ON THE ISSUE OF CONVENTIONAL TEST METHODS FOR ELECTRIC VEHICLE FLUIDS

DUCOM INSTRUMENTS

STAND 347

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ABOUT US

Core Competency

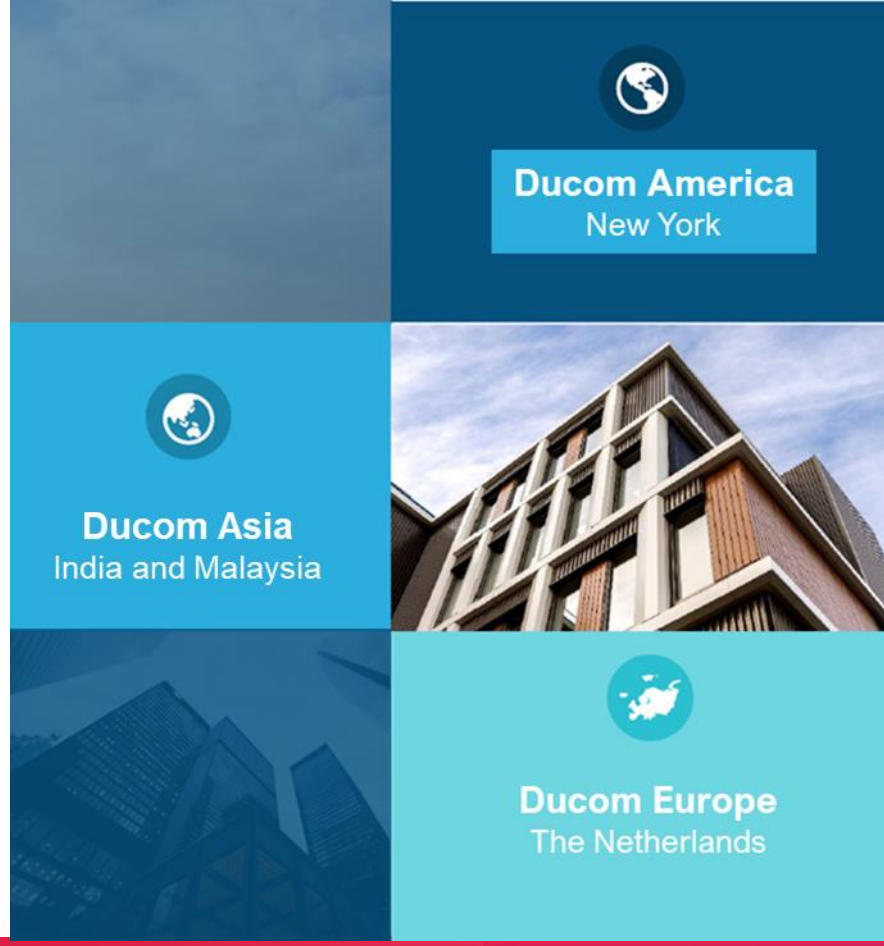
Precision Manufacturing (AS 9001 certification), Lean Innovation, Customer Journey Mapping

Strategies

Position as a “one-stop-solutions” provider. Defend our leading market position for core products. Consistent interactions with ASTM/ISO/STLE/ELGI/NLGI.

Values

Quality, Customer Satisfaction, Empathy, Compliance to Standards, Integrity, Diversity, Repeatability, Reproducibility

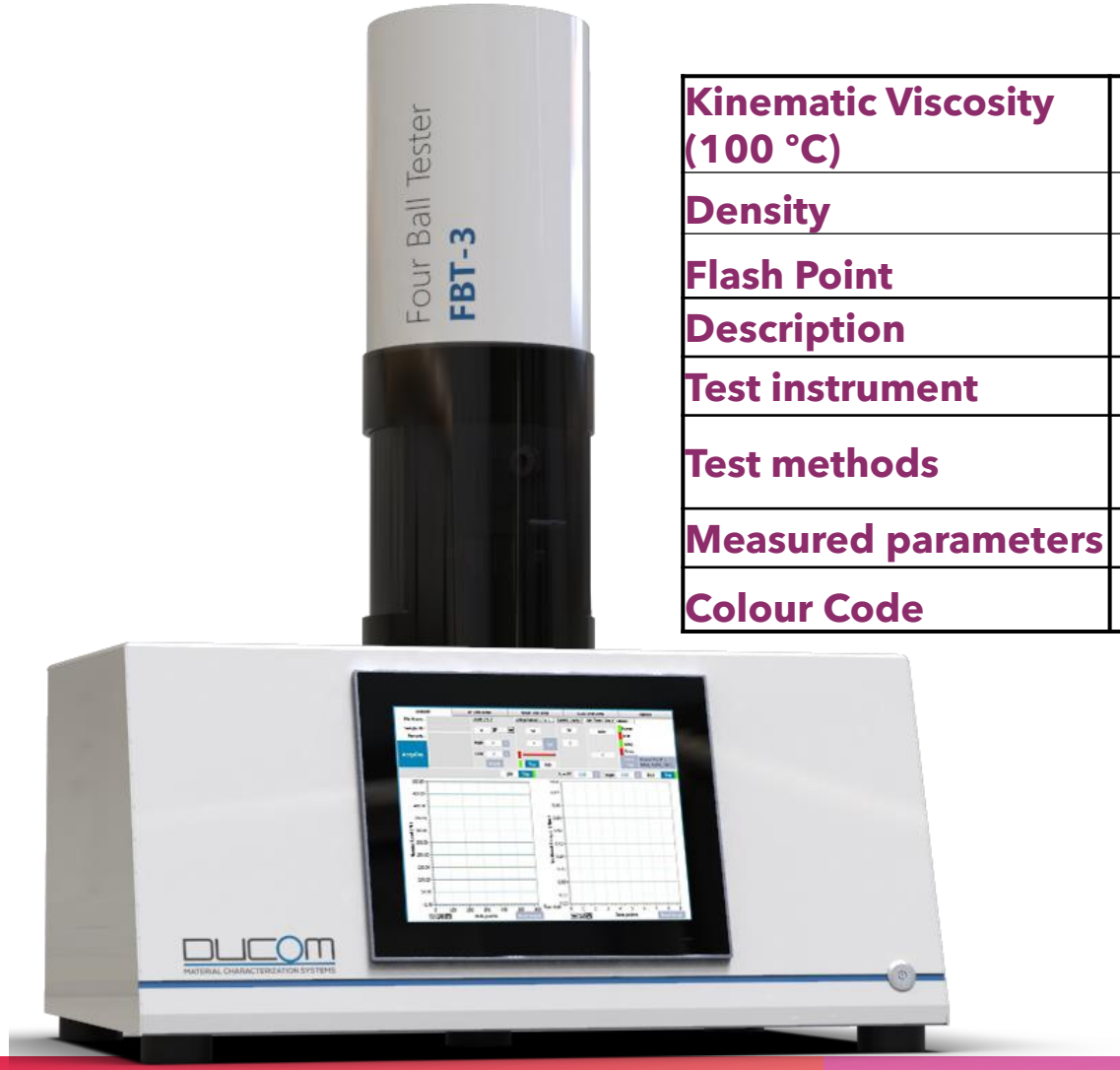


VISION: WORKING TOGETHER ON PRECISION MEASUREMENTS FOR INSTRUMENTATION LEADERSHIP

“THE GREEN DEAL”

ELECTRIFICATION OF TRANSPORT AND INDUSTRY

BENCHMARKING OF EV FLUIDS |
TEST METHODS



		Low AW	High AW	Low visc	High visc
Kinematic Viscosity (100 °C)	cSt	4.0	4.0	7.5	9.0
Density	Kg/m³	950	950	950	950
Flash Point	°C	200	200	200	200
Description	-	Low viscosity		Baseline	
Test instrument	-	**Four Ball Tester**		**KRL Shear Stability Tester**	
Test methods	-	ASTM D4172-B*, ASTM D2783 *standard and modified		CEC L-45-99 *standard and modified	
Measured parameters		COF, wear scar diameter		Visosity loss, COF	
Colour Code	-				

ASTM D4172 | STANDARD AND MODIFIED TEST

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Standard ASTM D4172 (392 N)

Parameter	Unit	Value
Load	N	392 ± 2
Speed	Rpm	1200 ± 60
Temperature	C	75 ± 2
Duration	s	3600 ± 60
Hertzian contact pressure	MPa	3445.2
Circular contact pressure diameter	mm	0.298

Modified ASTM D4172 (50 N)

Parameter	Unit	Value
Load	N	50 ± 2
Speed	Rpm	1200 ± 60
Temperature	C	75 ± 2
Duration	s	3600 ± 60
Hertzian contact pressure	MPa	1734.3
Circular contact pressure diameter	mm	0.15

Goal: Measure the low load wear to compare with the ASTM standard results

WEAR SCAR MEASUREMENT

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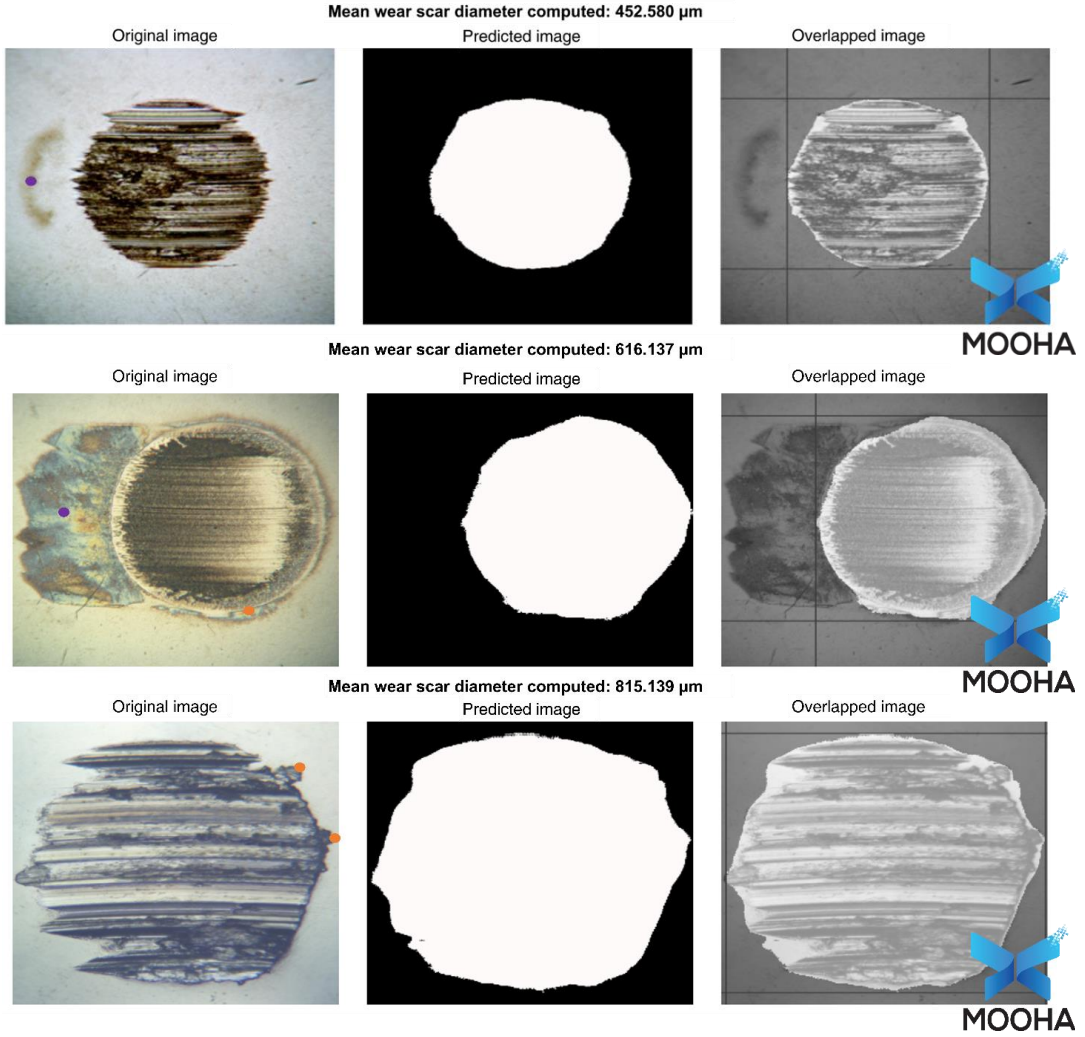
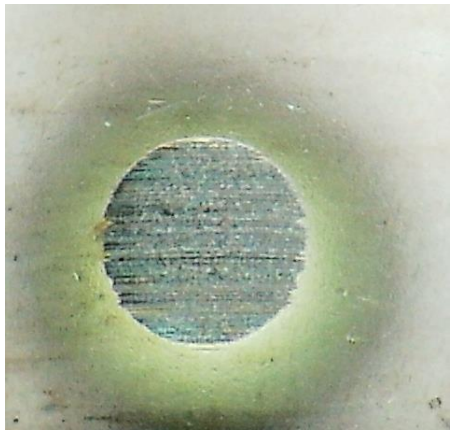
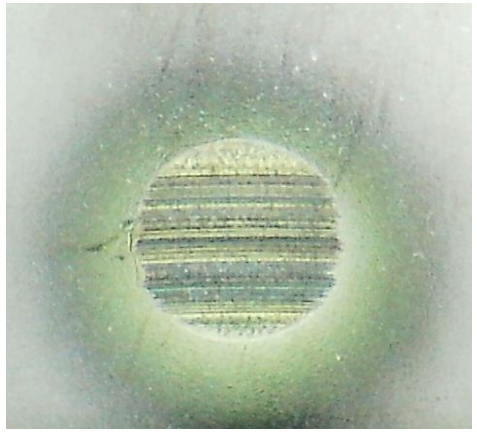
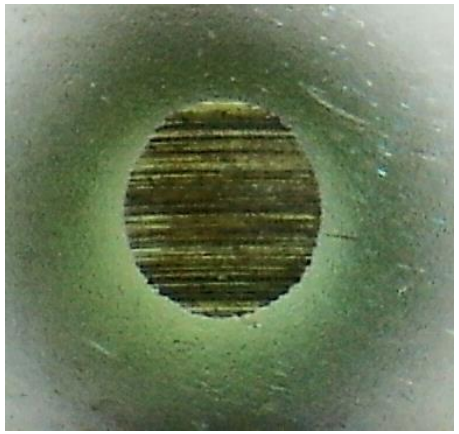
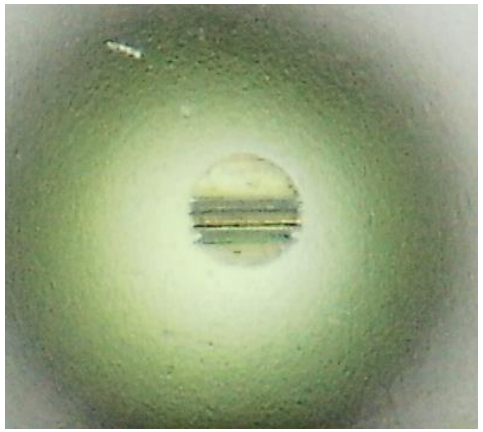
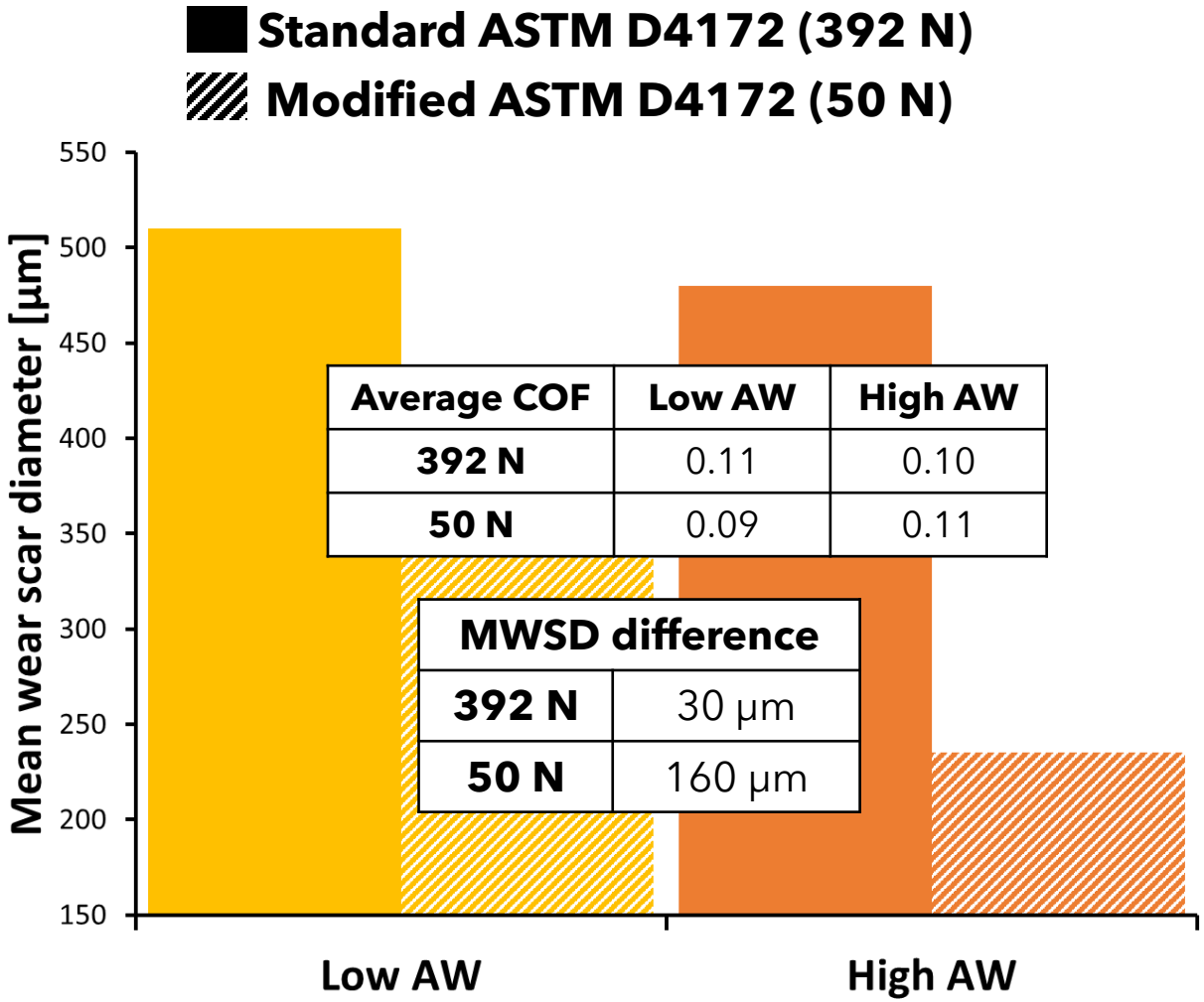
BALL WEAR IMAGING IN NATURE STATE!

AI BASED WEAR SCAR DETECTION



WEAR SCAR IMAGES |
STANDARD AND MODIFIED ASTM D4172

	Low AW	High AW
Standard ASTM D4172 (392 N)		
Modified ASTM D4172 (50 N)		



Average COF	Low AW	High AW
392 N	0.11	0.10
50 N	0.09	0.11

MWSD difference	
392 N	30 µm
50 N	160 µm

EXTREME PRESSURE TEST – ASTM D2783

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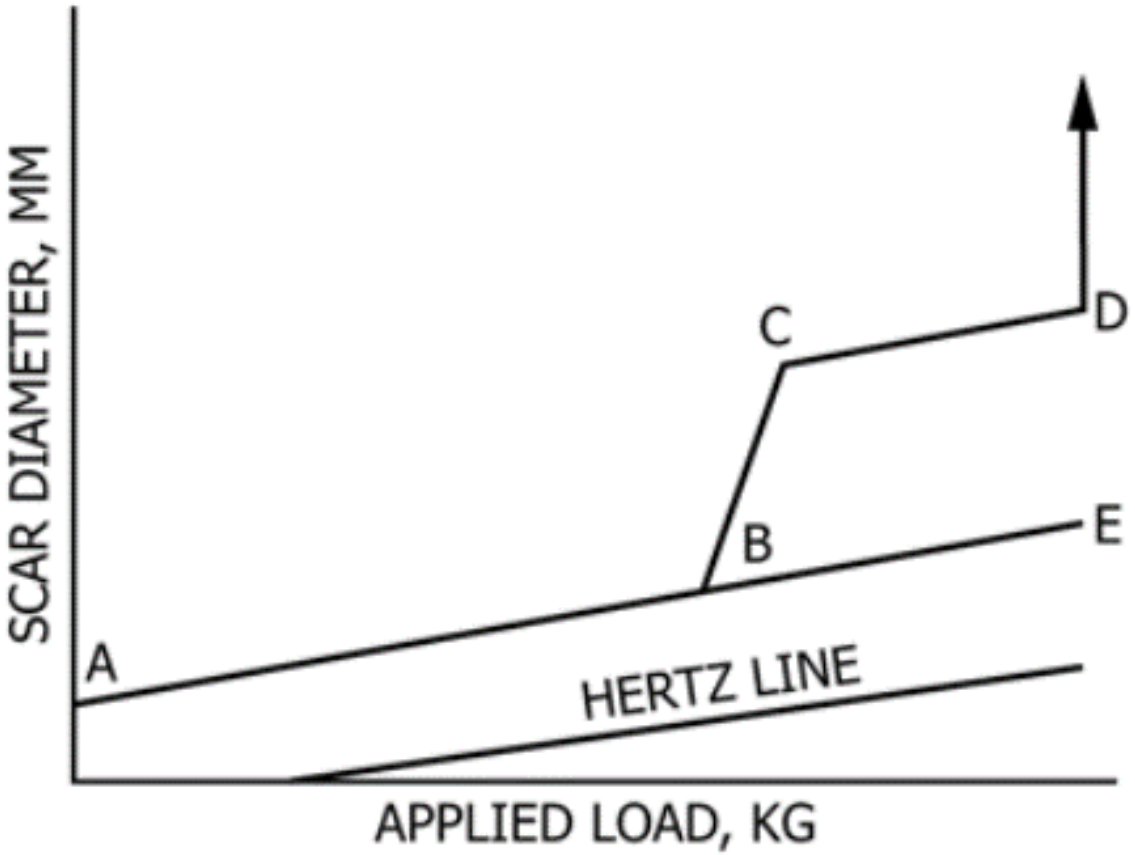
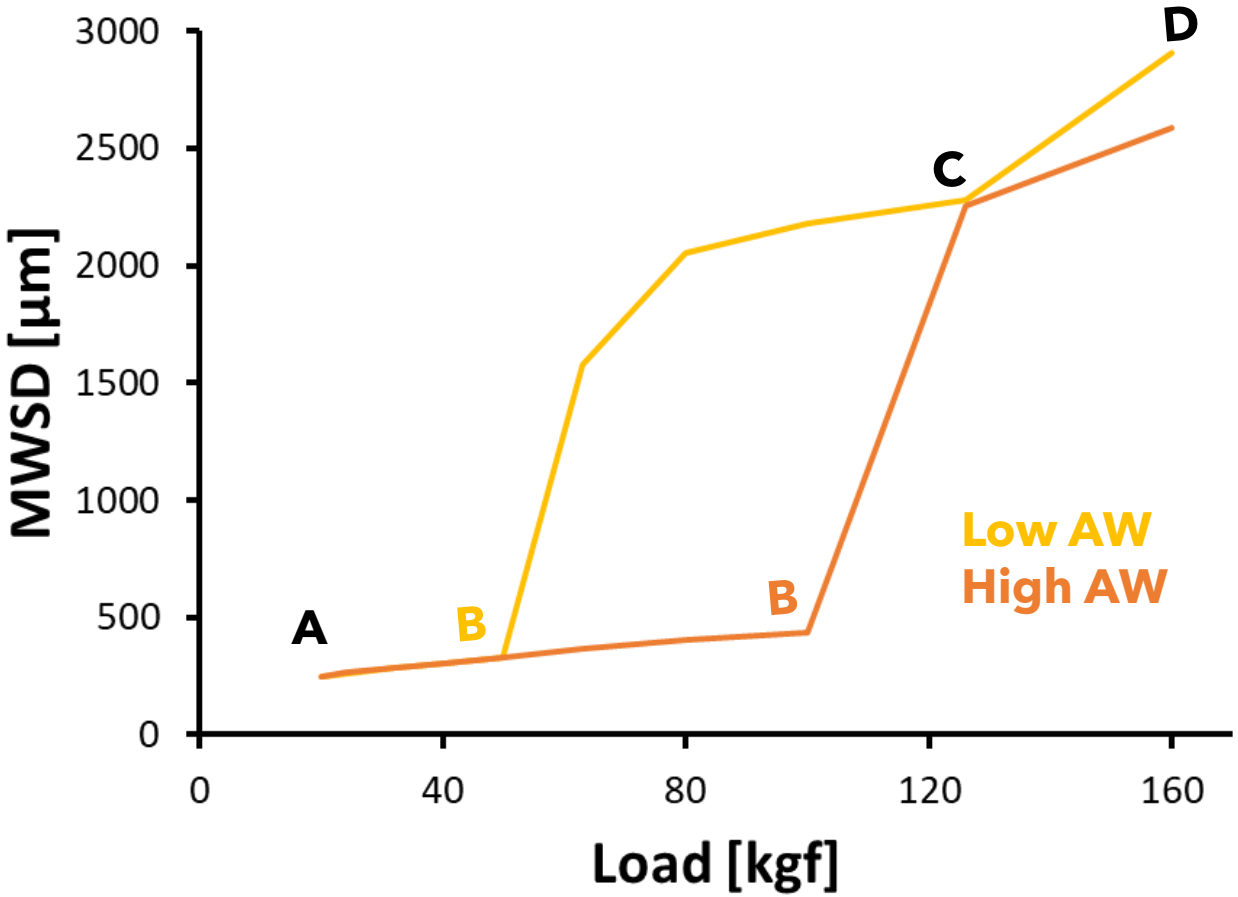
ASTM D2783

Parameter	Unit	Value
Load	kg	10 tests between low load and weld load
Speed	Rpm	1760 ± 40
Oil Temperature	C	18-35
Oil Quantity	ml	10
Duration	s	10

Goal: Determine the load-carrying properties of the test fluids.

INITIAL SEIZURE, PASS AND WELD LOAD





Incipient Seizure Load

(~B) Load where initial welding is observed, but not fully

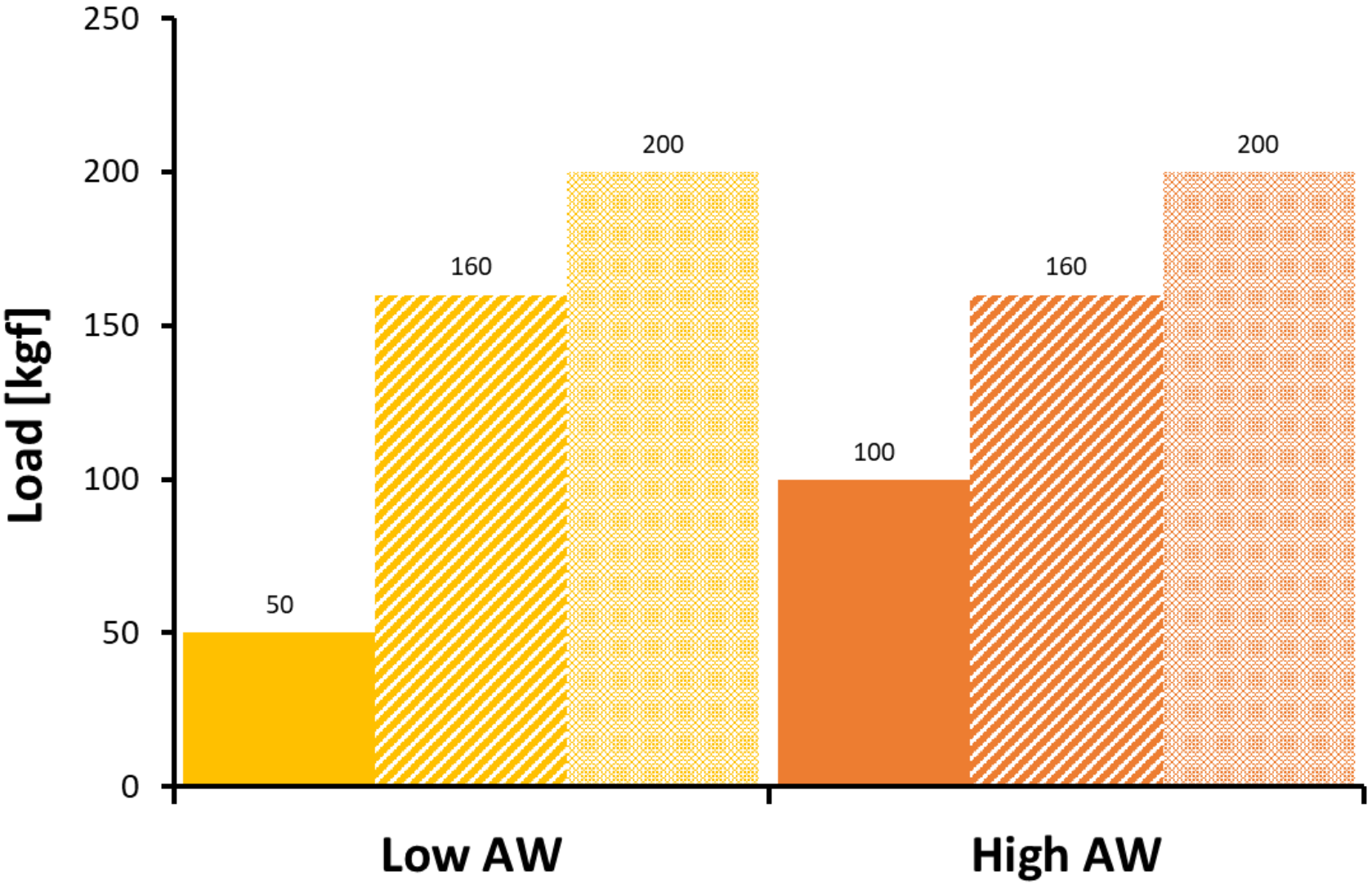
Pass Load

(C) Load immediately smaller than weld load

Weld Load

(D) Load where the top ball is welded against the lower three balls

INITIAL SEIZURE, PASS AND WELD LOAD



Incipient Seizure Load

(~B) Load where initial welding is observed, but not fully

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Weld Load

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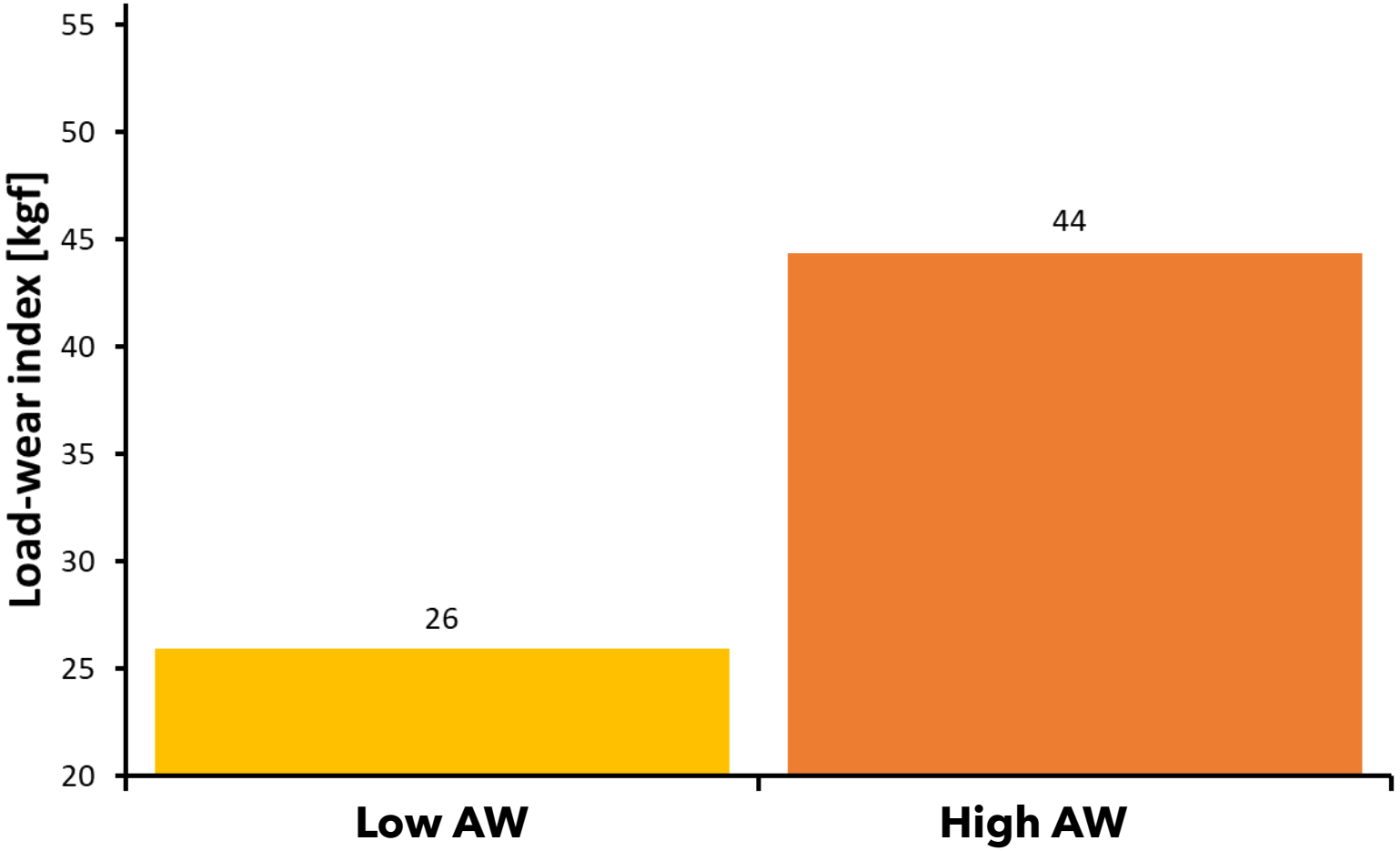
LOAD WEAR INDEX

Lubricant's ability to prevent wear under varying loads

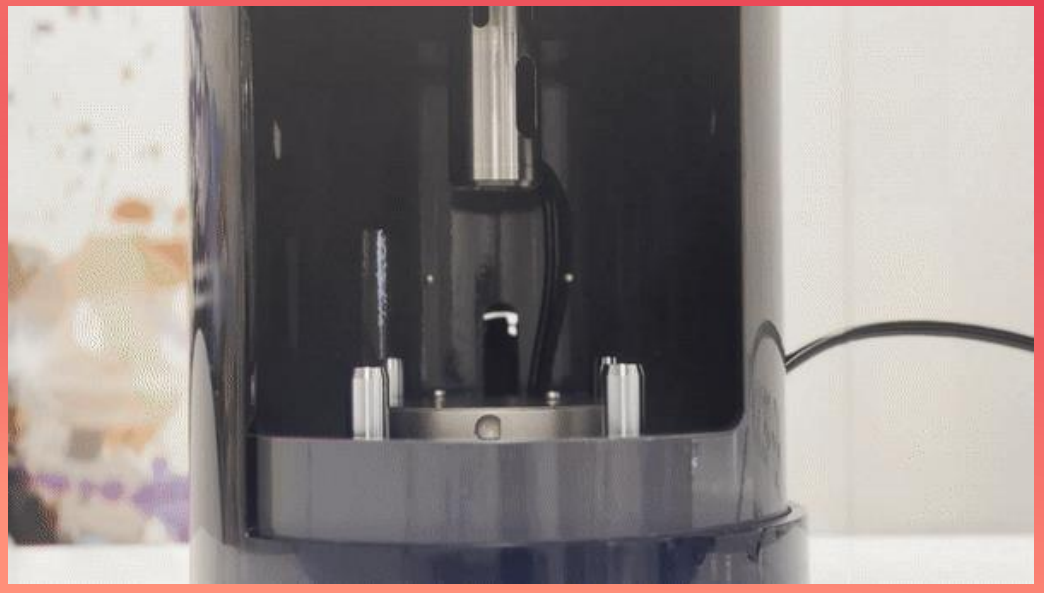


Load Wear Index ↑ = **More resistant fluid** ✓

Load Wear Index

$$LWI = \frac{\Sigma_{10} L \cdot \frac{D_h}{X}}{10}$$

Load · **Hertz scar diameter** · **MWSD**



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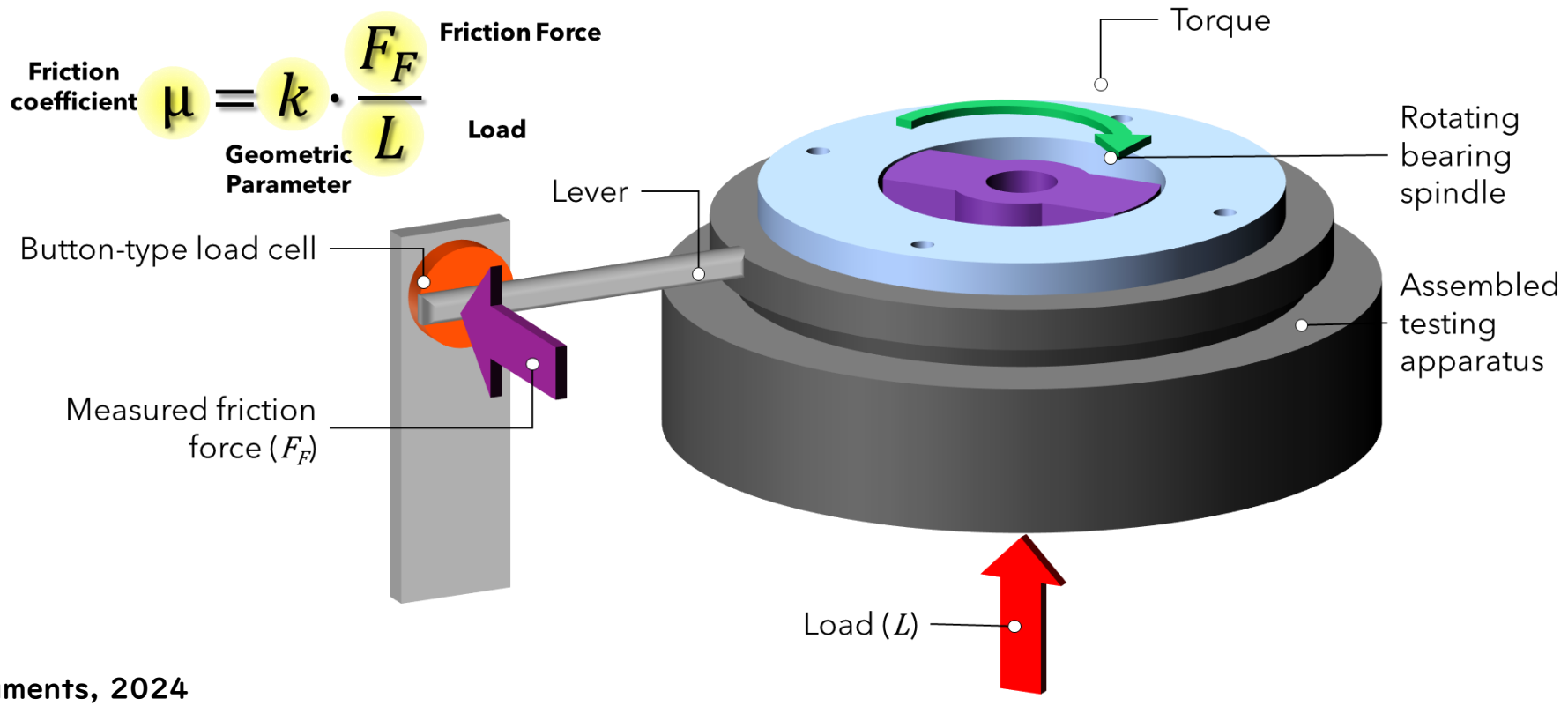
FRICTION MEASUREMENT IN TAPER ROLLING BEARING USING KRL SHEAR STABILITY TESTER

Friction coefficient $\mu = k \cdot \frac{F_F}{L}$ Friction Force / Load

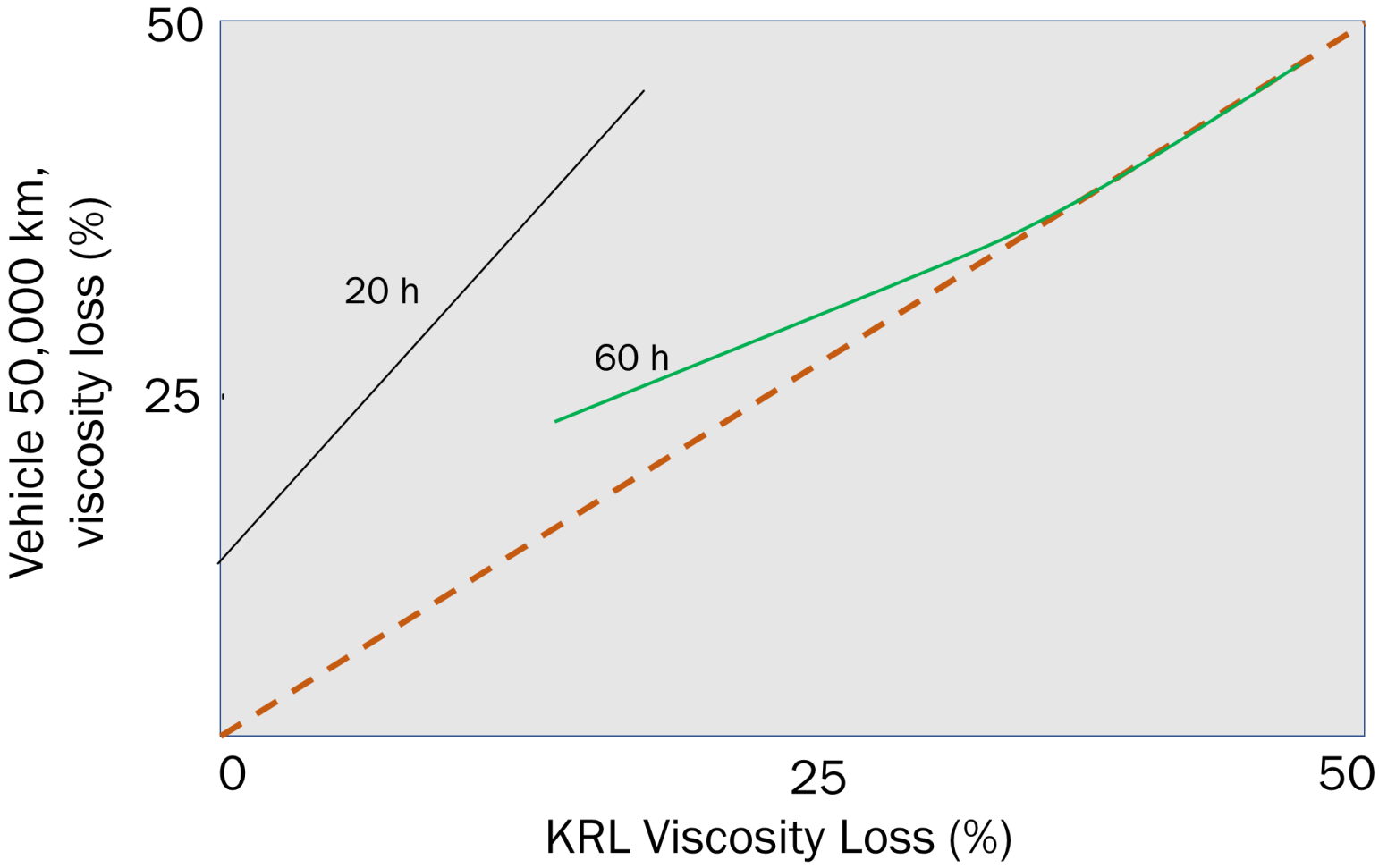
Geometric Parameter



FIELD VS. LAB

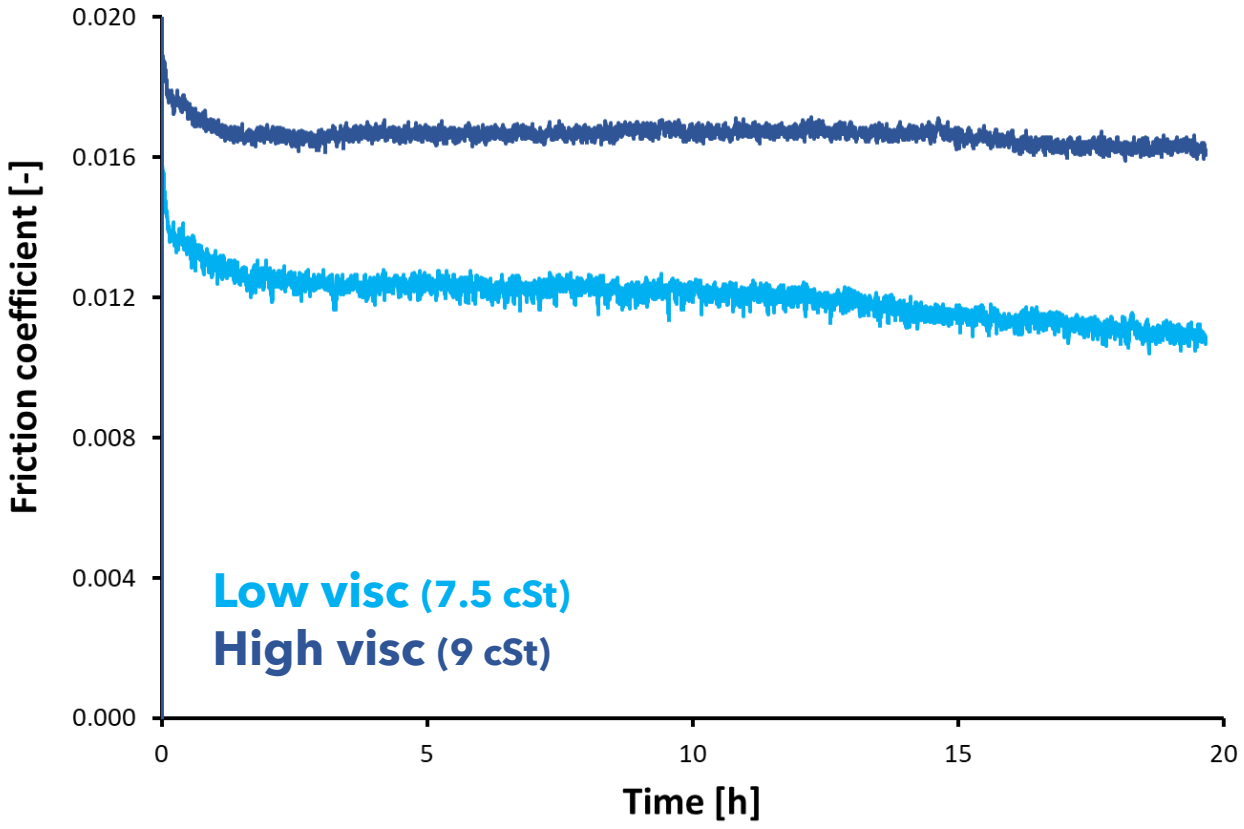
Lubricants – Transmission Oil

Development of shear stable VM technology

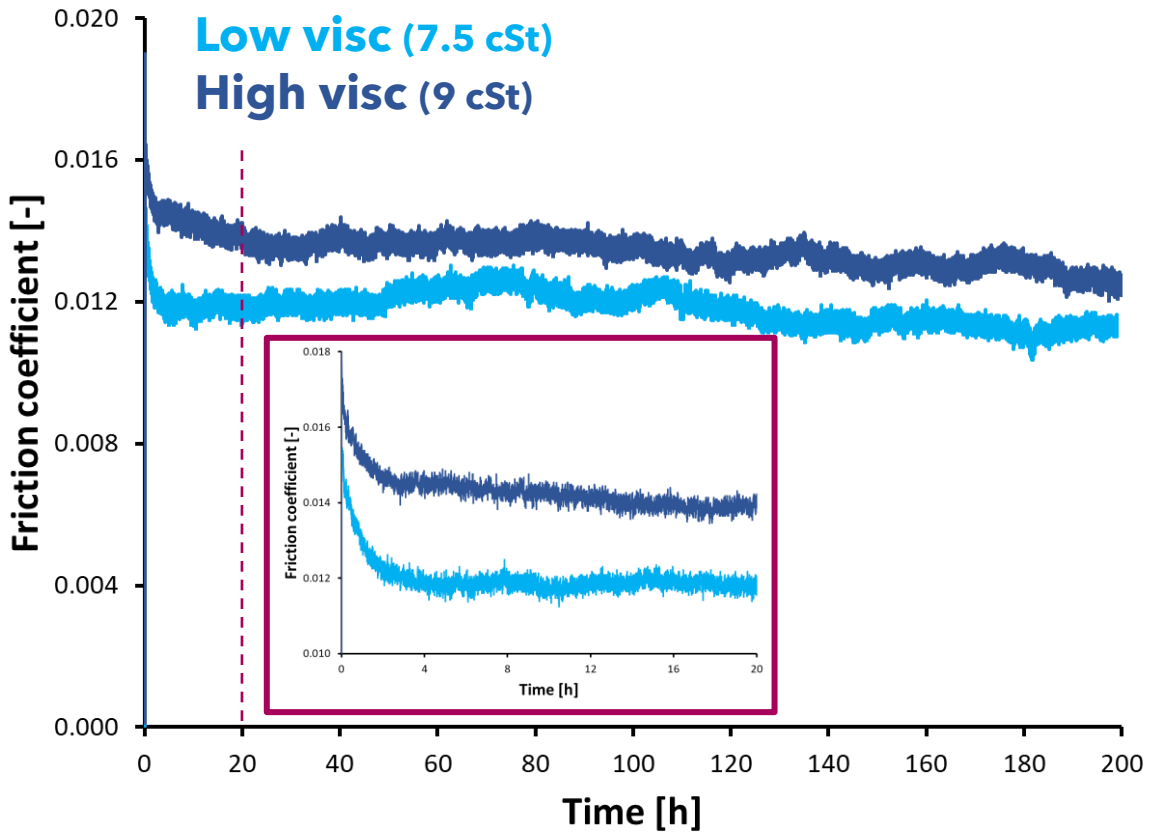


FRICTION COEFFICIENT

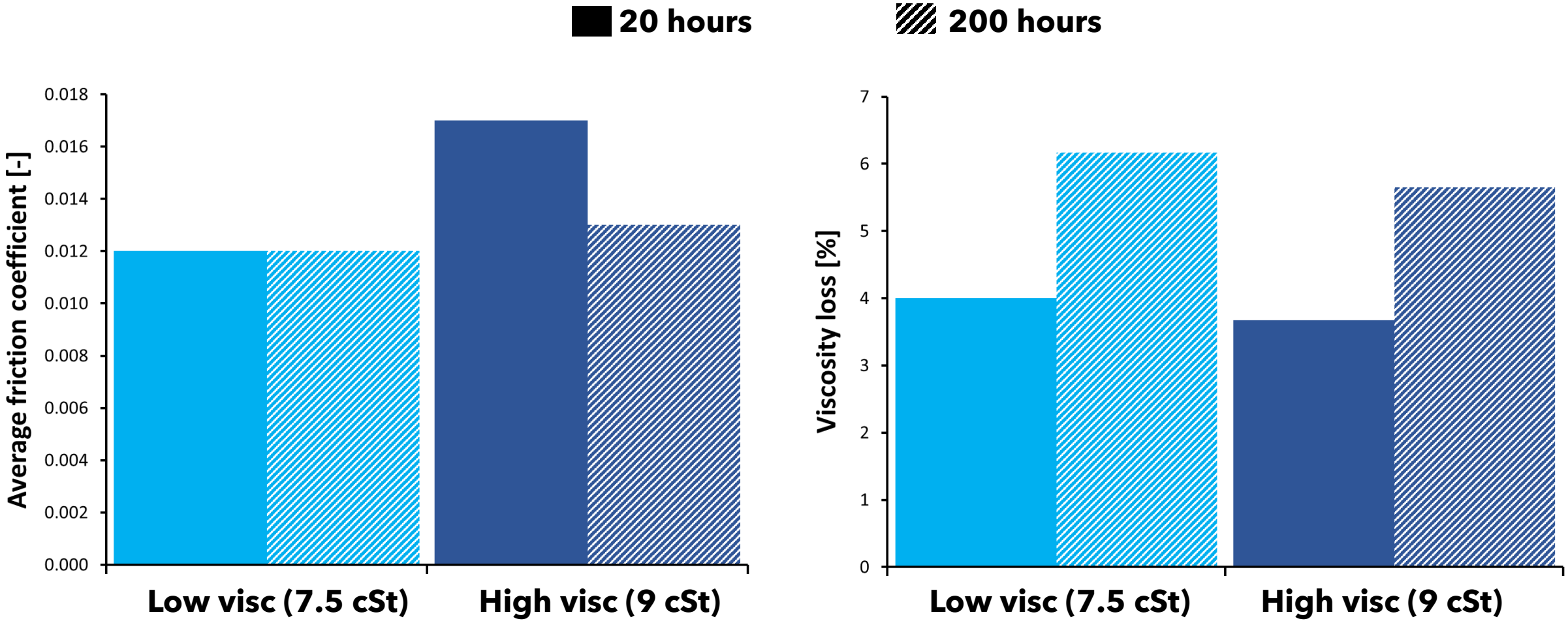
20 hours



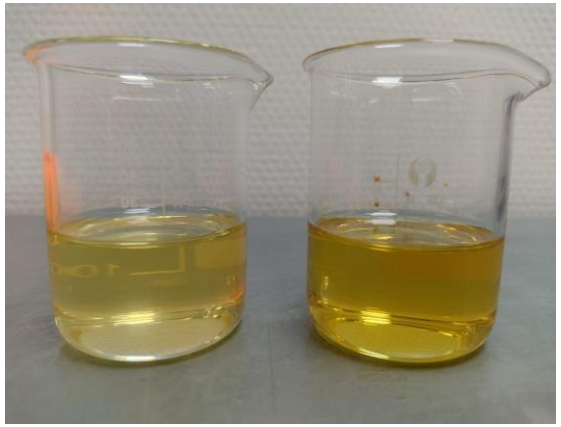
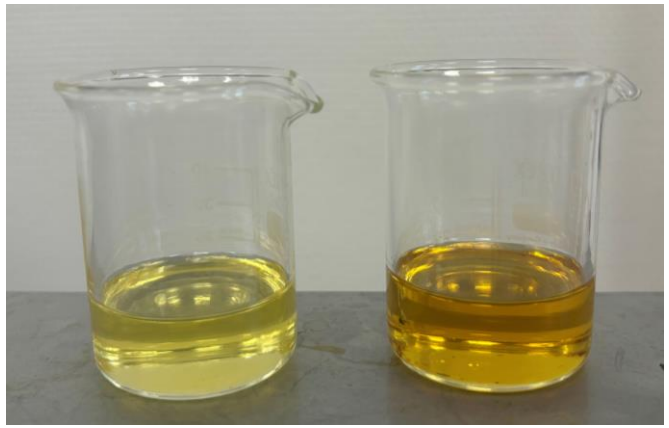
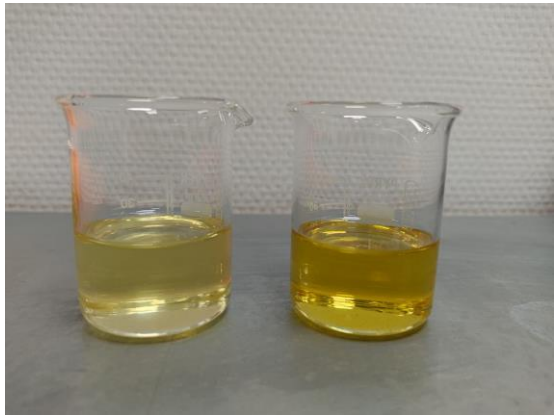
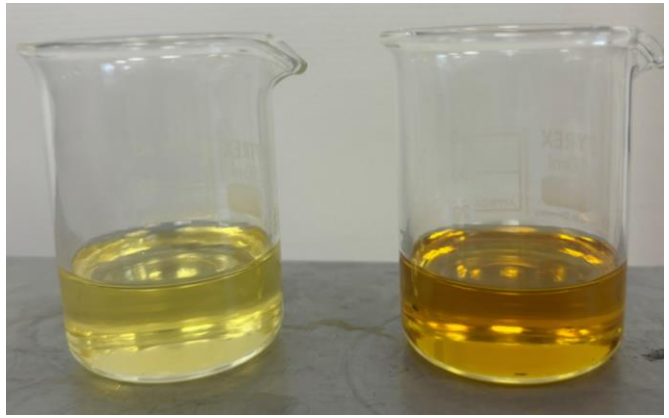
200 hours



AVERAGE COF AND VISCOSITY LOSS

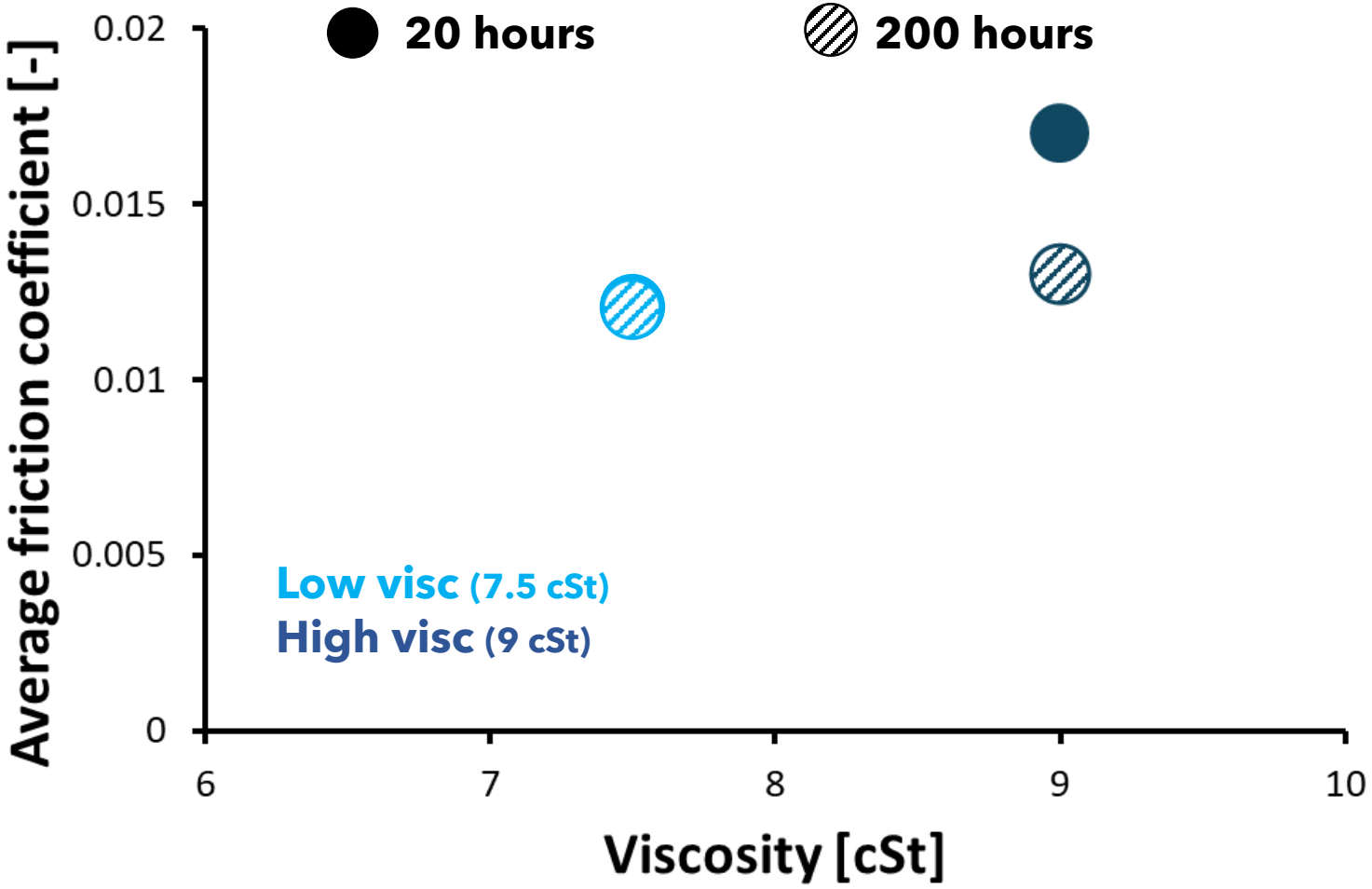


FLUIDS IMAGES

	20 hours	200 hours
Low visc (7.5 cSt)		
High visc (9 cSt)		

Note: Fresh fluid (left) – After shearing in KRL (right)

VISCOSITY LOSS & FRICTION |
20 H VS 200 H



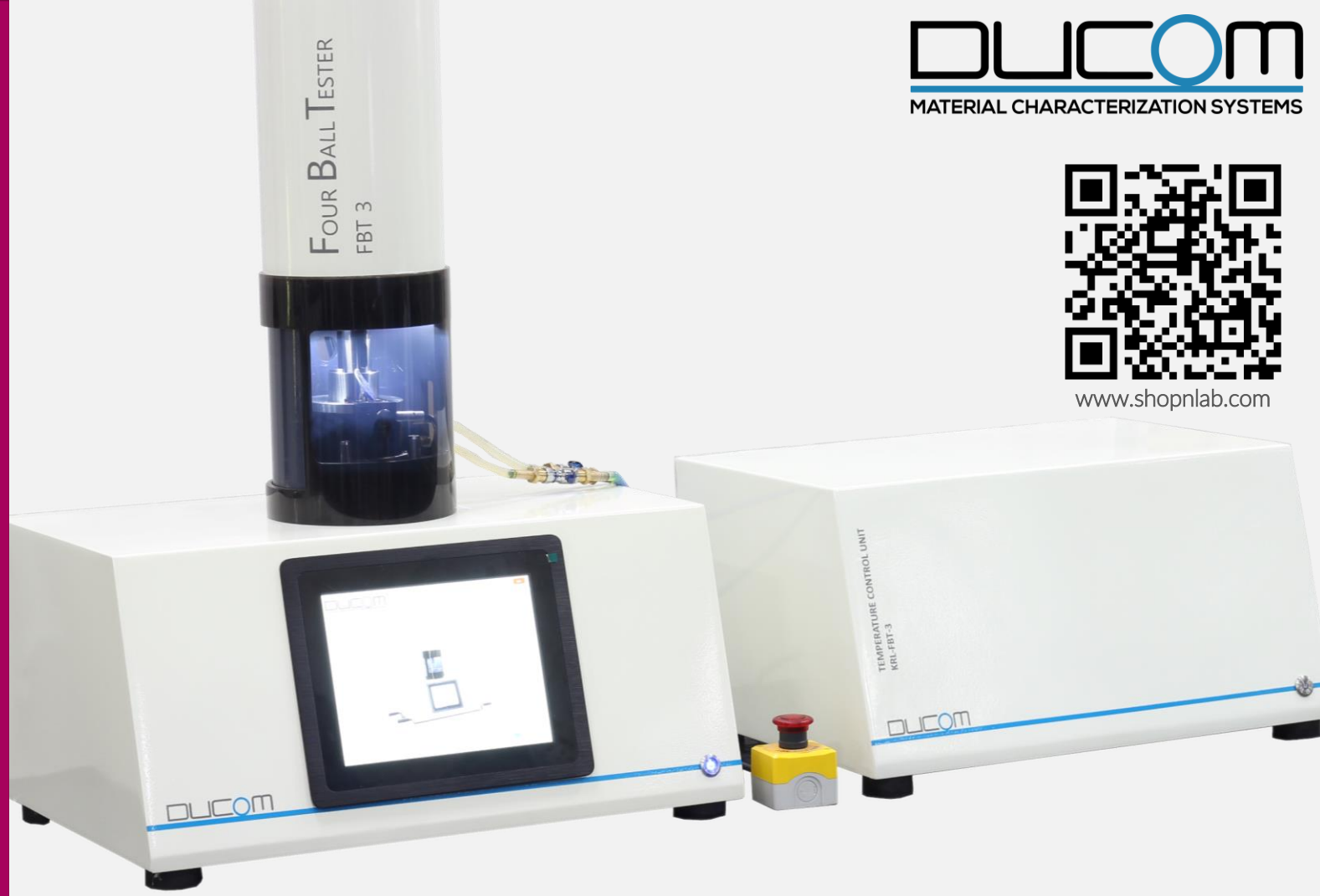
Difference between Low visc and High visc Viscosity Loss [%]	
20 hours	200 hours
8%	8%

CONCLUSIONS

- Standard test methods like ASTM D4172 and CEC L-45-99 cannot significantly differentiate new formulations for EV
- Modified ASTM D4172 (50 N) in four ball tester can be used to investigate **additive performance** by analyzing the friction coefficient, wear and temperature.
- Modified CEC L-45-99 (200 hours) in KRL shear stability tester can be used to estimate **aging of e-fluids** based on visual inspection (color change), friction coefficient and viscosity loss of sheared fluids

Thank you for your attention

Questions?



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