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

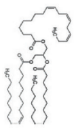
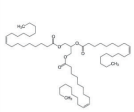
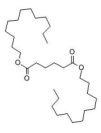
			Thickened Biobased A (tbA)	Thickened Biobased B (tbB)	Thickened Biobased C (tbC)
Thickener			Organoclay	Organoclay	Organoclay
Base Oil	Nature		Vegetable oil	Unsaturated oil	Saturated oil
	Viscosity 40°C (mm²/s)	ASTM D445	Iso viscosity		
	Iodine value (mg KOH/g)	ASTM D5554	105-126	80-90	≤ 7
	Chemical structure type				
Addtivation			Same minimal oxidation protection		

Figure 1. *Thickened Biobased A, B & C characteristics and compositions.*

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.

			CONDAT Railway Lubricant 1 (CONDAT RL 1)	CONDAT Railway Lubricant 1 (CONDAT RL 2)
Thickener			Organoclay	Organoclay
Base Oil	Nature		Blended oil Saturated / Unsaturated	Blended oil Saturated / Unsaturated
	Viscosity 40°C (mm²/s)	ASTM D445	32	68
	Iodine value (mg KOH/g)	ASTM D5554	≤ 30	≤ 45
Addtivation			Fully additived	Fully additived

Figure 2. *Greases characteristics and compositions.*

AGEING TEMPERATURE

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.

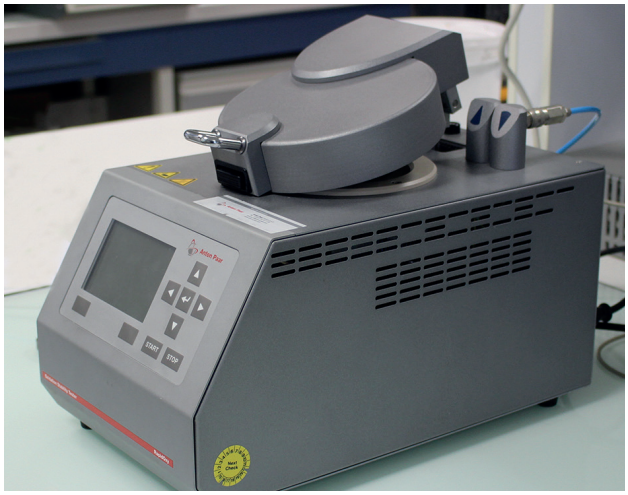


Figure 3. *Rapid Small Scale Oxidation test.*

An ASTM standard was published last year (ASTM D8206-18) for the oxidation test with this apparatus.

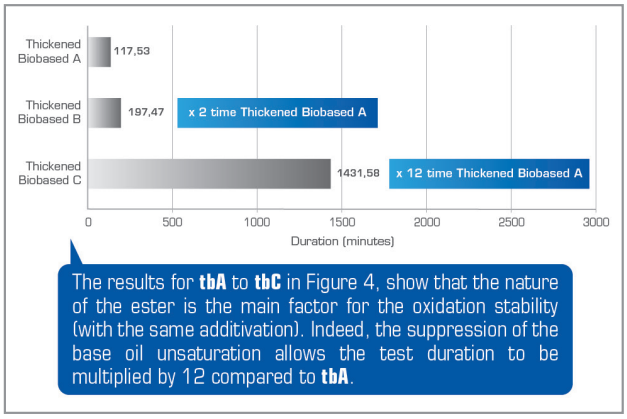


Figure 4. *Thickened Biobased A, B & C RSSOT Oxidation results.*

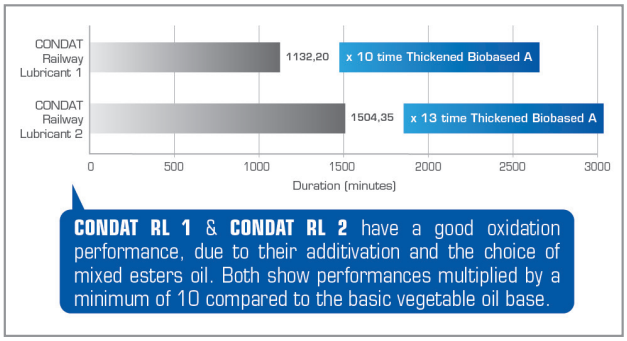


Figure 5. *CONDAT Railway Lubricants RSSOT oxidation results.*

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).

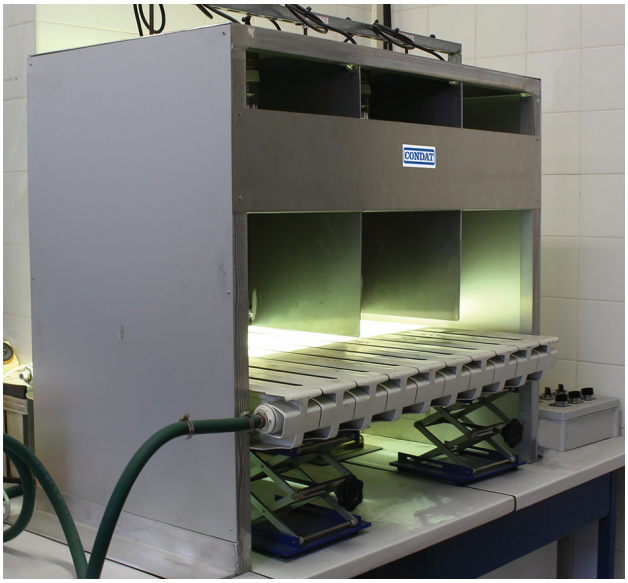


Figure 6. *UV test bench.*

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.

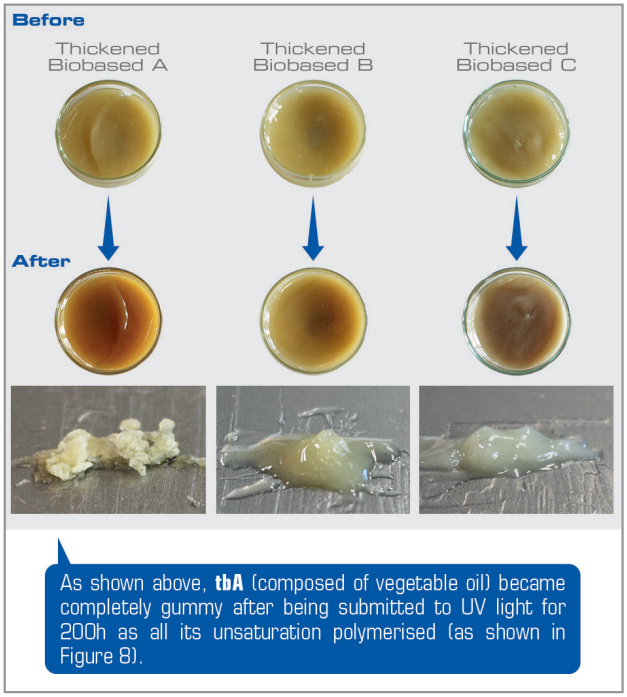


Figure 7. *Thickened Biobased A, B & C aspect before and after UV test.*

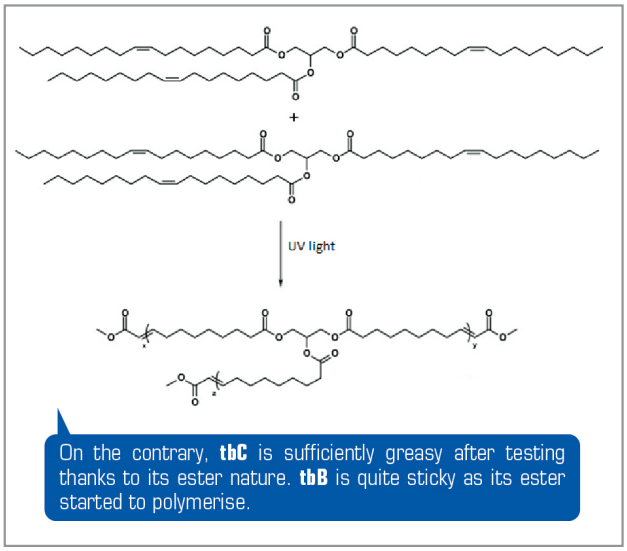


Figure 8. *Vegetable oil unsaturation polymerisation.*

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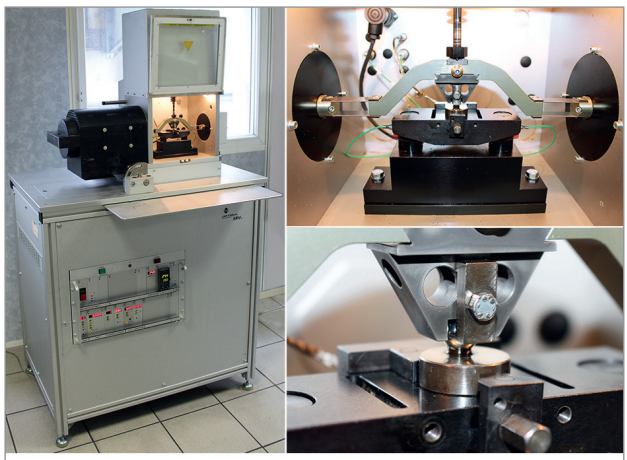
Figure 9. *CONDAT Railway Lubricants aspect before and after UV test.*

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).



	Test conditions
Temperature (°C)	50
Duration (min)	120
Load (N)	200
Stroke (µm)	1000
Frequency (Hz)	50

Figure 10. *ASTM D5707 conditions and SRV test.*

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.

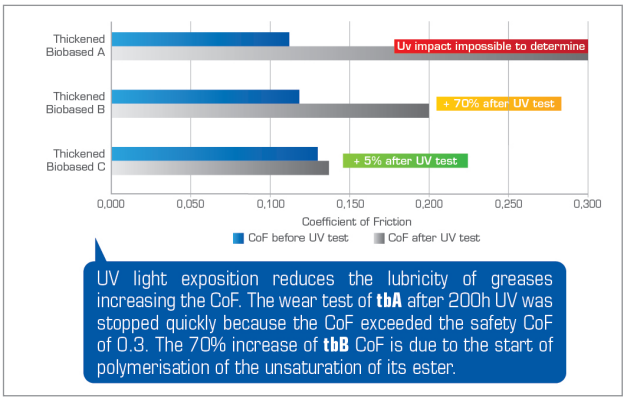


Figure 11. *Thickened Biobased A, B & C SRV wear results.*

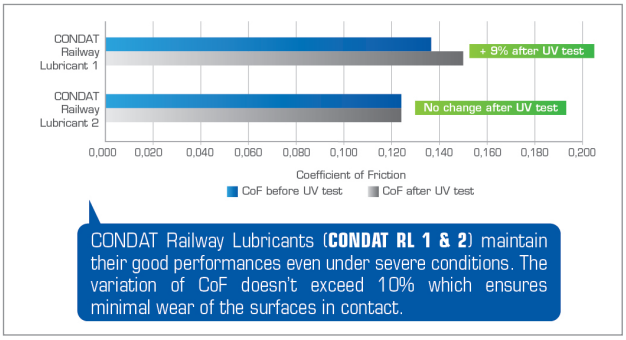


Figure 12. *CONDAT Railway Lubricants SRV wear results.*

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
www.condat.fr