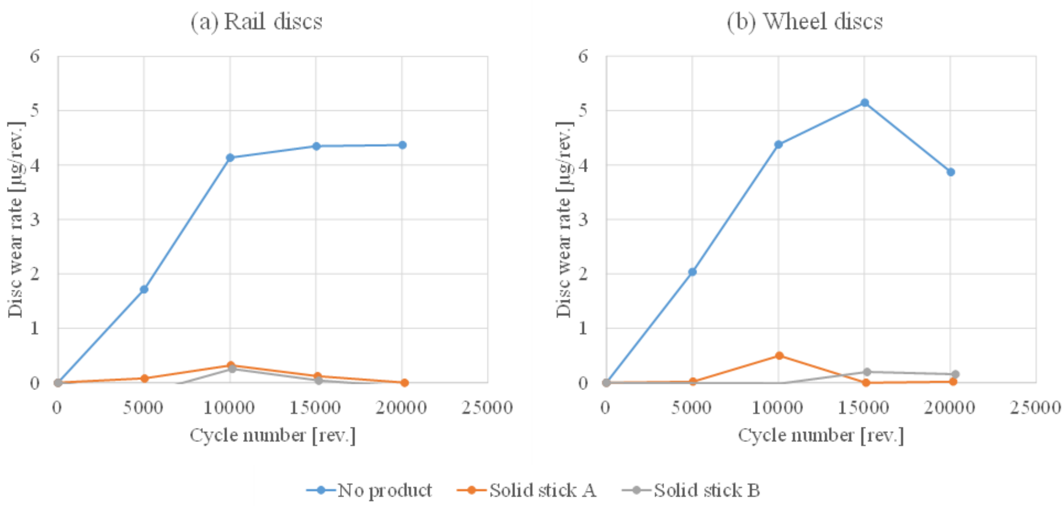

Figure 5: Disc wear rate of (a) rail discs and (b) wheel discs when untreated and treated with the solid stick.

4 Conclusions and Contributions

This study shows the methodology proposed for testing the efficacy of solid sticks using a twin disc rig. The most essential factor when performing tests regardless of test types with solid stick is the application load. Selecting which application load became complicated with different products having different suggested application load. Therefore, it is more important to ensure sufficient product transfer from the solid stick to the discs rather than using the suggested application load. In this study, the solid sticks function like a top-of-rail friction modifier, which normally gives intermediate coefficient of traction between 0.1 and 0.4. Therefore, this shows that the test methodology proposed is suitable to be used to test various solid stick products. The test conditions can also be adjusted when the solid stick is more lubricious in nature, such as those used for flange lubrication.

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