Eco-friendly lubricants:
Choose the best formulation for railway applications

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INTRODUCTION
In Europe, the railway sector is a part of our daily lives. In France, more than 3.8 Billion passengers use the almost 30 000 km of railway network each day (the second largest railway network in Europe after Germany). All the infrastructure and rolling materials need lubrication. Due to the increase of Eco-citizen concerns, we aim to provide more and more Eco-friendly and heavy-duty lubricants.

Raw material selection is the key to offering the most appropriate lubricants for the railway industry. Prior laboratory work guarantees suitable biodegradable products for various applications such as: Switch-plates, Wheel flanges, Curve tracks and Buffers.

METHODOLOGY & EXPERIMENTS
FORMULATION PLAN
The base oil choice for railway greases is essential to fulfil the necessary application specifications. It is the reason why several esters used in the manufacture of greases have been screened and studied in terms of:
- Resistance to oxidation
- Resistance to UV
- Wear reduction

The main characteristics of these raw materials and greases are summarised in Figure 1 (above) and Figure 2 (below). Three types of Biobased oil, with similar viscosity, are selected and thickened by organophilic clay.

According to their operational results, two greases for railway market are formulated.

<table>
<thead>
<tr>
<th>Thicker</th>
<th>CONDAT Railway Lubricant 1 (CONDAT RL 1)</th>
<th>CONDAT Railway Lubricant 2 (CONDAT RL 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature</td>
<td>Blended oil Saturated / Unsatuated</td>
<td>Blended oil Saturated / Unsatuated</td>
</tr>
<tr>
<td>Viscosity (cSt)</td>
<td>ASTM D445</td>
<td>32</td>
</tr>
<tr>
<td>Indene value (mg/100g)</td>
<td>ASTM D5704</td>
<td>≤ 30</td>
</tr>
<tr>
<td>Additive</td>
<td>Fully additized</td>
<td>Fully additized</td>
</tr>
</tbody>
</table>

The resistance to oxidation was tested using the Rapid Small Scale Oxidation Test (RSSOT, see Figure 3). The test parameters such as the initial pressure have been defined for this study and are the same for all the trials.
An ASTM standard was published last year (ASTM D8206-18) for the oxidation test with this apparatus. The tested grease is spread (with a predetermined thickness) on a metal plate. This plate is then placed under UV light for 200h (i.e. 6 months field test). After this lapse of time, the appearance of the grease on the plate is checked. It is necessary that the product remains greasy to be considered as UV resistant.

**Figure 4.** Thickened Biobased A, B & C RSSOT Oxidation results.

**Figure 5.** CONDAT Railway Lubricants RSSOT oxidation results.

**AGEING UV**

UV resistance is an important factor for a railway grease as it could be exposed to sunlight during use. In fact, the grease must be able to retain its lubricating characteristics without producing a solid layer or gumming under UV light. In order to simulate UV effect on grease, a bench test has been developed with a major railway actor (see Figure 6).

**Figure 6.** UV test bench.

**Figure 7.** Thickened Biobased A, B & C aspect before and after UV test.

**Figure 8.** Vegetable oil unsaturation polymerisation.

The results for thA to thC in Figure 4, show that the nature of the ester is the main factor for the oxidation stability (with the same additivation). Indeed, the suppression of the base oil unsaturation allows the test duration to be multiplied by 10 compared to thA.

CONDAT RL 1 & CONDAT RL 2 have a good oxidation performance, due to their additivation and the choice of mixed esters oil. Both show performances multiplied by a minimum of 10 compared to the basic vegetable oil base.

As shown above, thA (composed of vegetable oil) became completely gummy after being submitted to UV light for 200h as all its unsaturation polymerised (as shown in Figure 8).

On the contrary, thC is sufficiently greasy after testing thanks to its ester nature. thB is quite sticky as its ester started to polymerise.

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LUBRICATION CAPACITY

The lubricating capacity is measured by a SRV tribometer according to ASTM D5707 (see Figure 10). We monitor the variation of coefficient of friction (CoF).

Greases were tested for their lubrication capacity before and after the UV ageing process. The first general conclusion shows the major impact of base oil which can create (as seen in Figure 8) gumming or solid layer that will lead to a dramatic increase of CoF. This is a major issue for the end-user as it could block switch-plates for instance.

CONCLUSIONS

For the biodegradable greases’ railway market, the main characteristics are certainly resistance to UV, Oxidation and Lubricity. To ensure optimal performances, the best solution seems to be ester base, offering better characteristics than basic vegetable oils. Base oil is part of the formulation, another important part is linked to the use of the right blend of additives, either to protect equipment or to adhere on the surface to ensure the perfect availability of the grease. Additional tests can be carried out with manufacturers equipment for the railway market, such as for example spraying tests for onboard systems. A formulation is always a result of a compromise between performances and cost.

To conclude, Environmental concerns should lead to a major use of these biodegradable greases, which already demonstrate a high level of performance.

LINK
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