
Pitch and yaw bearing grease

Beneficial influences on the service life

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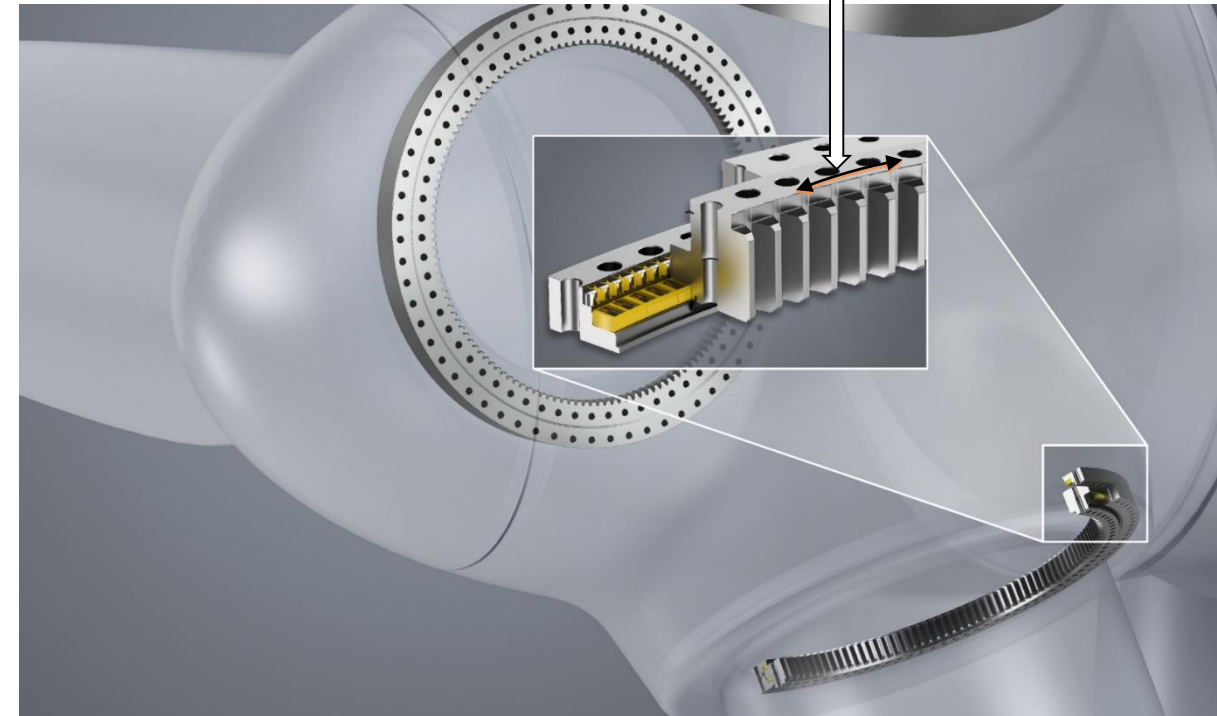
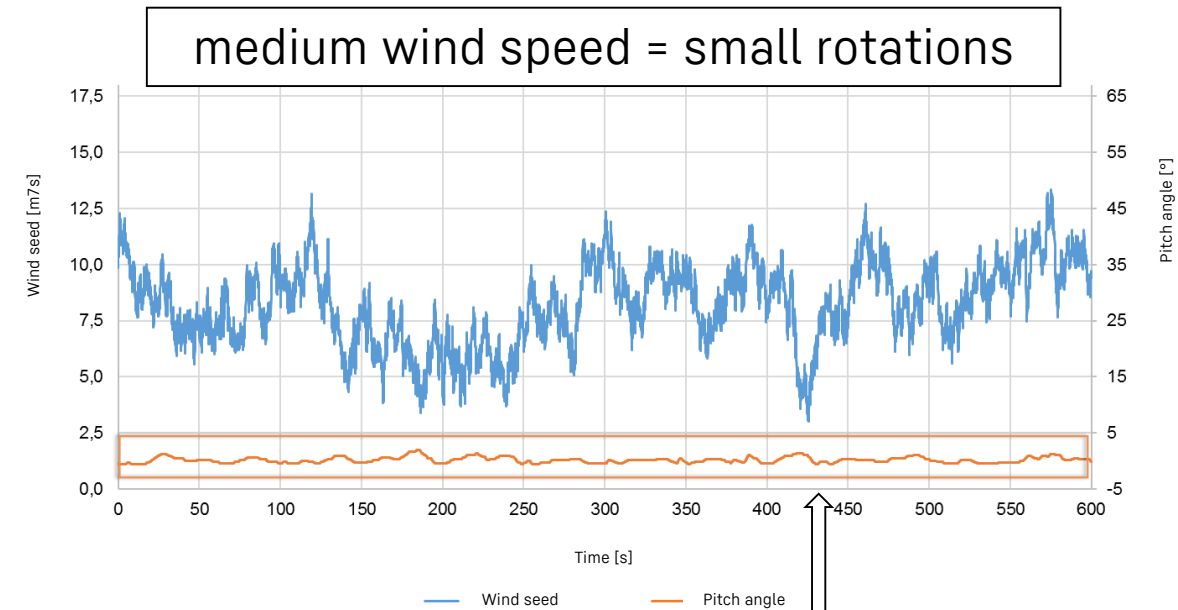
Pitch bearings: Challenges

Challenges

Pitch bearings for blade adjustment are subject to special loads:

- Partial standstill
- Small rotations / pitch angles
- Changing loads

These stresses lead to corrosions, such as idle/stand still marks (SSM) and false brinelling marks (FB).



False Brinelling Corrosion (FB)

Critical $x/2b$ ratio – **False Brinelling** marks appear (path of oscillation x / double width Hertzian semi axis $2b$)

Sliding or mixed friction of metallic contact partners result in:

- Adhesion
- Abrasion
- Surface disruption
- Tribochemical reactions

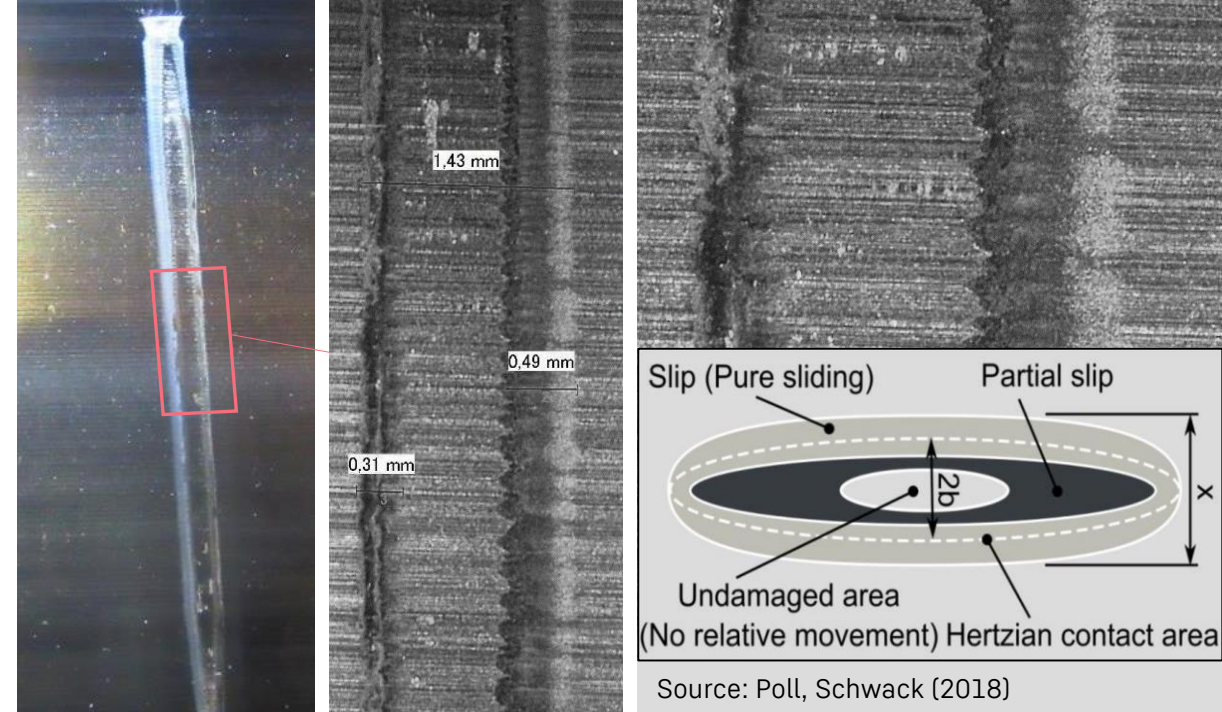
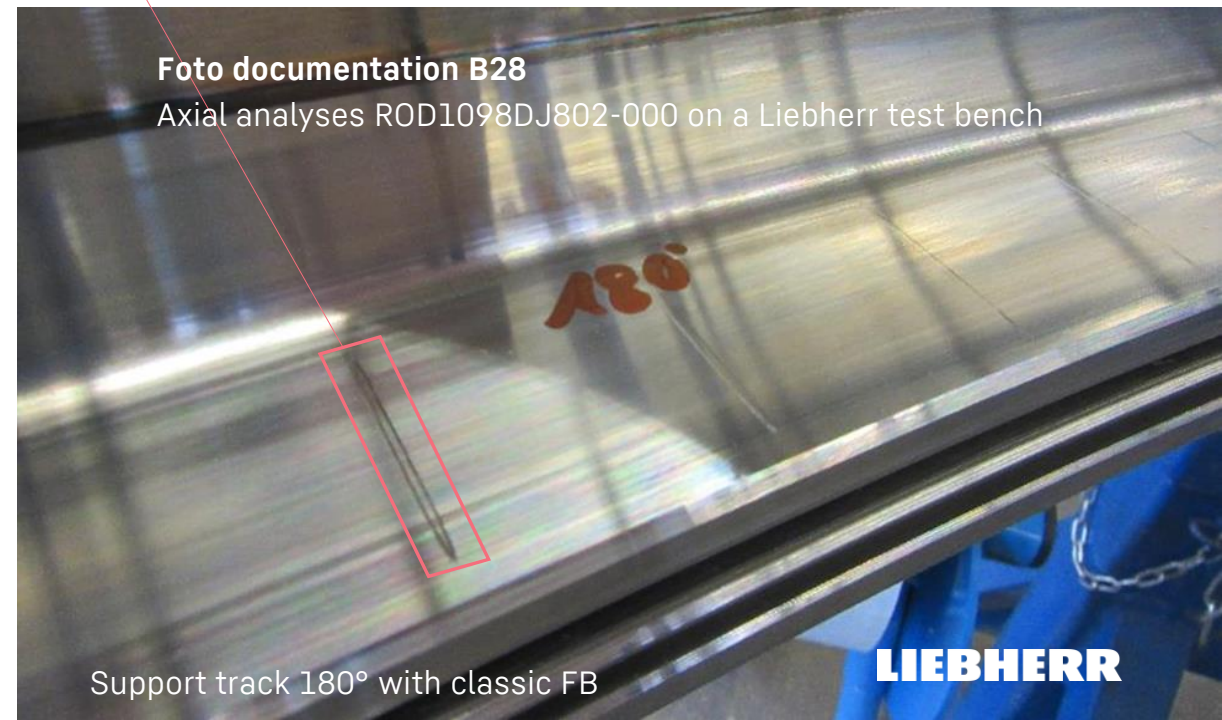


Foto documentation B28

Axial analyses ROD1098DJ802-000 on a Liebherr test bench



Support track 180° with classic FB

Stand Still Marks (SSM)

Sliding along radial rolling element contact axis due to axial deflections.

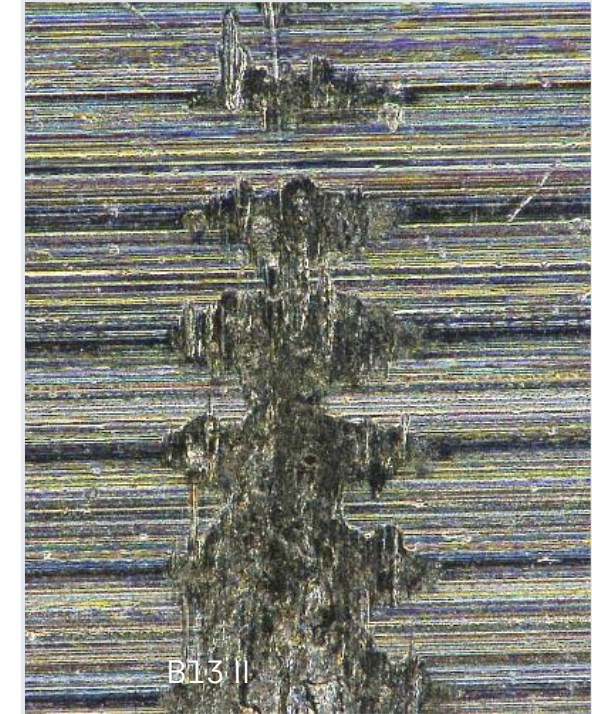
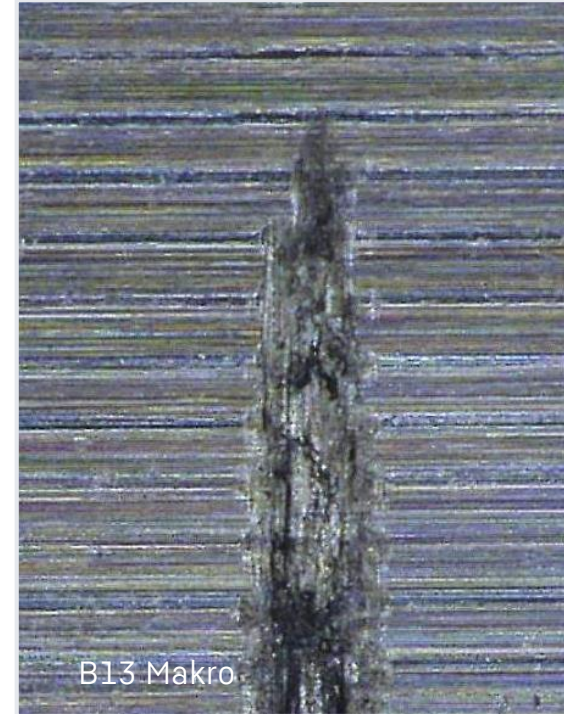
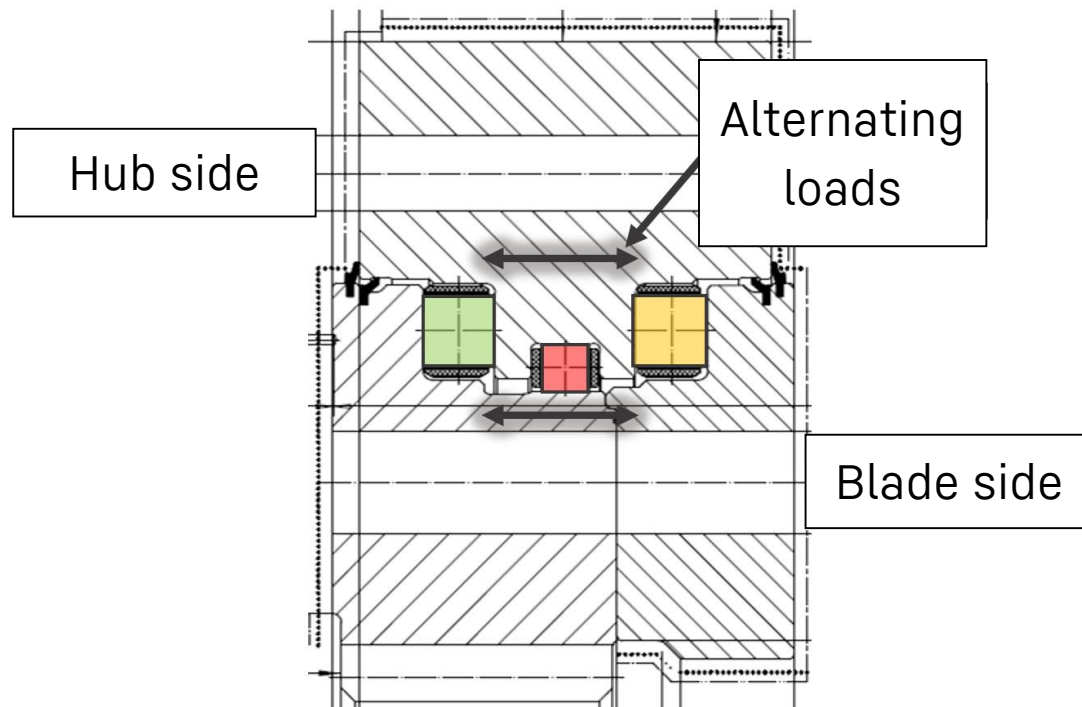
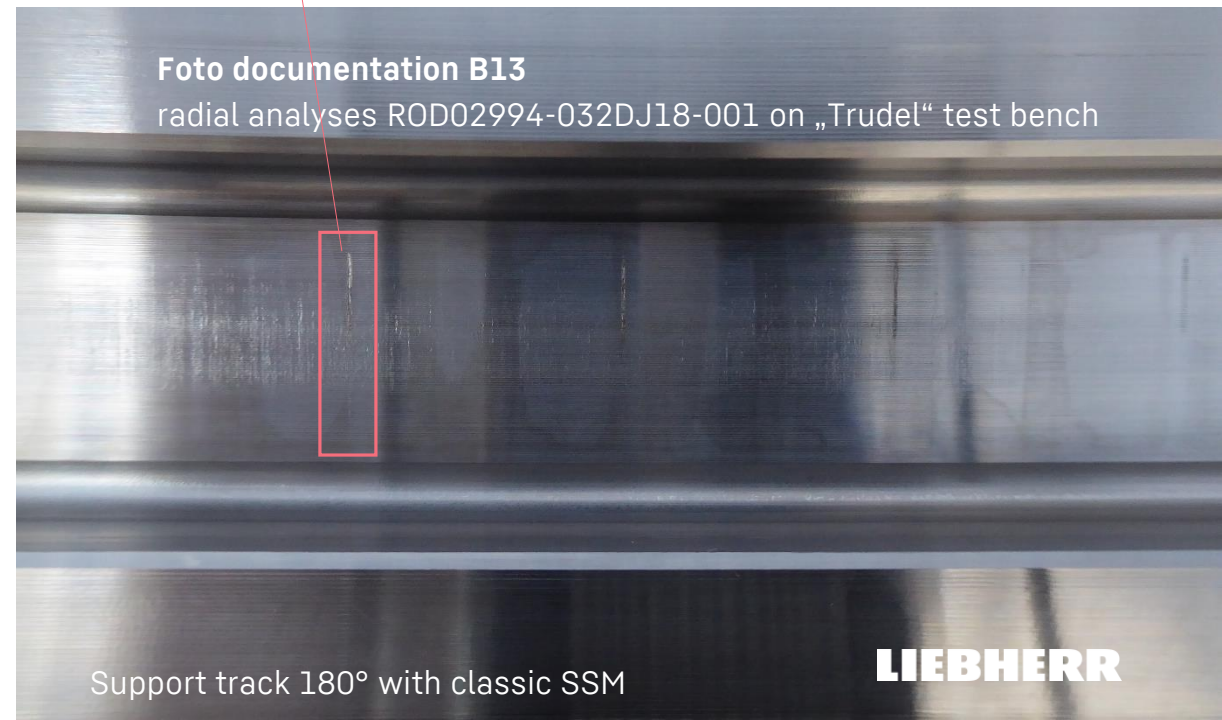


Foto documentation B13
radial analyses ROD02994-032DJ18-001 on „Trudel“ test bench



Support track 180° with classic SSM

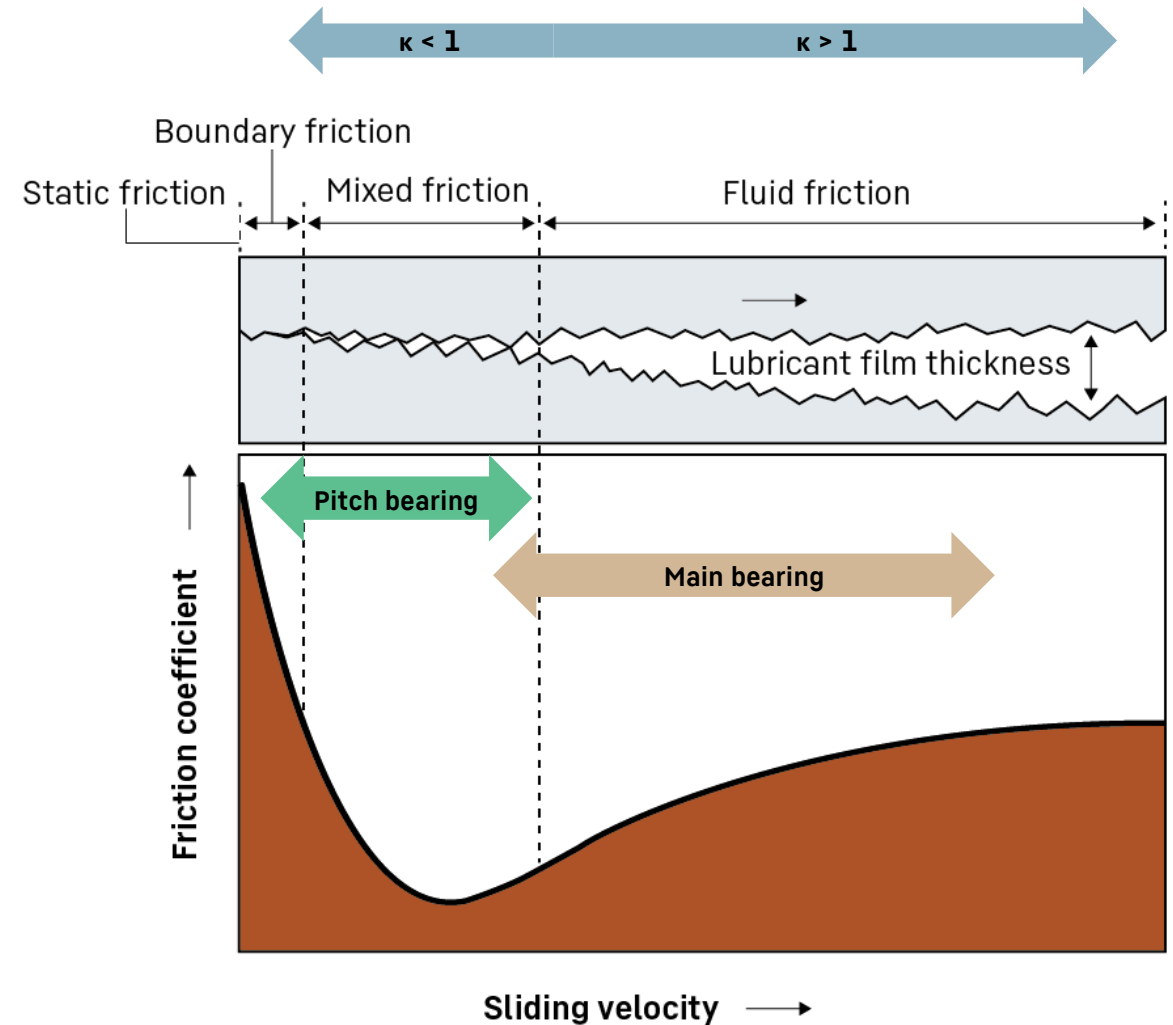
Sliding friction conditions

Universal greases are never optimally designed for all friction conditions.

Specialisation leads to an advantage!

Pitch and yaw bearings have a **slow rotational speed** with a tendency to **boundary and mixed friction** in rolling contact.

Duro Wind PBG as pitch bearing grease with **special additive** for mixed friction ($\kappa < 1$).



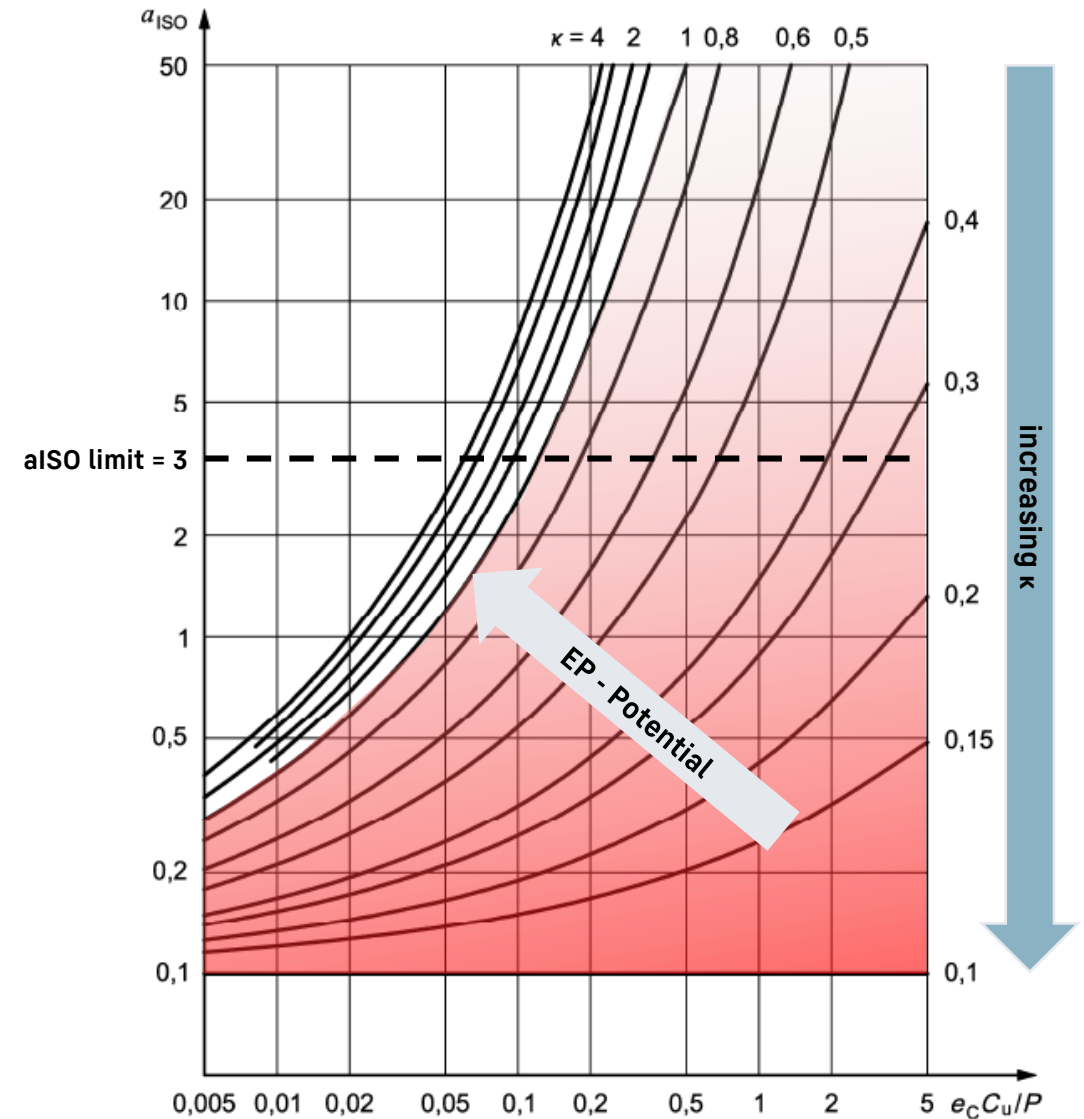
ISO 281 - EP Potential

Duro Wind PBG optimally exploits the EP* potential in the range $K < 1$.

Use of effective EP additives has beneficial smoothing effect on contact surfaces.

$$L_{nm} = a_1 \cdot a_{ISO} \left(K, e_c, \frac{C_u}{P} \right) \cdot \left(\frac{C}{P} \right)^P$$

* Extreme Pressure



Source: ISO 281

Duro Wind PBG: Test results

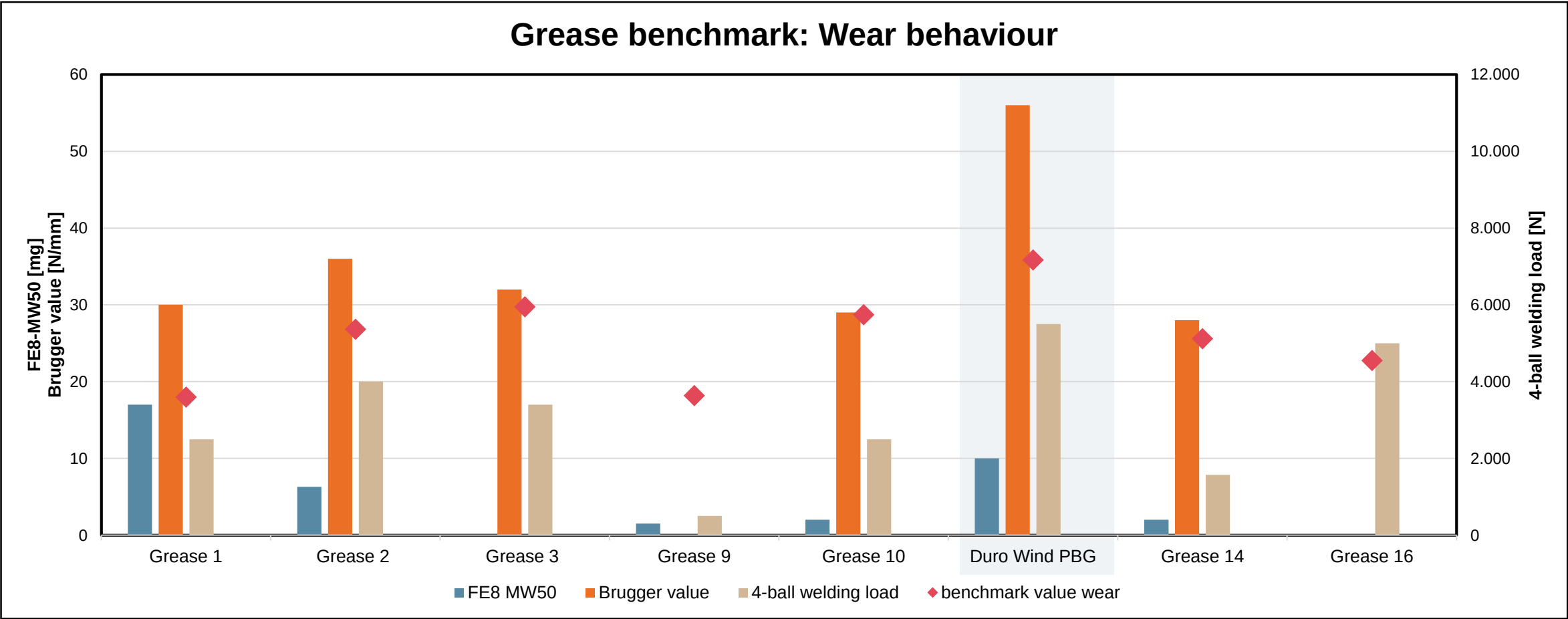
Performance comparison

How are mostly used competitor pitch bearing greases performing in comparison to Liebherr Duro Wind PBG in following categories?

- **Wear protection (FE8/VKA/Brugger)**
- **Low-temperature properties**
- **Corrosion protection (VCI)**
- **Riffel test (False Brinelling)**

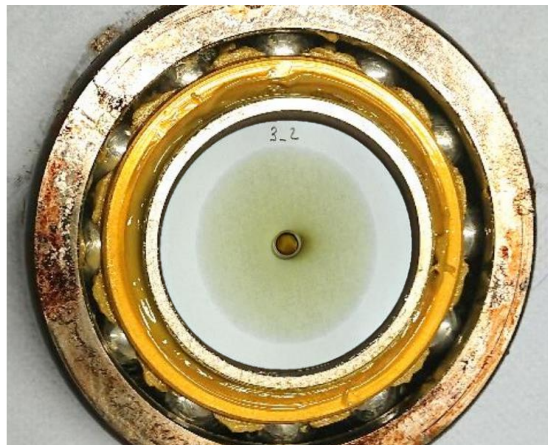


Wear protection

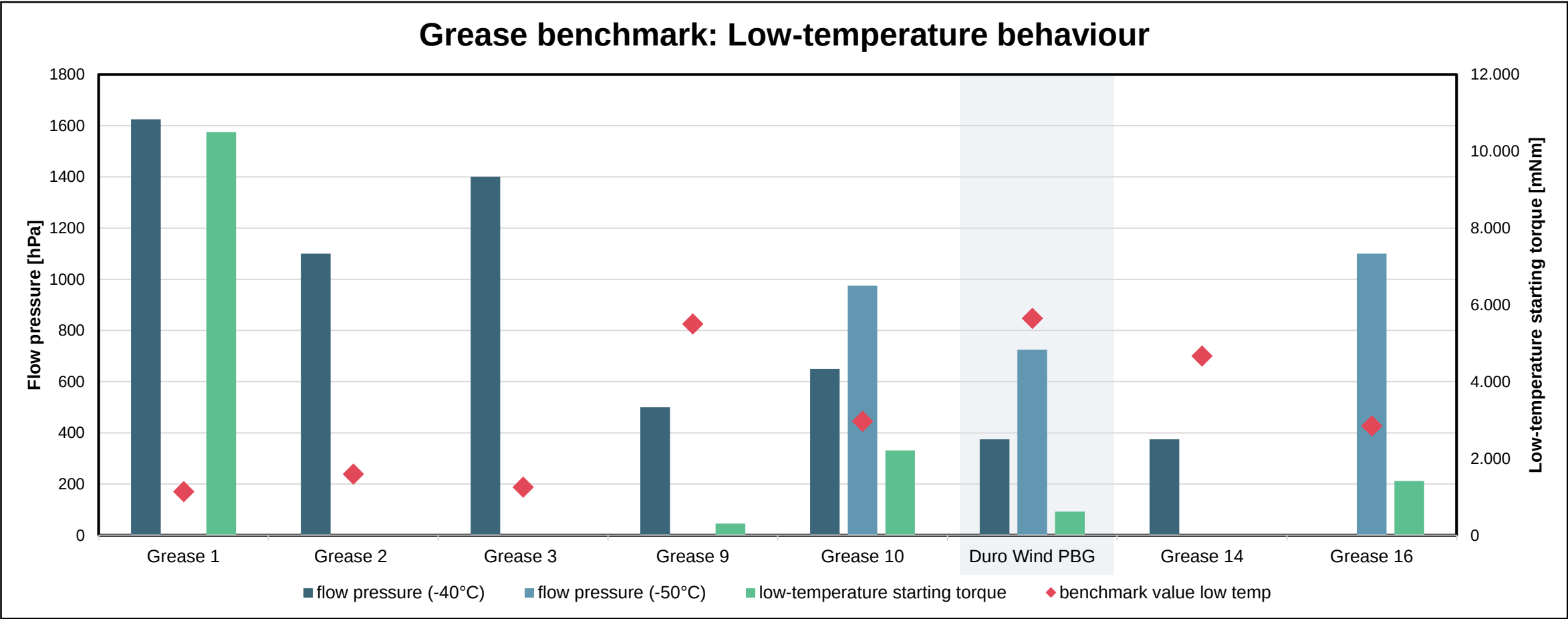


Results FE8-Test: lubrication aging (oil bleeding)

DIN 51817 (oil bleeding): app. 50 g → Filterpaper ring method (6h @ 80 °C): 0,4 cm³

Liebherr Duro Wind	Grease 02	Grease 03	Grease 10
$\text{oil}_{\text{new};13} = 37,9\%$	$\text{oil}_{\text{new};02} = 36,8\%$	$\text{oil}_{\text{new};03} = 40,1\%$	$\text{oil}_{\text{new};10} = 16,6\%$
			
	$\text{oil}_{\text{old}7,5;02} = 18,4\%$ $\text{oil}_{\text{old}7,5;02} / \text{oil}_{\text{new};02} = 50\%$	$\text{oil}_{\text{old}7,5;03} = 33,4\%$ $\text{oil}_{\text{old}7,5;03} / \text{oil}_{\text{new};03} = 83\%$	$\text{oil}_{\text{old}7,5;10} = 12\%$ $\text{oil}_{\text{old}7,5;10} / \text{oil}_{\text{new};10} = 30\%$

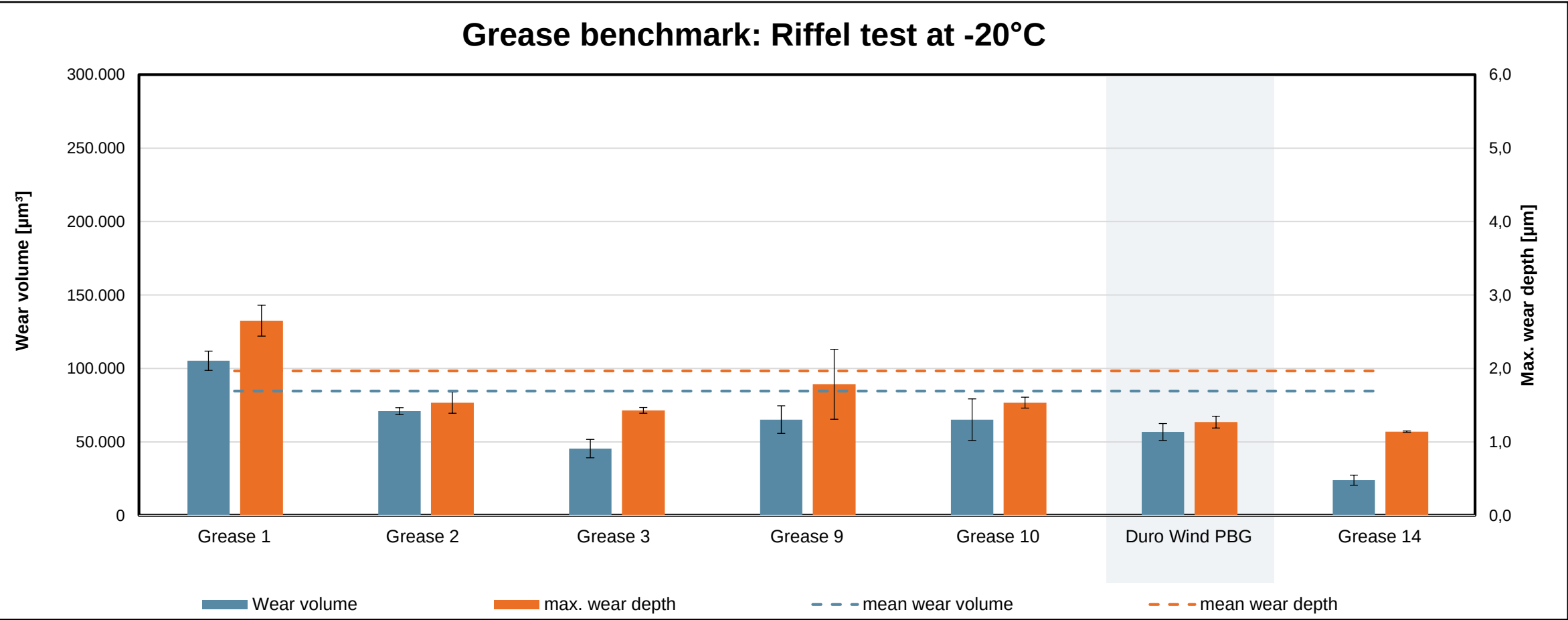
Low-temperature properties



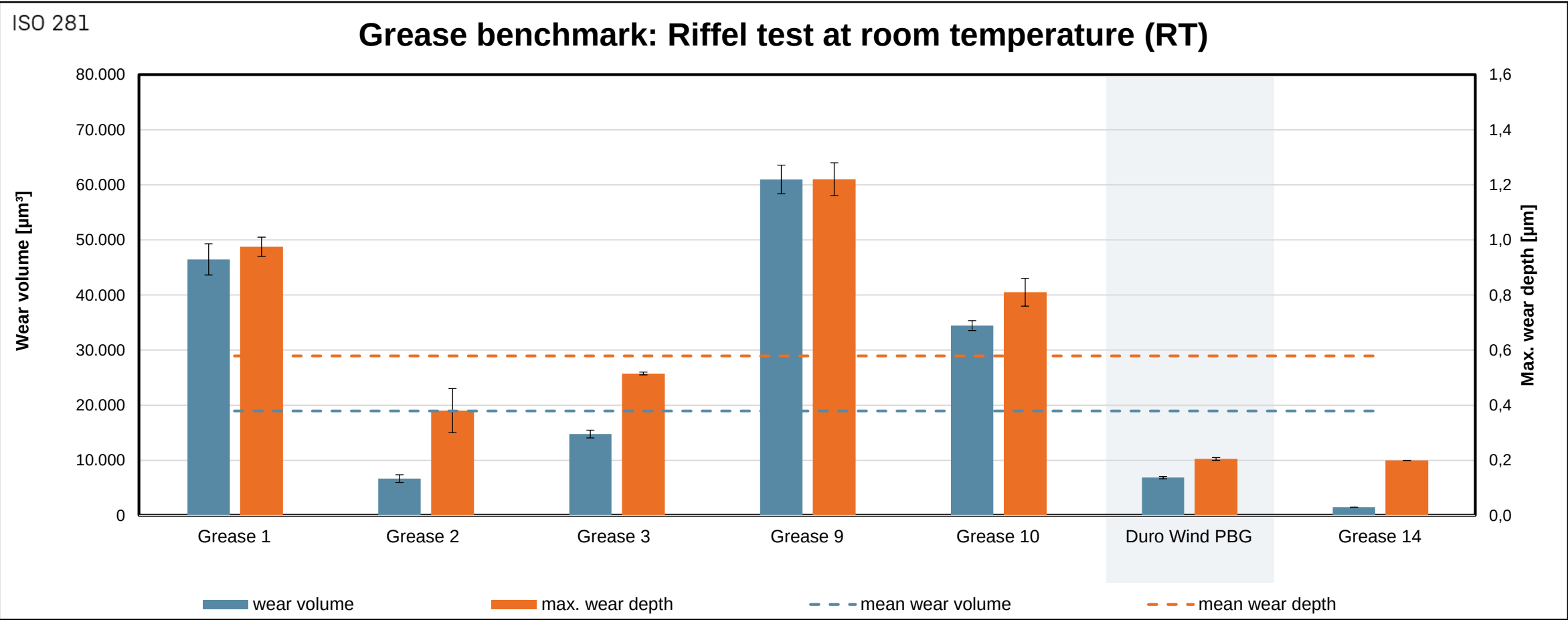
Overview of False Brinelling testing possibilities

	Fafnir Fretting Test	SNR-FEB2-Test	HRE-IME-Riffeltest (RWTH Aachen)	False-Brinelling-Prüfstand (FVA 540 Uni Magdeburg)	Riffel-Schwenk-Prüfstand ITR	False-Brinelling-Prüfstand (MA)	Mod. FE8-Prüfstand IMKT Hannover
Bearing type:	Axial ball bearing	Axial ball bearing	4 point bearing	angular ball bearing tapered roller bearing	4 point bearing	Axial ball bearing	angular ball bearing
Load:	2450 N, 4450 N	8000 N (stat.)	bis 70kN	bis 25 kN (axial,radial)	bis 23,3 kN	750 N / ball	axial load
Frequency:	- (stat.)	- (stat.)	8 – 10 Hz	bis 25 Hz	8 – 10 Hz	- (stat.)	- (stat.)
Pitch angle:	± 6°	± 3°	-	± 0,025 – 1,0°	± 4,6°	± 0,1° - 5°	Small and large alternating
Frequency:	30 Hz	25 Hz	-	bis 25 Hz	7 Hz	bis 25 Hz	real LTS
Duration:	22 h ~ 2.376.000 LW	50 h ~ 4.500.000 LW	1.000.000 LW (28 – 35 h)	1.000.000 LW (28 – 35 h)	1.000.000 LW (43 h)	1 min - 100 h	n.n.
Contamination:	-	-	6 ml water	-	6 ml water	-	-
Rating:	visual, loss of mass	visual, loss of mass	wear depth, korrosion rating	wear depth; wear volume	wear depth friction torque	visual, wear depth	laser scan, reaktion product

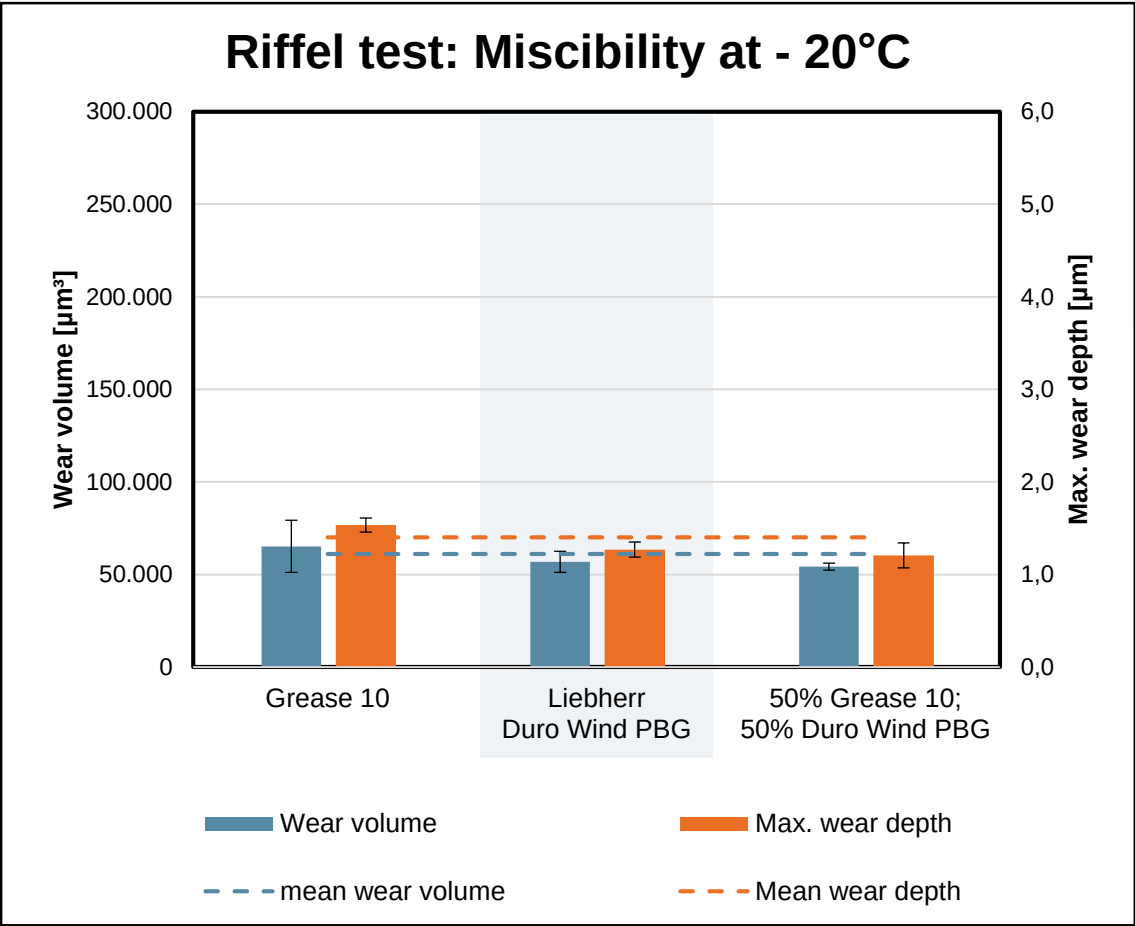
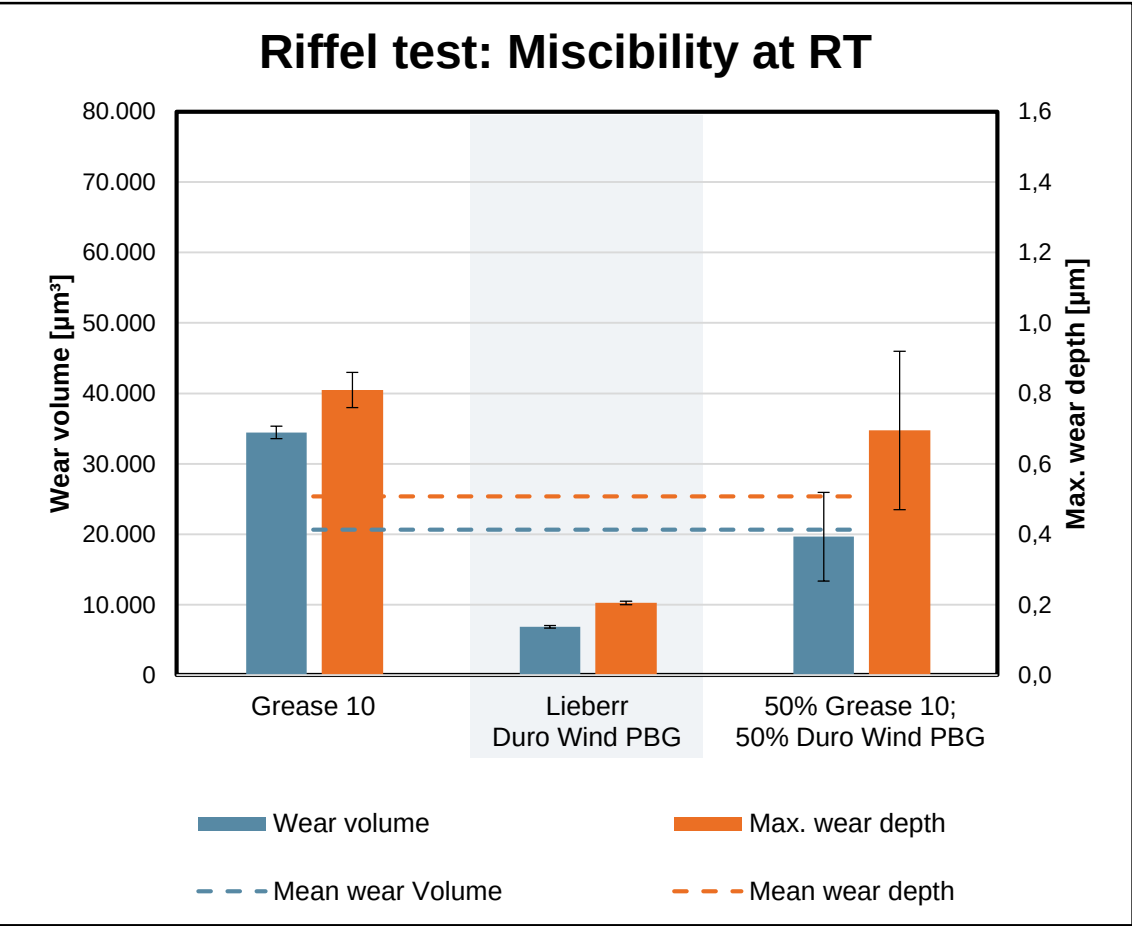
Riffel test -20°



Riffel test 19°



Riffel test with reference to miscibility



Liebherr Duro Wind PBG: Data sheet

Colour:	White	
Thickener:	Lithium complex	
Base oil properties:	synthetic	
Kinematic viscosity at 40°C:	32 mm ² /s	DIN 51562
Kinematic viscosity at 100°C:	5,7 mm ² /s	DIN 51562
Viscosity Index	119	
Worked penetration PW60, approx.:	341 1/10 mm	ISO 2137
Worked penetration difference		
PW60 to PW100.000:	<30 1/10 mm	ISO 2137
VKA welding force:	5.500 N	DIN 51 350-4
Corrosion protection:	C. grade 0	DIN 51 818
Water resistance :	1-90	DIN 51 807 T1
NLGI Consistency class:	1	DIN 51 818
Corrosive effect on copper:	C. grade 1	DIN 51 811
Drop point:	>250°C	DIN ISO 2176
Labelling:	ISO-L-XEDEB	ISO 6743-9

Flow pressure at -40°C:	375 hPA	DIN 51805
Flow pressure at -50°C:	725 hPA	DIN 51805
Oil separation after 24h RT:	≤ 2%	ASTM D1742
Oil separation after 168h 40°C:	≤ 6%	DIN 51817
Rolling stability (50h, 80°C) delta:	< 20 1/10 mm	ASTM D1831
Cryogenic torque at -40°C, start:	611 g-cm	ASTM D1478
Cryogenic torque at -40°C, running:	260 g-cm	ASTM D1478
False Brinelling at 22°C:	6.860 µm ³ /0,21 µm	FVA 540
False Brinelling at -20°C:	56.841 µm ³ /1,27 µm	FVA 540
FE8-Test (C/75/50-RT, 500 h)	10 mg MW50	DIN 51819

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