Extruded materials

Tribological, PV and friction performances

Results obtained from official tests
permofermed at:

TECHNISCHE UNIVERSITÄT
CHEMNITZ

Movex®

1 Objective

The friction coefficients of different chain and slide rail materials in dry running and water lubrication conditions with and without lubricant additives are to be investigated under realistic conditions on a test conveyor.

2 Test set-up and execution

The tests were carried out on a test stand according to figure 1 (page 2) or figure 5 (page 6). This has three straight chain tracks which are driven via a common shaft. Two of these tracks are equipped with a cushion lubrication system, which can apply pure or lubricant-containing water to the chains, thus enabling lubrication. The good load is simulated by means of a slide, where the slide rails are mounted on the underside. This slide rests on the chain and is pressed by the chain movement against a force sensor attached to the frame, allowing the friction force to be measured and recorded (Figure 6, page 6).

In the case of the lubricated tracks, lubrication is continuous and takes place immediately in front of the carriage (Figure 7, page 7). The total hardness of the water used was 5.3 °dH (soft hardness range) [source: Wasserwerk Chemnitz Einsiedel]. The lubricant mixture consisted of water with the addition of the synthetic lubricant from a german company. The manufacturer recommends adding 0.2...0.5% for all water hardnesses. In the tests, an average proportion of 0.35% was selected.

Figure 01: Test stand

The tests were carried out with 2 different chain materials (Figure 2 page 2):
- LF and PFX as well as 4 slide bar materials (Figure 2 page 2):
- TI WHITE, BluLub, Green and HDPE Black (Figure 3 page 3).

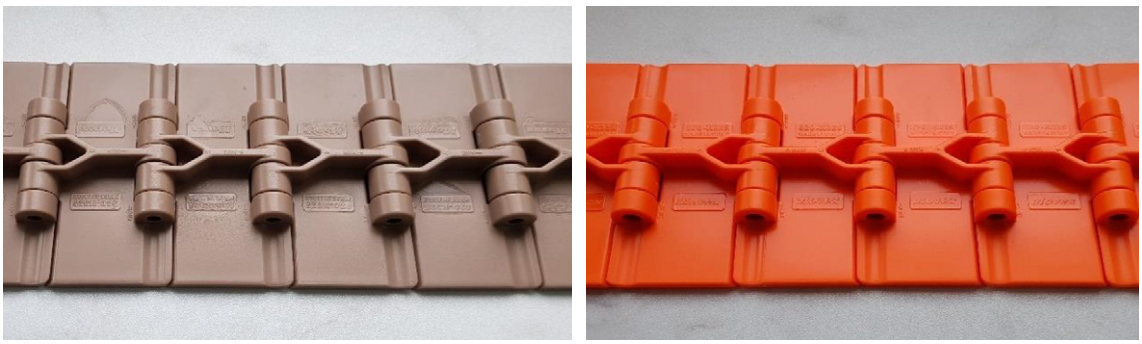


Figure 2: Examined slatband chains 820 K325, material LF (left) and PFX (right)

Figure 03: Examined slide rail samples, prepared for the test, from left to right: Ti-White, BluLub, UHMW-PE Green and HDPE Black (competitor material).

Material	Molecular density	Operating temperature	Linear expansion coefficient	FDA
BluLub®	9.200.000 g/mol	-40 to + 80°C (-40 to 176°F)	2 x 10-4°C-1 (1.1 x 10-4 °F-1)	V
Ti-White®	9.200.000 g/mol	-40 to + 80°C (-40 to 176°F)	2 x 10-4°C-1 (1.1 x 10-4 °F-1)	V
UHMW-PE Green	5.600.000 g/mol	-40 to + 80°C (-40 to 176°F)	2 x 10-4°C-1 (1.1 x 10-4 °F-1)	X
HDPE Black (competitor material)	400.000 g/mol	-40 to + 80°C (-40 to 176°F)	2 x 10-4°C-1 (1.1 x 10-4 °F-1)	X

Each rail material was tested with each chain in all lubrication conditions. A test run on the test stand was carried out simultaneously in the three conditions dry, water and soap solution. In order to exclude possible running-in effects, the tests ran for at least 36 hours in each case. The friction values were recorded during the entire duration, whereby the friction value used for the comparisons was averaged from the measured values between 30 and 36 hours.
Before each test, all slide rail sections were replaced. The chains as well as the water and lubricant mixture were changed after every 4 tests. A slight discolouration was visible on the chain running in the "dry" condition after the tests, the chains were therefore cleaned with ethanol after each individual test.

The chain speed was 0.15 m/s and the nominal surface pressure of approx. 0.0035 MPa corresponded to a chain load of filled 1-litre returnable bottles (diameter approx. 80 mm, mass approx. 1.1 kg).

3 Results

Important note: When evaluating the results, it should be noted that there is only one test per pairing and therefore no statistical certainty. Values that are close together therefore do not allow any conclusions to be drawn about generally "better" or "worse" friction values. Furthermore, it must be taken into account that the upper side of the chain (contact point during measurement) has a significantly rougher erosion structure than the underside (contact point during operation of the conveyor). It is known that rough structures often have lower friction values than smooth sliding surfaces, i.e. the friction values measured in the comparative tests of this report could be below the real friction values in practice.

The recorded friction value curves of all tests (up to 36 hours), subdivided according to chain material LF and PFX as well as lubrication condition, are shown in appendix 3a/b. There was a tendency for very uniform curves and the lowest friction values to be recorded with lubrication.

Table 01: Friction values (averaged between 30 and 36 hours running time)

Conveyor test	Dry		Wet		Lubricated	
	PFX	LF	PFX	LF	PFX	LF
BluLub®	0,100	0,119	0,137	0,094	0,096	0,061
Ti-White®	0,153	0,104	0,142	0,064	0,094	0,066
UHMW-PE Green	0,171	0,128	0,159	0,078	0,105	0,090
HDPE Black (competitor material)	0,275	0,205	0,25	0,18	0,160	0,161

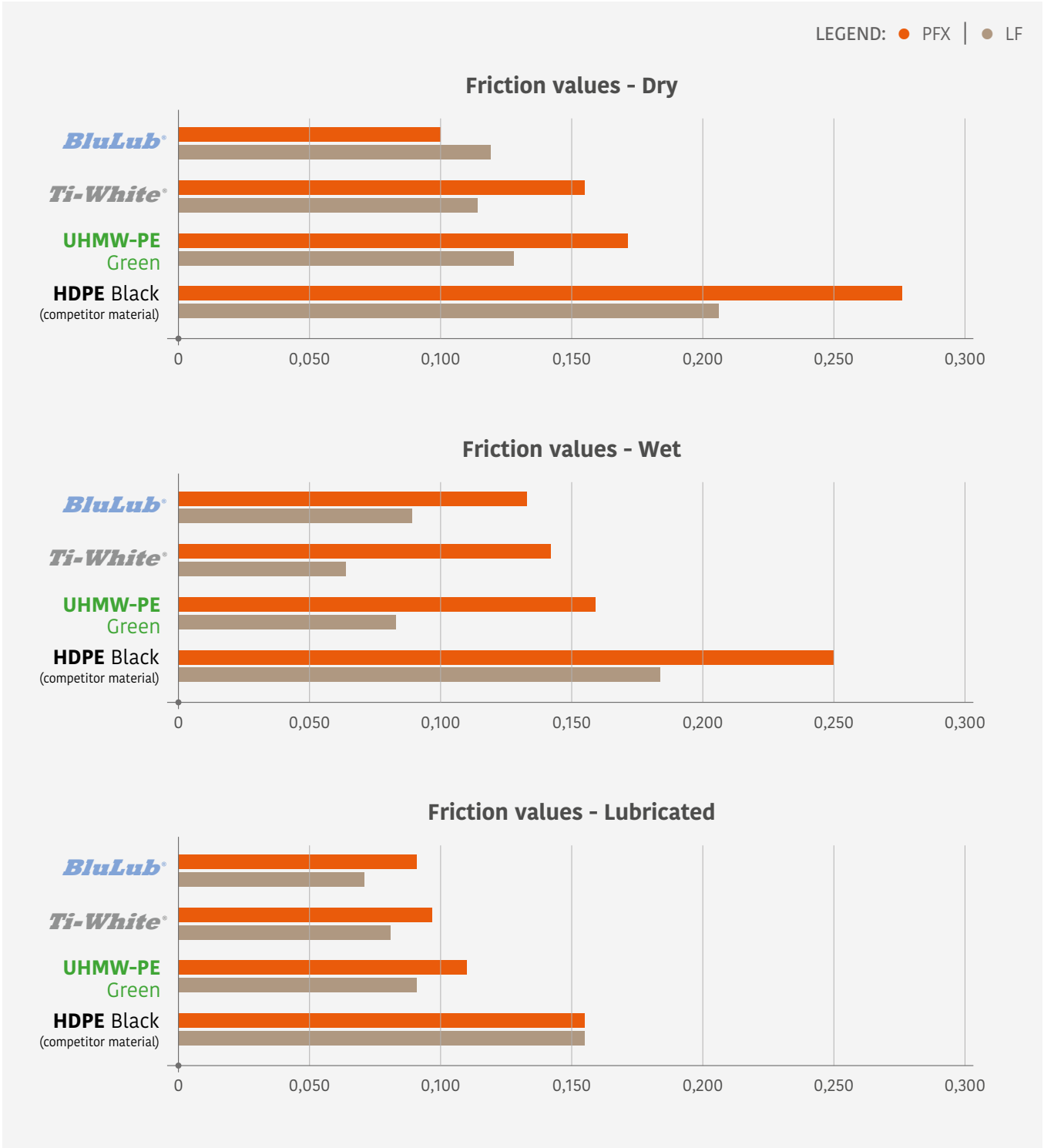


Figure 4: Friction values (averaged between 30 and 36 hours running time)

Table 1 lists the friction values averaged over the period between 30 and 36 hours for all material pairings and lubrication conditions. In general, it can be seen that these friction values are below 0.15 in all tests for BluLub and Titanium White, i.e., the pairings consistently exhibit very good sliding behavior. For UHMW-PE and HDPE the values show clearly different performances.

The LF chain produced the expected results with the drop in friction values from dry running to water lubrication to lubricant. It is noticeable that significantly lower friction values were measured with water and lubricant compared to PFX chain. With the PFX chain, the phenomenon also occurs that the friction values with water lubrication are noticeably higher than those with dry running.

For dry conditions, BluLub and PFX combination offers the best performances, even if the combination of Titanium White and LF is not that far away; the main differences between the two combinations is reported in the next pages (page 12) where it's shown a clear difference in terms of wear.

Another clear difference (which is not analyzed in this report, as was not the scope of it) is the carried product stability; in fact, the coefficient of frictions of PFX and LF are very different (more information on the Movex catalog, page 651 and page 657).

In water condition it is evident that LF in combination with Ti-White offers the best performance.

In lubricated condition, all the combinations are more or less in line. It is also clear that the choice of chain material and profile material is a combination of different factors:

- Friction between chain and profile (this report)
- Friction between chain and product (not in this report)
- Friction between profile and product (this report, page 11)
- Wear resistance (this report, page 12)

(all the other technical factors e.g. temperature, load etc... have to be considered as well).

Appendix 1: Test rig

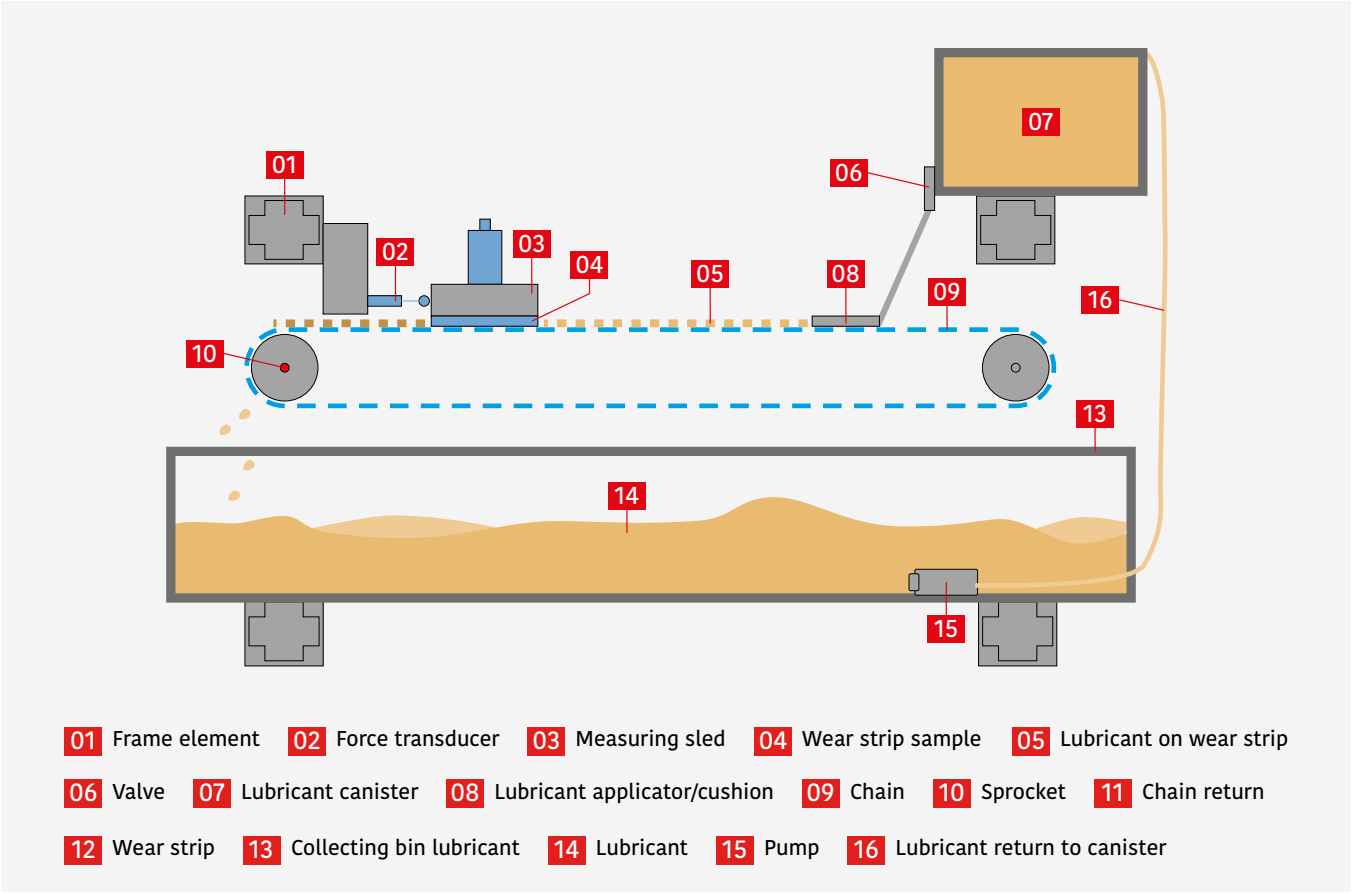


Figure 5: Test setup (schematic)

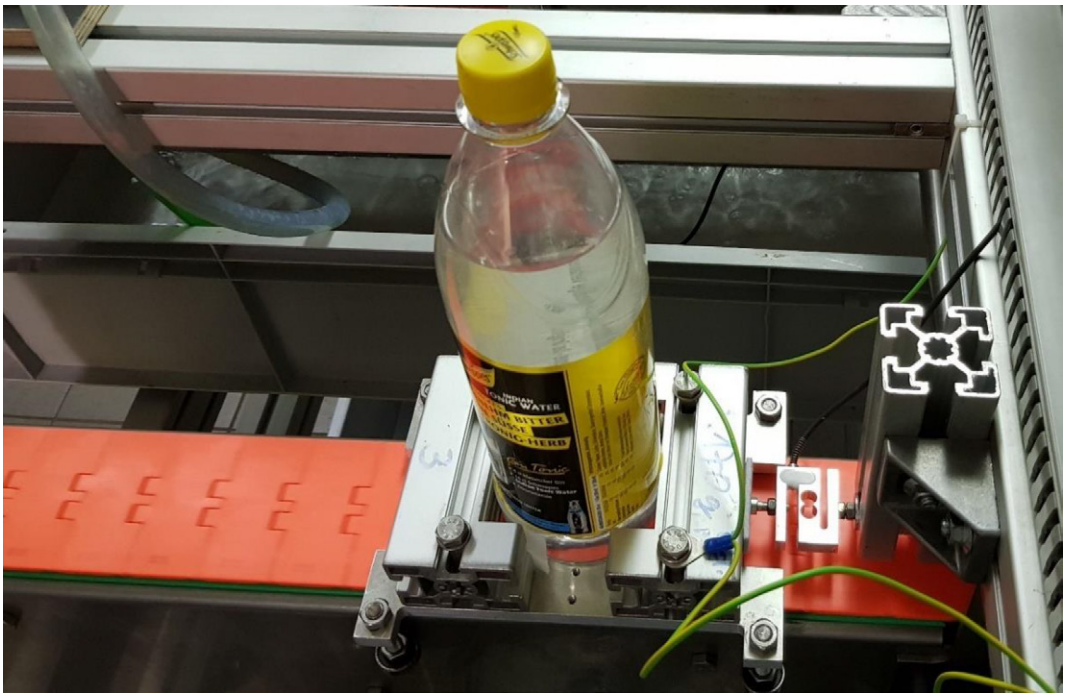


Figure 6: Loaded test sled with mounted slide rail material and force sensor (nominal force 20 N)

Figure 7: Continuous water or lubricant application via circulation pump.

Figure 8: Grease residues on the inside of the tub after approx. 190 hours of operation with belt lubricant (water + 0.35% Lubricant)

Appendix 2: Test parameters

Sample mass			
Holder	kg	1,176	Incl. foil and samples
Filled bottle	kg	1,107	1litre returnable, lemonade
Total mass of sample	kg	2,283	-

Contact surface/pressure			
Chain width	mm	82,5	-
Length of rail	mm	160	Approx. 2x bottle diameter
Distance between rails	mm	42	-
Contact surface	mm^2	6480	-
Pressure	MPa	0,0035	-

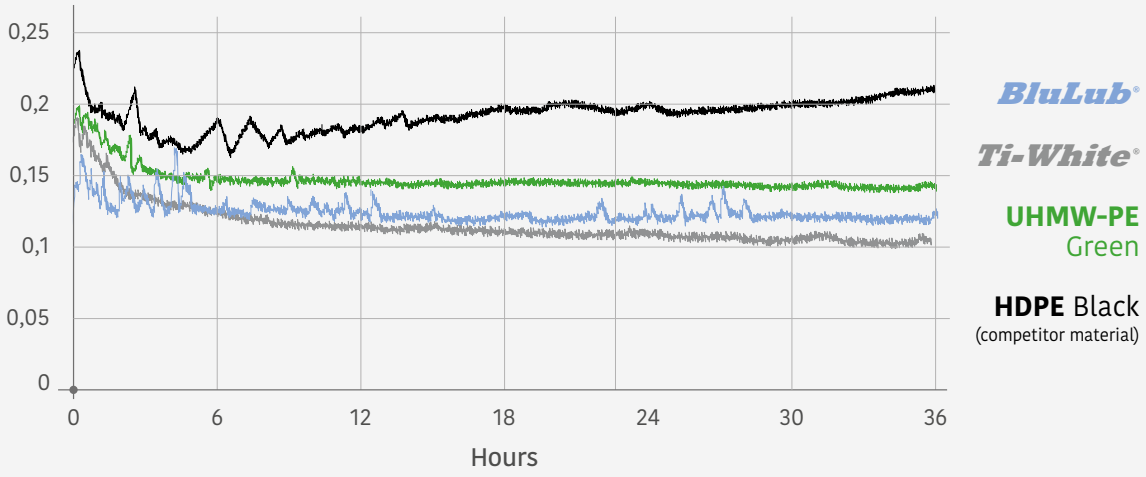
Speed			
Chain pitch	mm	38,1	Type 820 K325
Number of links in test	-	48	-
Chain length in test	m	1,83	-
Cycle time	s	12,5	-
Speed	m/s	0,15	-

Lubricant			
Type	-	-	
Manufacturer	-	-	
Recommended concentration	-	0,2-0,5% for all water hardnesses	
Concentration for trials	%	0,35	-
Water volume (tub)	l	32	-
Volume concentrated lubricant	ml	112	-

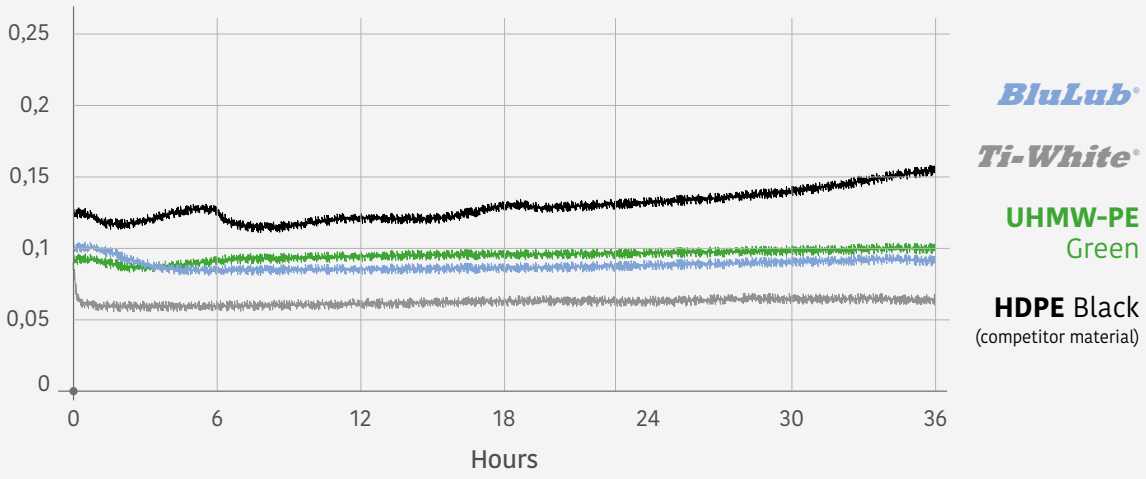
Lubrication continuously, directly in front of sled

Appendix 3a: Measured value curves chain material LF

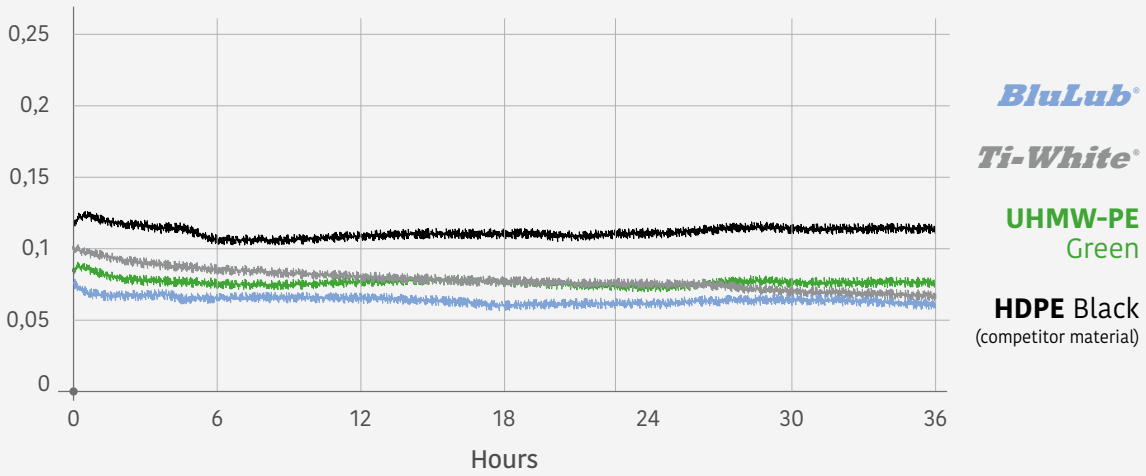
Friction values - Dry



Friction values - Wet

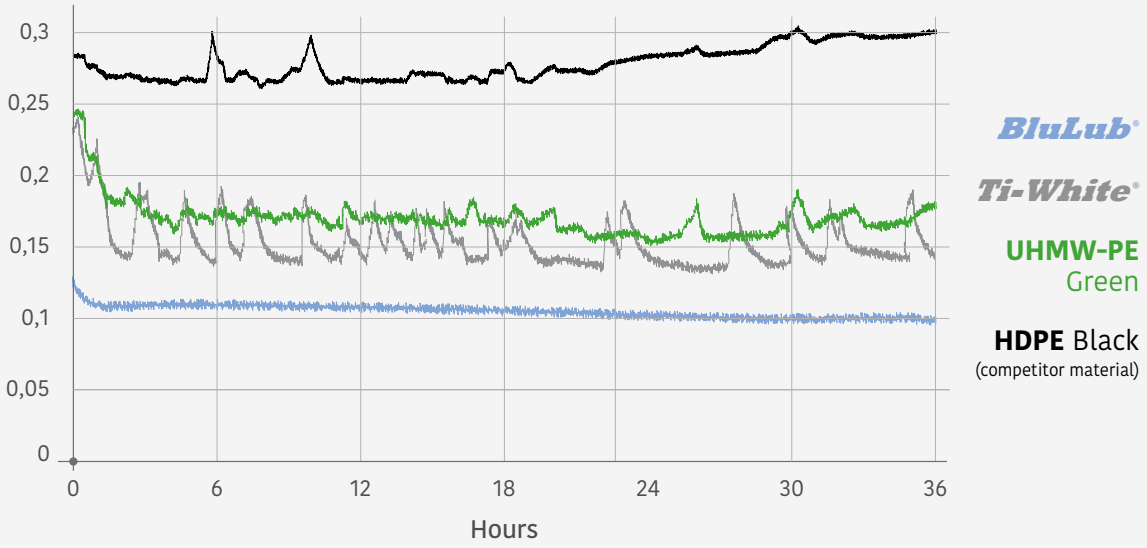


Friction values - Lubricated

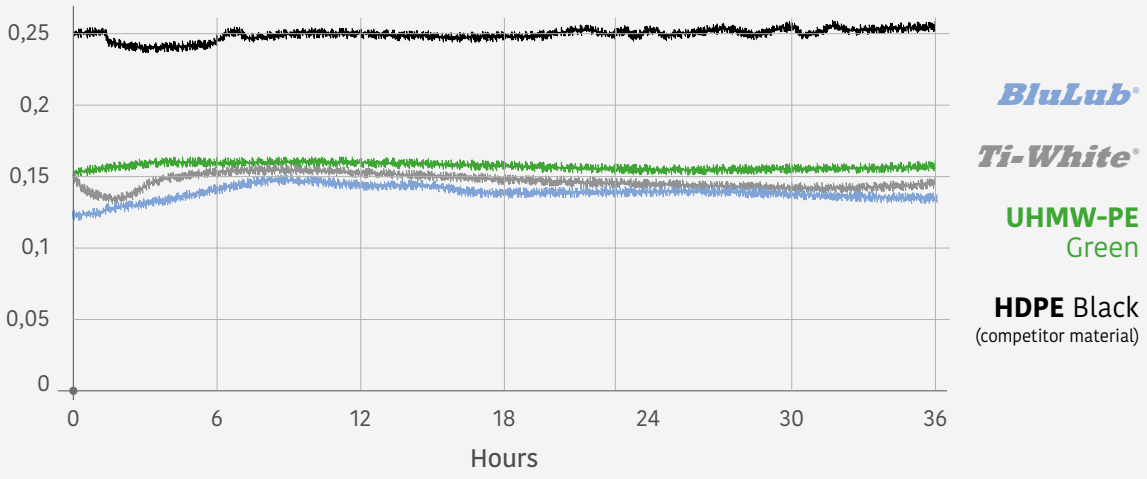


Appendix 3b: Measured value curves chain material PFX

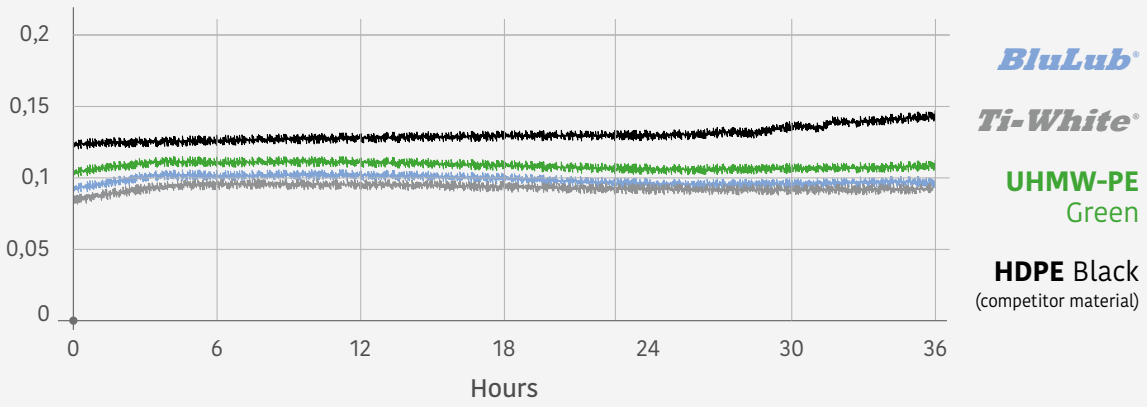
Friction values - Dry



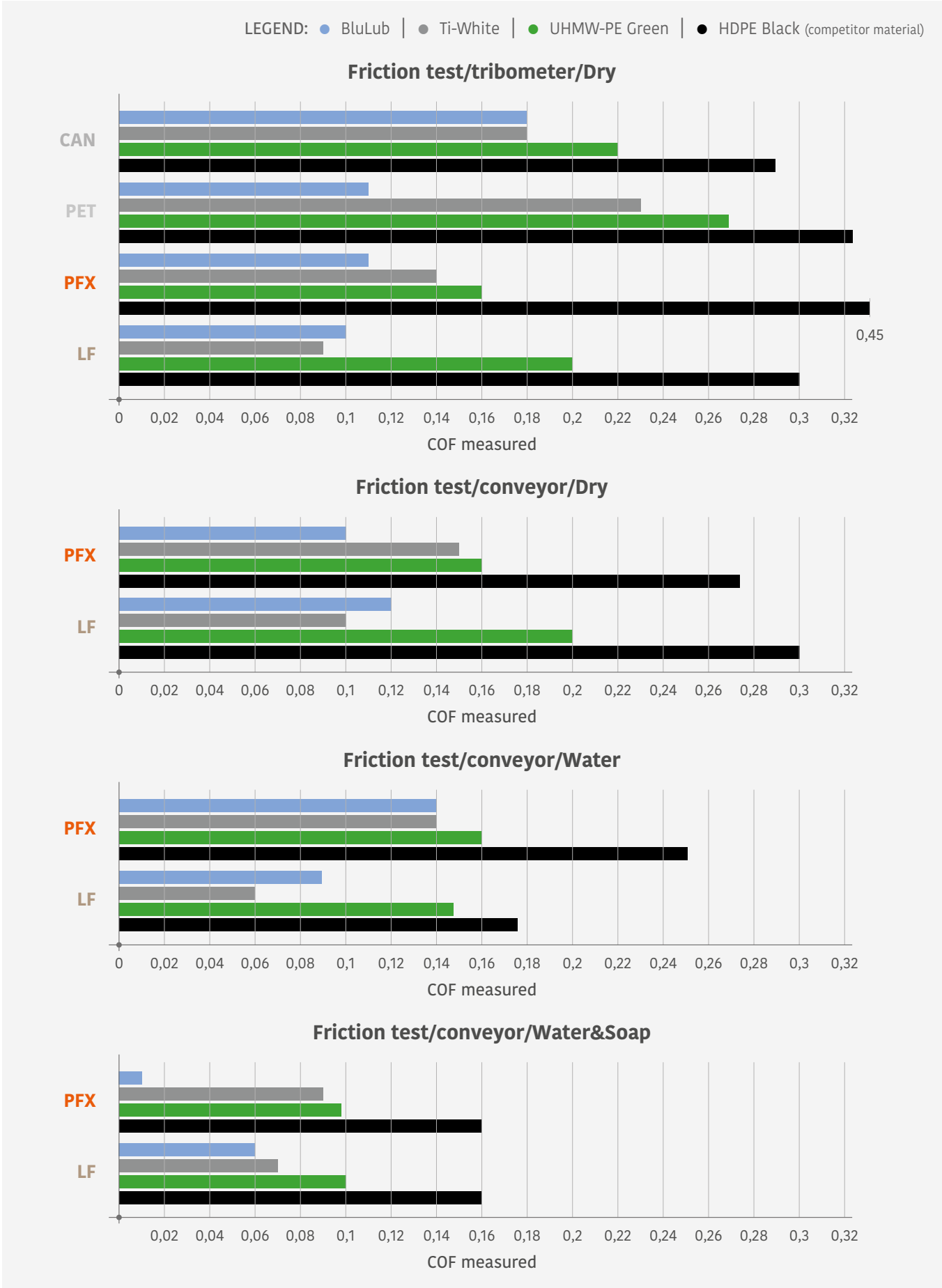
Friction values - Wet



Friction values - Lubricated



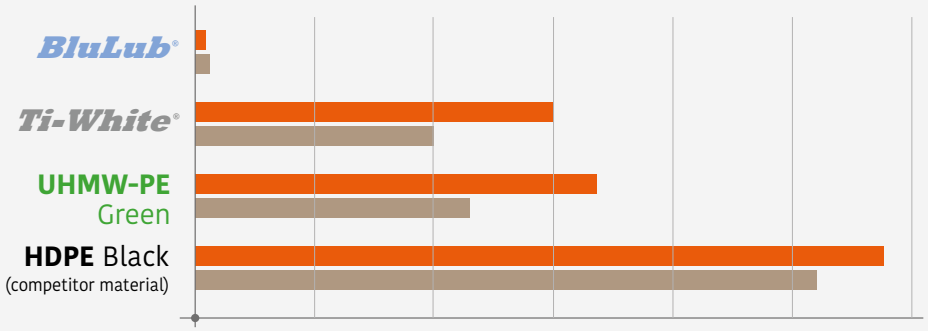
Friction and wear verification test conducted on so called tribometer device with material probes cut out of original parts



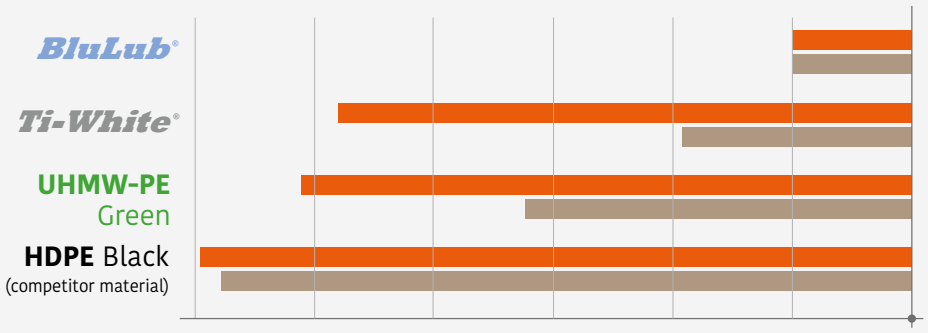
Appendix 3b: Measured value curves chain materials PFX and LF

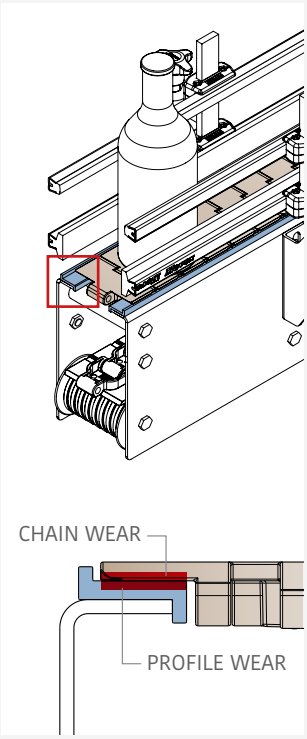
LEGEND: ● PFX | ● LF

Chain wear values



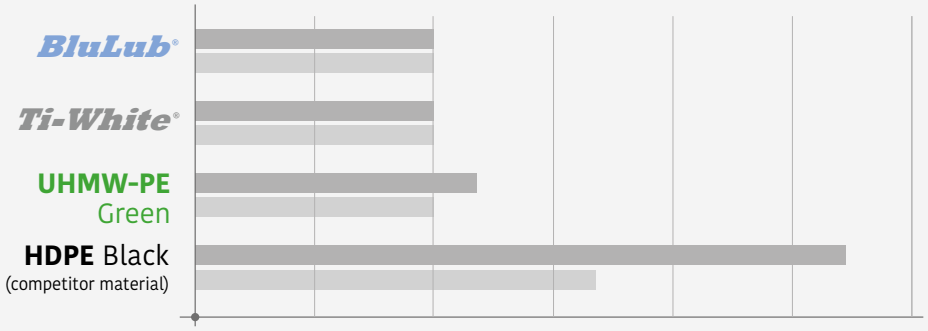
Profile wear values



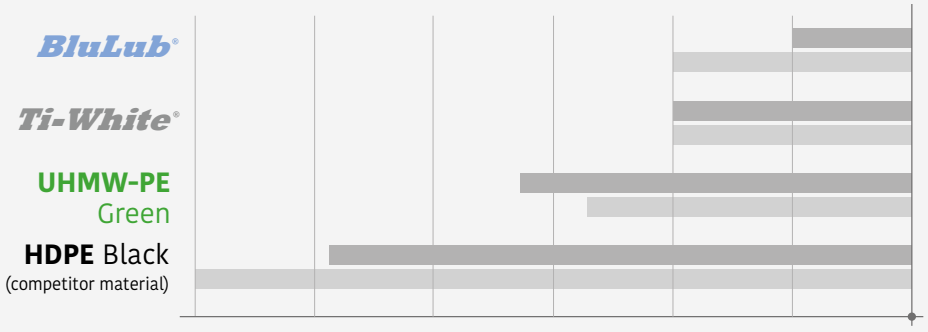


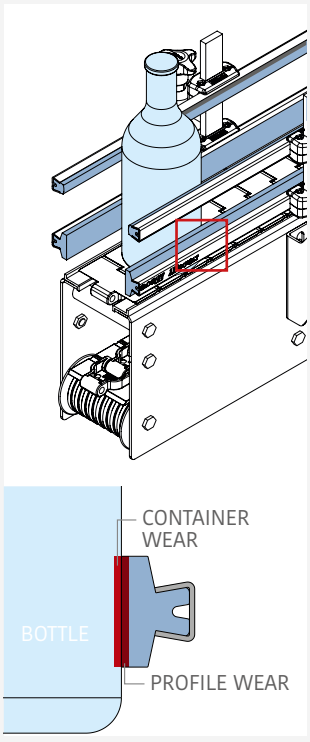
LEGEND: ● PET | ● CAN

Container wear values



Profile wear values





Resulting overview & selection guidelines

*Favourite

Dry

Chain	Chain guide	Best choice		Good choice		Still possible		Worst choice	
		Good sliding	Good wear resistance	Good sliding	Good wear resistance	Good sliding	Good wear resistance	Good sliding	Good wear resistance
PFX*	BluLub® *	●	●						
	Ti-White®					●	●		
	UHMW-PE Green					●	●		
	HDPE Black (competitor material)							●	●
LF	BluLub®			●	●				
	Ti-White®	●					●		
	UHMW-PE Green					●	●		
	HDPE Black (competitor material)							●	●

Dry

Container	Product guide	Best choice		Good choice		Still possible		Worst choice	
		Good sliding	Good wear resistance	Good sliding	Good wear resistance	Good sliding	Good wear resistance	Good sliding	Good wear resistance
PET*	BluLub® *	●	●						
	Ti-White®		●			●			
	UHMW-PE Green				●	●			
	HDPE Black (competitor material)							●	●
CAN	BluLub®	●			●				
	Ti-White®	●			●				
	UHMW-PE Green				●	●			
	HDPE Black (competitor material)							●	●

Water

Chain	Chain guide	Best choice		Good choice		Still possible		Worst choice	
		Good sliding	Good wear resistance	Good sliding	Good wear resistance	Good sliding	Good wear resistance	Good sliding	Good wear resistance
PFX	BluLub®					●			
	Ti-White®					●			
	UHMW-PE Green					●			
	HDPE Black (competitor material)							●	
LF*	BluLub®			●					
	Ti-White® *	●							
	UHMW-PE Green			●					
	HDPE Black (competitor material)							●	

Water & soup

Chain	Chain guide	Best choice		Good choice		Still possible		Worst choice	
		Good sliding	Good wear resistance	Good sliding	Good wear resistance	Good sliding	Good wear resistance	Good sliding	Good wear resistance
PFX	BluLub®			●					
	Ti-White®			●					
	UHMW-PE Green			●					
	HDPE Black (competitor material)							●	
LF*	BluLub®	●							
	Ti-White®	●							
	UHMW-PE Green	●							
	HDPE Black (competitor material)					●			

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