



QUALITY WORKS.

Successful Commercialization of an Ester-Functionalized High Viscosity PAO Base Stock

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STLE 2018, Commercial Marketing Forum, Minneapolis, MN

LANXESS
Energizing Chemistry

Outline

- 1. Elevance Aria™ WTP 40 – the basics**
- 2. Elevance Aria™ WTP 40 Properties and Performance Comparisons**
- 3. Summary**

Elevance Aria™ WTP 40



LANXESS

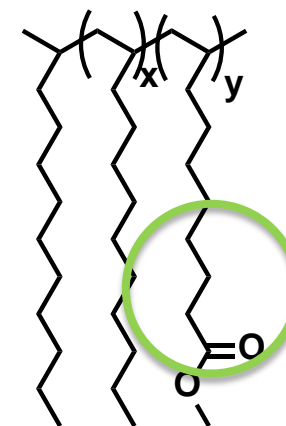
Background

- Licensing arrangement between Elevance Renewable Sciences and LANXESS
- LANXESS licensed the global rights to develop, derivatize, manufacture, use and sell products incorporating the Elevance Aria® WTP technology in lubricant applications
- First commercial material produced under this arrangement successfully completed and available to the market earlier this year.

Elevance Aria™ WTP 40

Unique Ester-Functionalized High Viscosity PAO

- High performance base stock combines the performance of Groups IV and V into one base stock
- “Bound” ester adds polarity and functionality to PAO within same macromolecule
- The Unique long chained ester is away from steric hindrance of backbone allowing it to “perform”
- Catalytic polymerization of linear alpha-olefins and linear alpha-olefin esters (9-DAME)

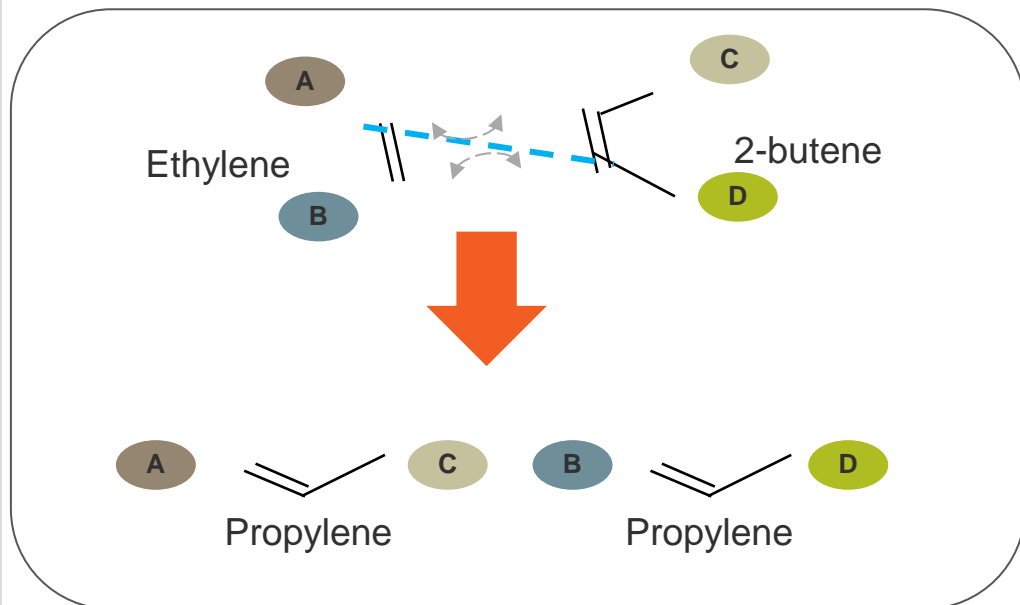


WTP 40

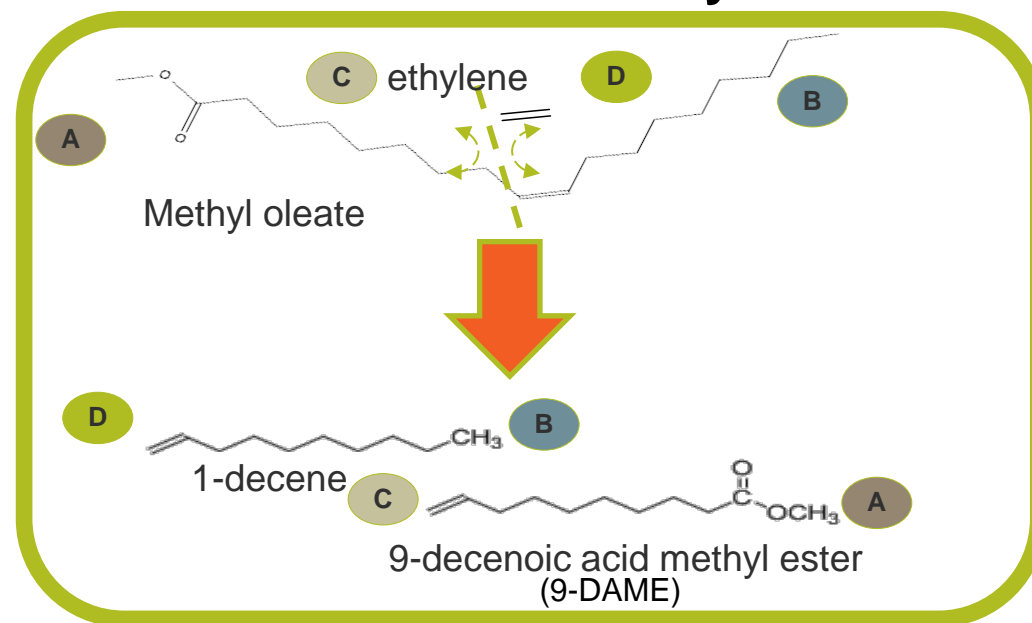
9-DAMe Differentiated Catalyst Technology

Allows for conversion of complex molecules such as fatty acids and esters

Traditional Catalyst



Proprietary Olefins Metathesis Catalyst



Elevance Aria™ WTP 40 Advantages

Advanced lubricant performance – Balanced formulation flexibility

- ✓ High viscosity index
- ✓ Enhanced additive solvency
- ✓ Elastomer seal compatibility
- ✓ Increased film thickness at boundary conditions
- ✓ Reduced friction and wear
- ✓ Lubricity and micropitting resistance
- ✓ Improved cleanliness and varnish control
- ✓ Partial bio sourced
- ✓ Food grade approved (NSF HX-1)



Elevance Aria™ WTP 40 Applications

Industrial Lubricants

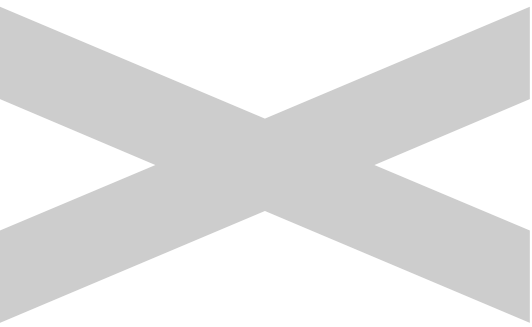
- Gear
- Compressor
- Hydraulic
- Food Grade
- Metalworking
- Grease

Transportation Lubricants

- Axle
- Transmission
- Engine Oil
- Grease



Elevance Aria™ WTP 40 Properties



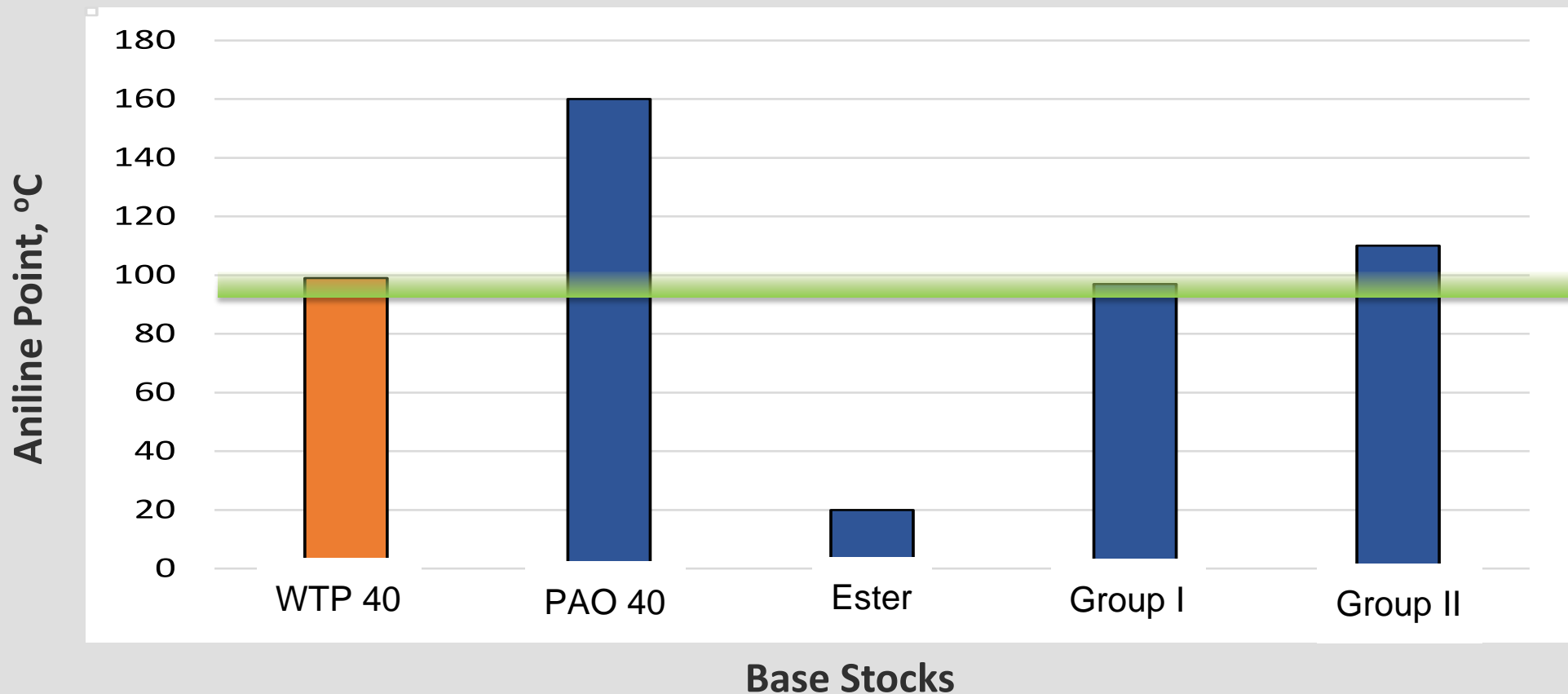
Elevance Aria™ WTP 40 Properties

Combines chemical and physical properties of PAO and ester into a single base stock

<u>Property</u>	<u>T7M15T729</u>
Kv, cSt @ 100C	39.63
Kv, cSt @ 40C	348.3
VI	165
Pour Point, C D-97	-36
Flash, C, D-92	266
Specific Gravity (60F)	0.883
Color, APHA	28
Moisture, ppm, KF	62
TAN, mg/g KOH, D-974	0.02
Brookfield Viscosity @ -26C, cP	92,700
Aniline Point, C	103.5

WTP 40 Balanced Solvency Enables Robust Formulations

Balanced aniline point for improved formulation compatibility and performance



Test Method: ASTM D611

WTP 40 Provides Additive Solvency and Compatibility

Clarity, brightness and color demonstrate excellent solubility of additives

Base Stocks + 6% Add Pack = Fully Formulated GL-5 Gear Lubricant

WTP 40

PAO 40

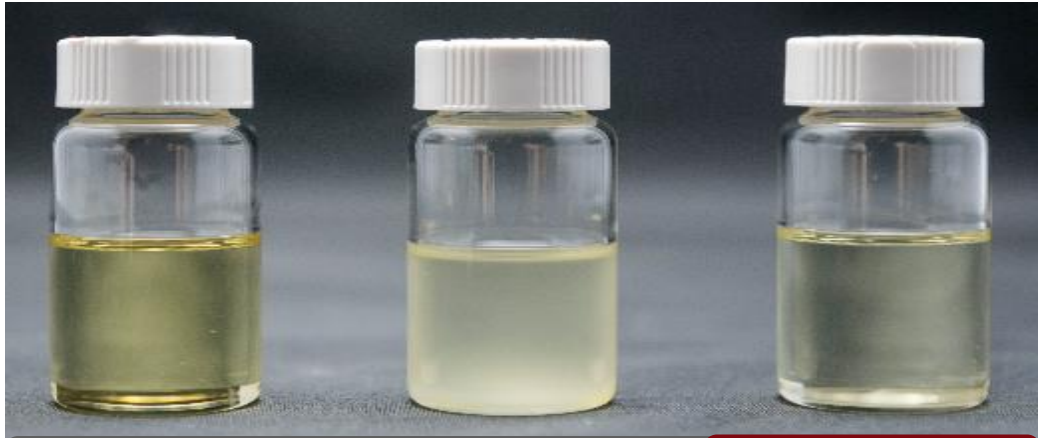
PAO 40 / 10%ester



WTP 40

PAO 40

PAO 40 / 10%ester



No compatibilizers added

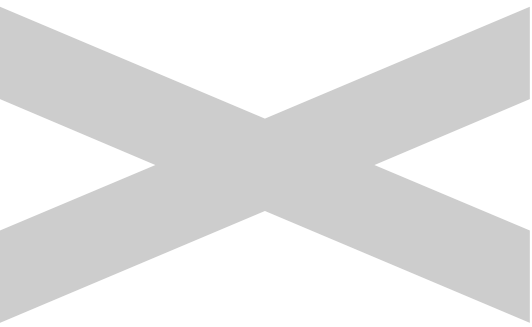
Compatibilizers

Formulation Simplicity Through Elimination of Ester

Industrial Gear Oil (ISO 220)		
	Conventional	Elevance Aria™
WTP 40 (%)	--	83.0
PAO 40 (%)	83.0	--
PAO 4 (%)	4.32	14.32
Ester (%)	10.0	--
Additive package (%)	2.68	2.68
Kv @ 100C	25.83	27.13
Kv @ 40C	230.2	220.2
VI	150	158
Bv @ -26C, cP	49,600	40,200
Demulsibility @ 82C	43/37/0 (10)	43/37/0 (15)
Seal Compatibility (NBR-VDA) 168 hrs @100C		
Volume Change, %	4.95	1.94
Points Hardness Change	-1	1
Tensile Strength Change, %	-13.4	-7.8
Elongation Change, %	-40.2	-36.3

Elevance Aria™ WTP 40

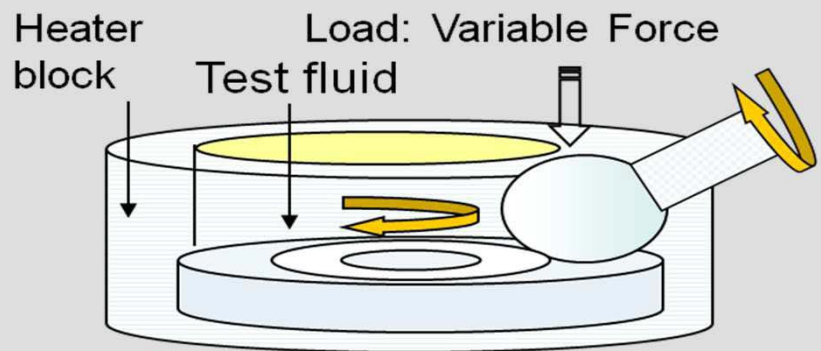
Performance Comparisons



WTP 40 Performance

Better boundary lubrication / Lower Friction

Mini-Traction-Machine (MTM)



(stainless steel (AISI 52,100))

Disc / ball rotation (variable speed)

Measure Friction coefficient f_c vs.

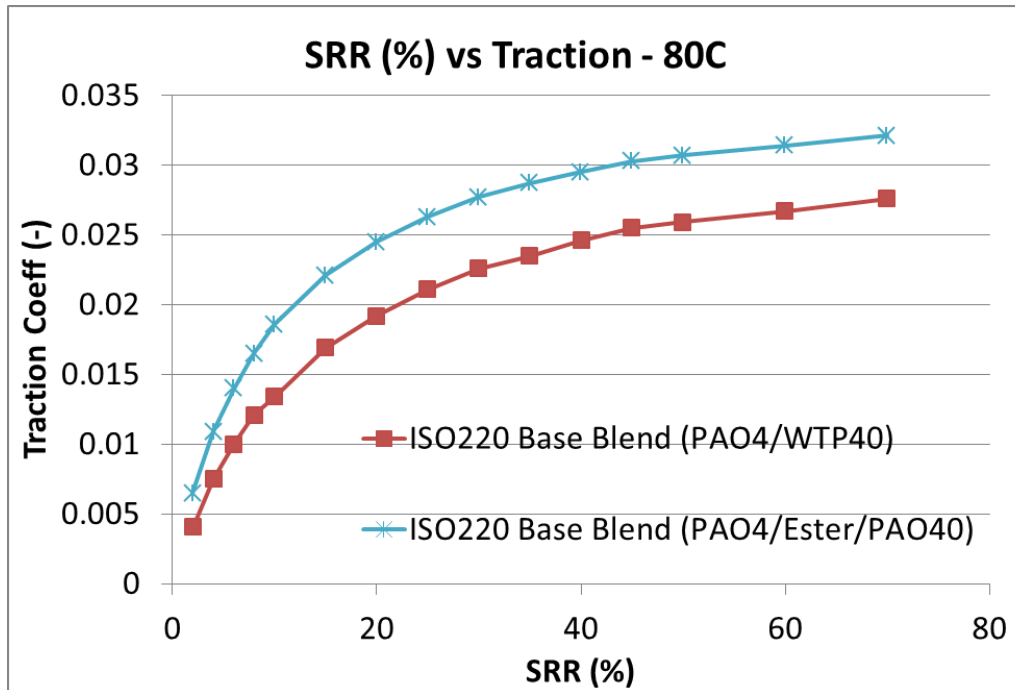
Entrainment speed or Slide to Roll Ratio

Test Conditions			
Contact Pressure, GPa (37N Load)	Temperature (°C)	Speed Range (mm/s)	Slide-Roll Ratio %
1.2	40 - 120°C	2000 – 5	0-70

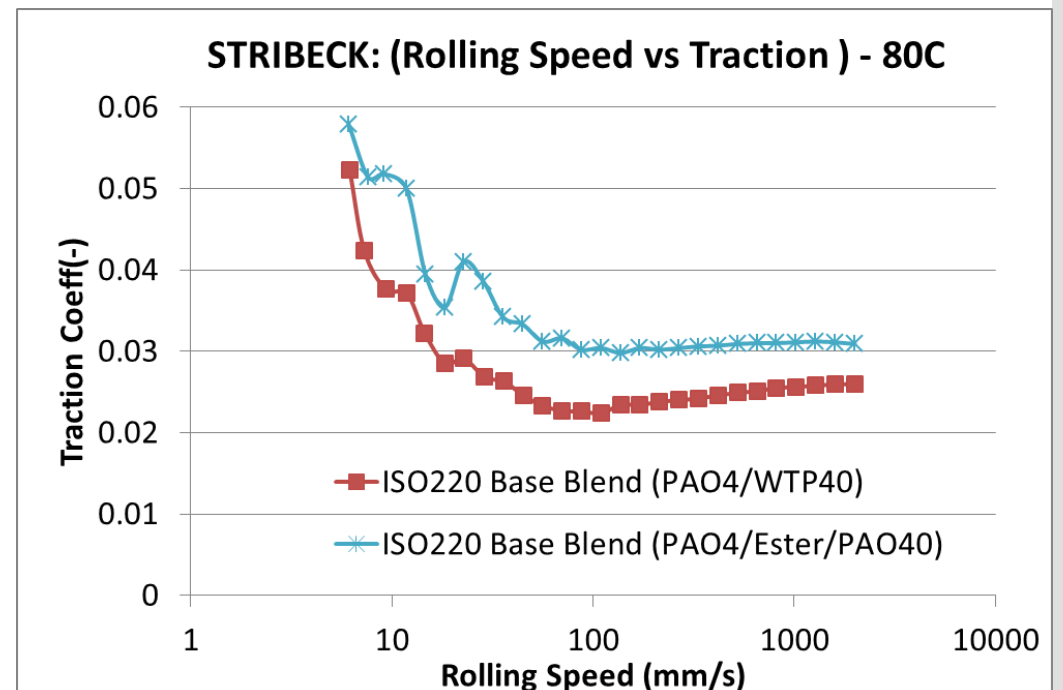
WTP 40 Shows Reduced Friction and Wear vs. PAO/ester

Improved friction and wear when compared to PAO 40/ester

Friction performance at 80C



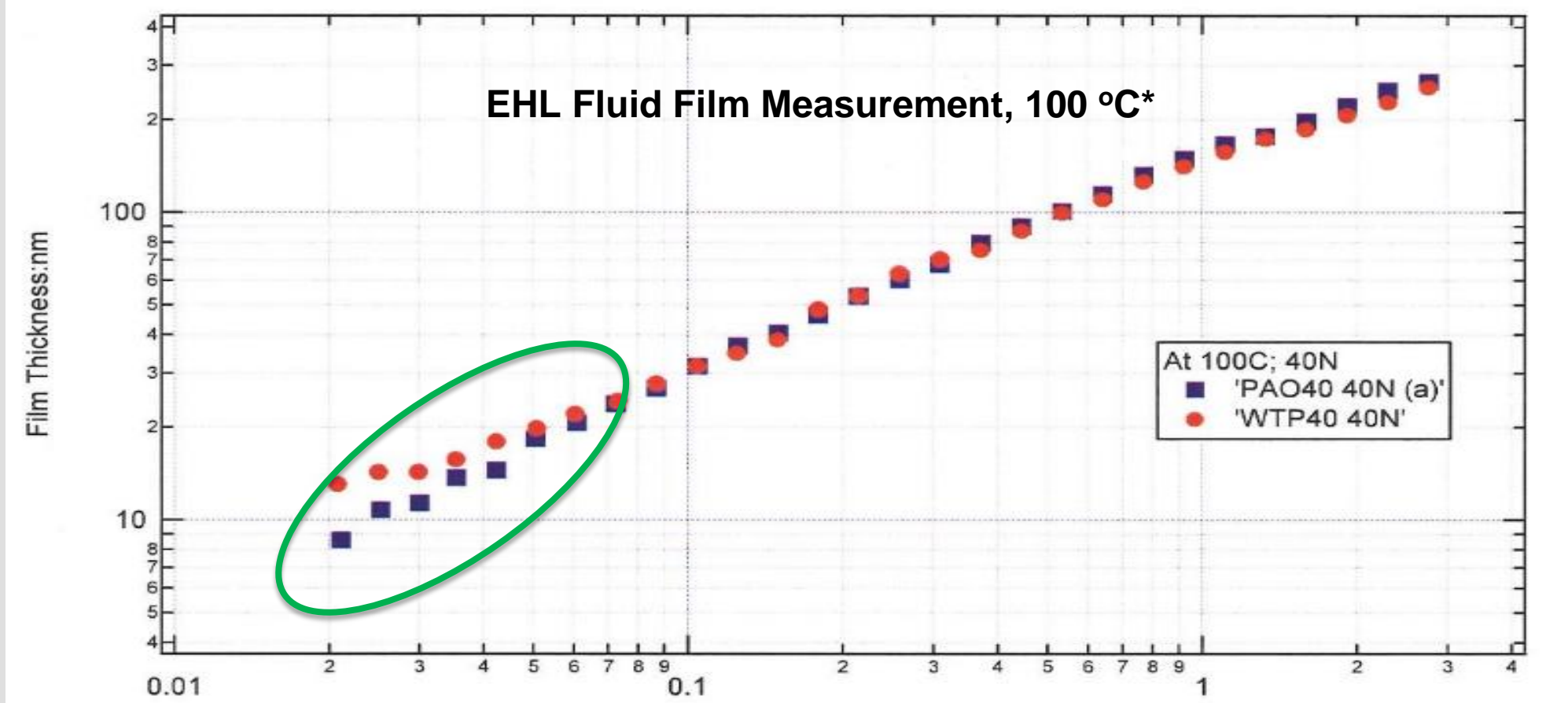
Wear performance at 80C



MTM Data

WTP 40 Gives Increased Film Thickness at Low Speeds

Demonstrates better boundary lubrication compared to PAO 40

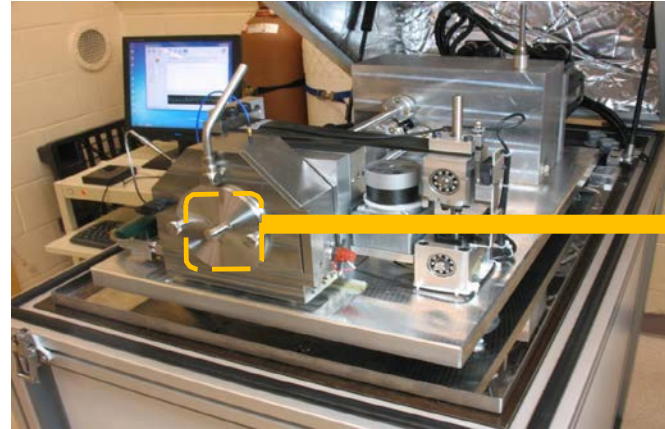


*EHL test was done by Dr. Girma Biresaw, USDA

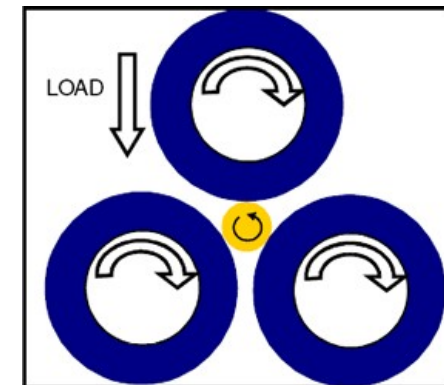
WTP 40 Demonstrates Less Micro-pitting in Screener Tests

Elevance Aria™ WTP 40 base stock shows reduced tendency micropitting when compared to PAO 40

Micropitting Test Rig (MPR) PCS Instruments



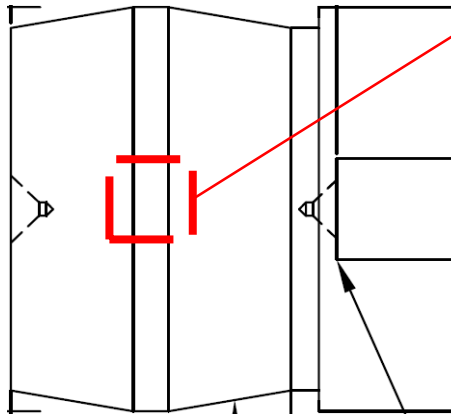
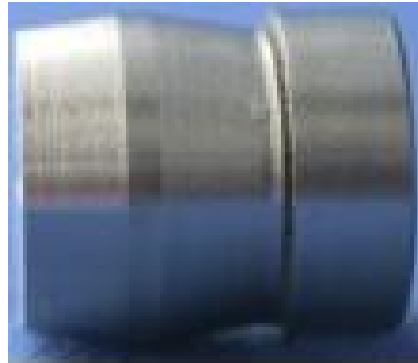
- Temperature = RT - 135C
- Velocity = 0 - 4m/s
- Load= 0 – 1250N (3GPa)
- SRR = 0 - 200%
- $\sim 1 \times 10^6$ contact cycles/hour



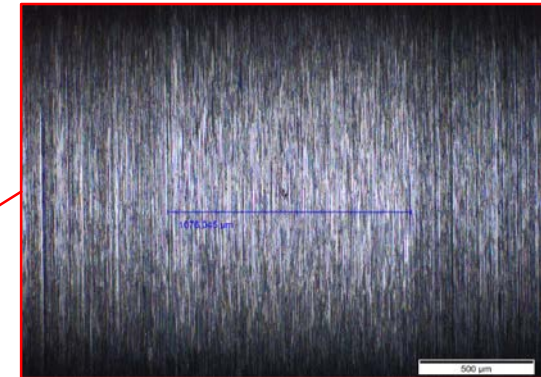
Micropitting Screener

Micropitting Test Rig (MPR)

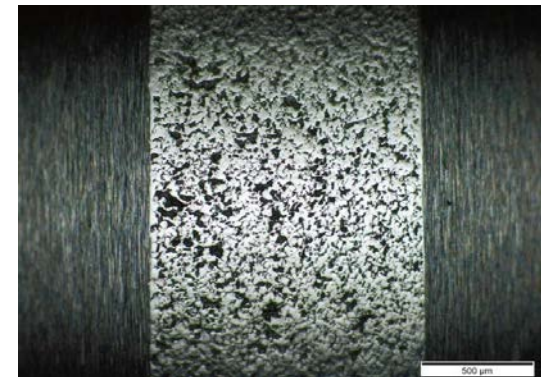
Test Roller



Pretest



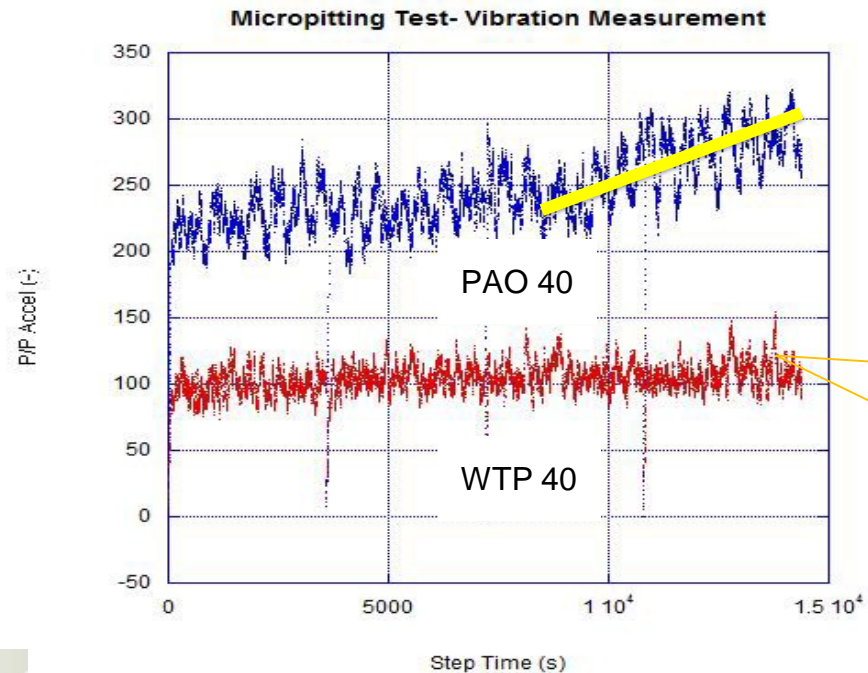
Micropitting



WTP 40 Advantage

MPR Test Conditions - to mimic wind turbine

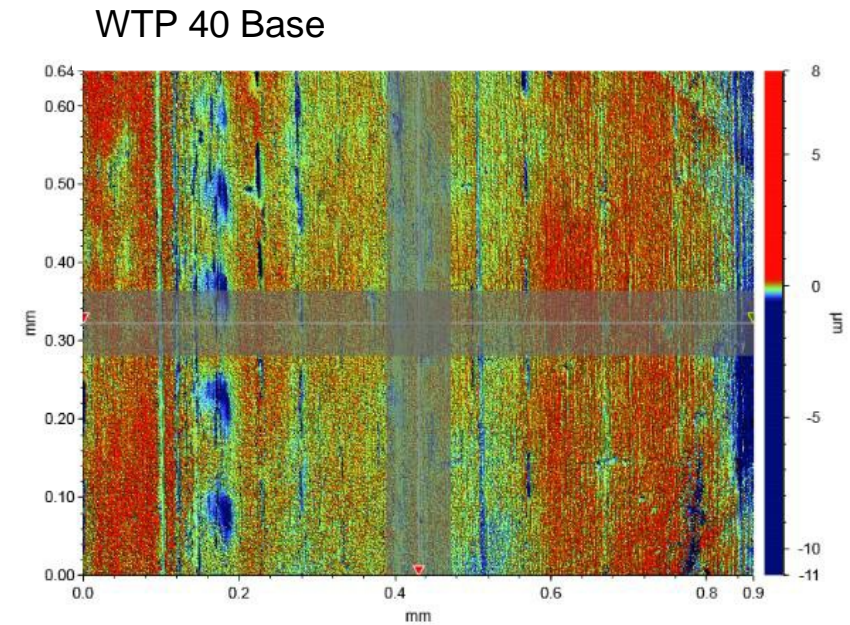
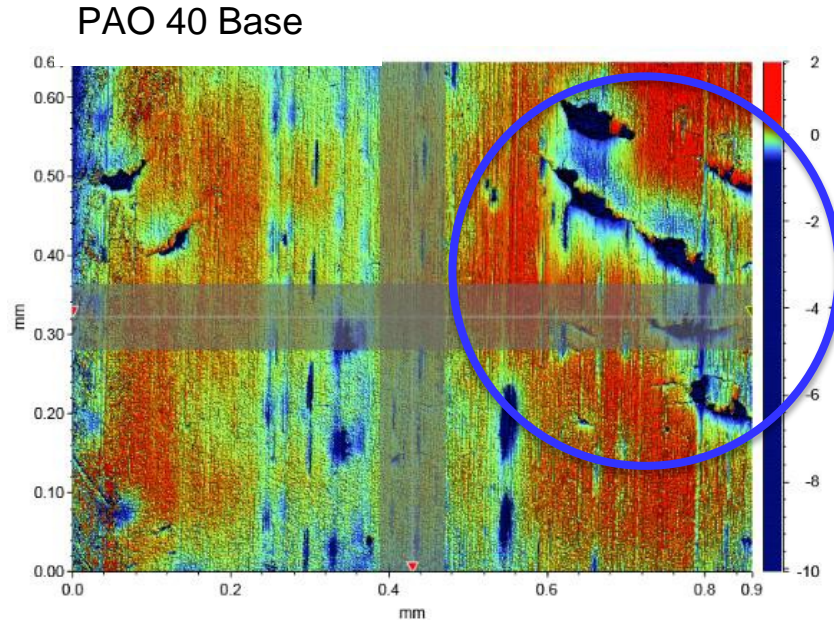
- Temperature = 90C
- Velocity = 3m/s
- Load= Varies based on track width
- SRR = 20%
- Time = Four 1 hour intervals
- Ring and Roller Material = 16MnCr5
- Oils:
 - Elevance Aria WTP 40
 - PAO40



WTP 40 Advantage

WTP 40 shows reduced micropitting as evidenced by no horizontal blue wear scars

- Post Test Roller Roughness and Wear Comparisons

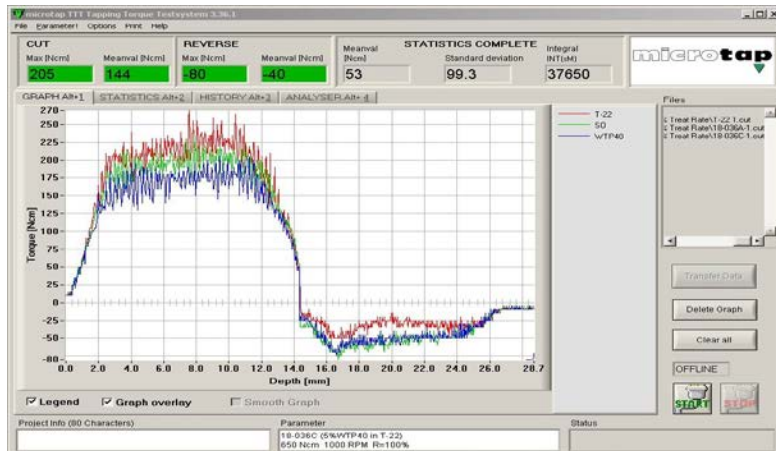


WTP 40 Lubricity

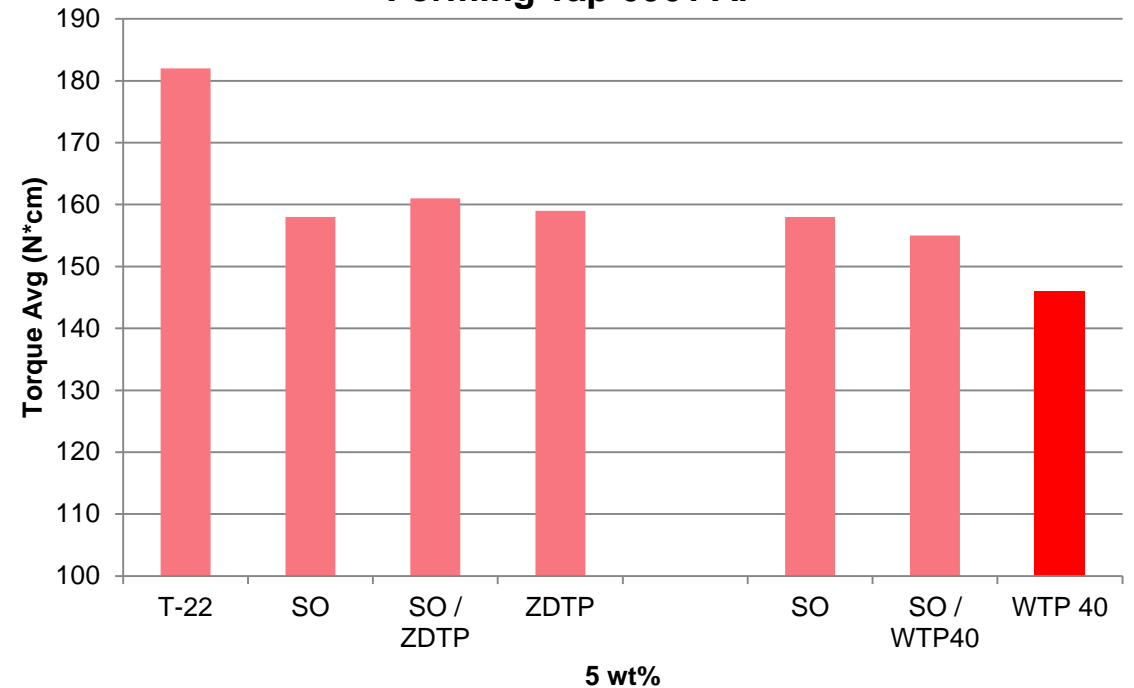
WTP 40 can be used as an additive

- Conditions

- 1000 rpm
- 5 wt% total additive in Oil
- 14.3 mm depth



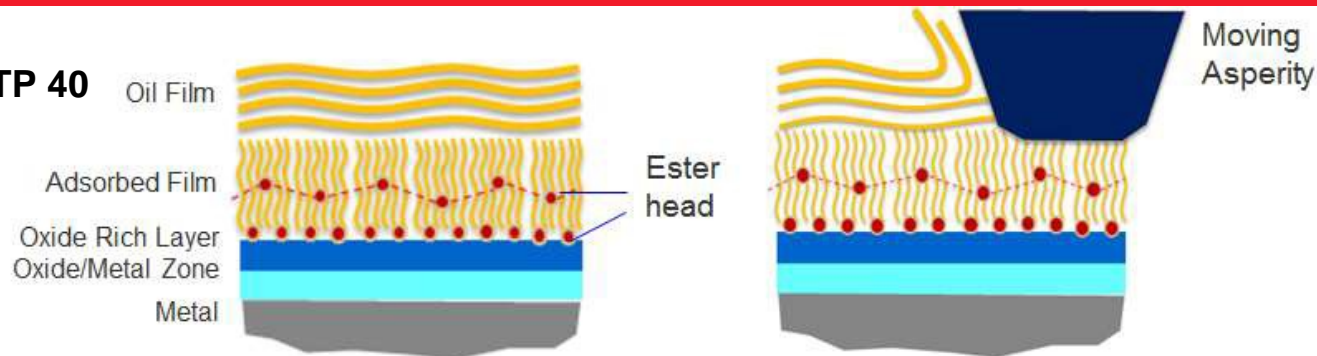
Microtap Testing
Forming Tap 6061 Al



WTP 40 Advantage

Long chain ester provides thicker more durable film

WTP 40



Strong, thicker adsorbed film, due to large polar molecules and intermolecular attractions which can stand higher load and shear at contacts.

**PAO /
Ester**



Thinner adsorbed film due to small ester molecules and is easily broken down and removed at contacts.

WTP 40 in GL-5 Gear Oil Enhances System Cleanliness

Impressive varnish reduction demonstrated vs. PAO 40/ester blends

	GL-5 Spec	PAO 40/ester		WTP 40
		Adipate	TMP	
Sludge	>9.4	9.7	9.7	9.7
% Visc Inc.	<100	7	8	14
Varnish	>7.5	7.5	7.7	9.5



*Automotive Gear Oil Oxidation Test, L-60-1 (ASTM D5704)

Key Takeaways

- Lanxess has successfully produced our first batch of Elevance Aria™ WTP 40 for commercial sales
- Elevance Aria™ WTP 40 is a high viscosity base stock that can help meet today's lubricant demands for severe industrial and transportation applications
- The molecular design of WTP 40, with chemically-bound ester, provides improved performance due to its inherent polarity and its stronger and thicker adsorbed fluid film under boundary conditions.
- These features can help provide advantages over simple PAO/ester blends in friction and wear performance, cleanliness and provides formulation simplicity

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Energizing Chemistry

Booth 127 / 129

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