OSP-New Group V Base Fluid for Manufacture of Sulfonate Greases

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DOW Lubricant & Fuel Additives

Presentation Objectives

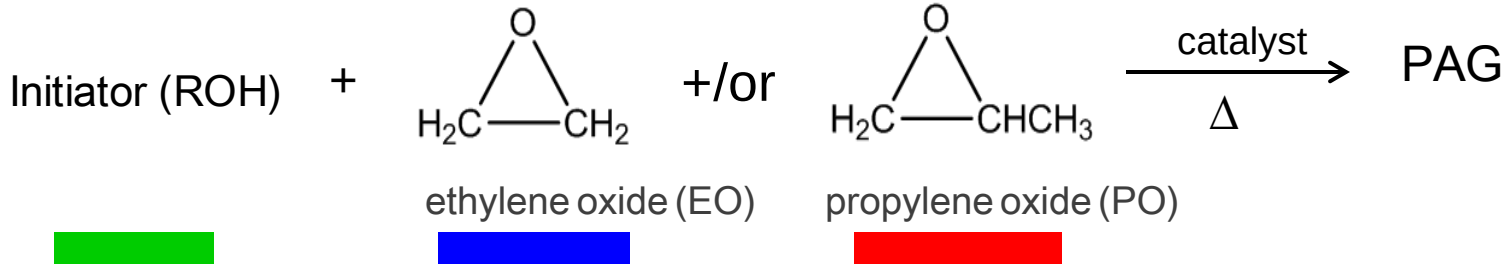
- To introduce oil soluble PAGs – (OSPs) a new type of Group V base oil and performance additive
- New OSP technology offers many benefits in grease formulations
- OSPs offer options to upgrade hydrocarbon oils, naphthenic oils and synthetic base fluids to boost solvent power and improve additive compatibility
- OSP with inherent corrosion and hydrolytic improvement characteristics provide an option for formulators to use vegetable oil/ester for grease formulation
- OSP-Overbased Calcium Sulfonate (OBCS) Complex Grease provides significantly high drop point, shear stability, low friction and water washout characteristics

What is Grease?

- Grease is a combination of oil, additives and a thickener
- The oil and additives serve the same function as in a lubricating oil
- The thickener converts the liquid lubricant to a semi-solid lubricant
- A grease can't be any better than its base oil

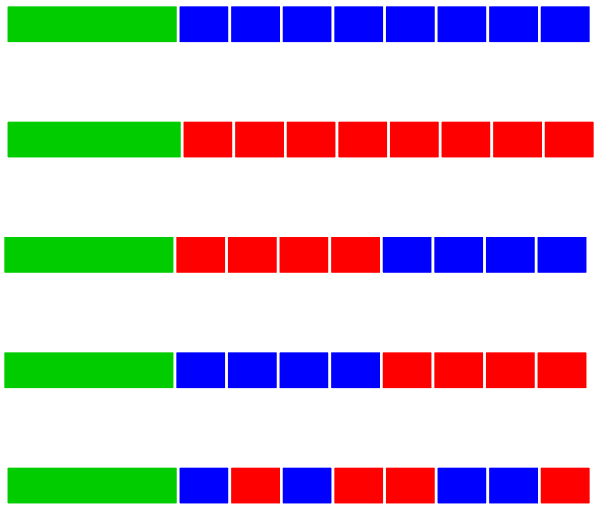
Conventional Polyalkylene Glycol Technology

Typical Synthesis Route to Polyalkylene Glycols



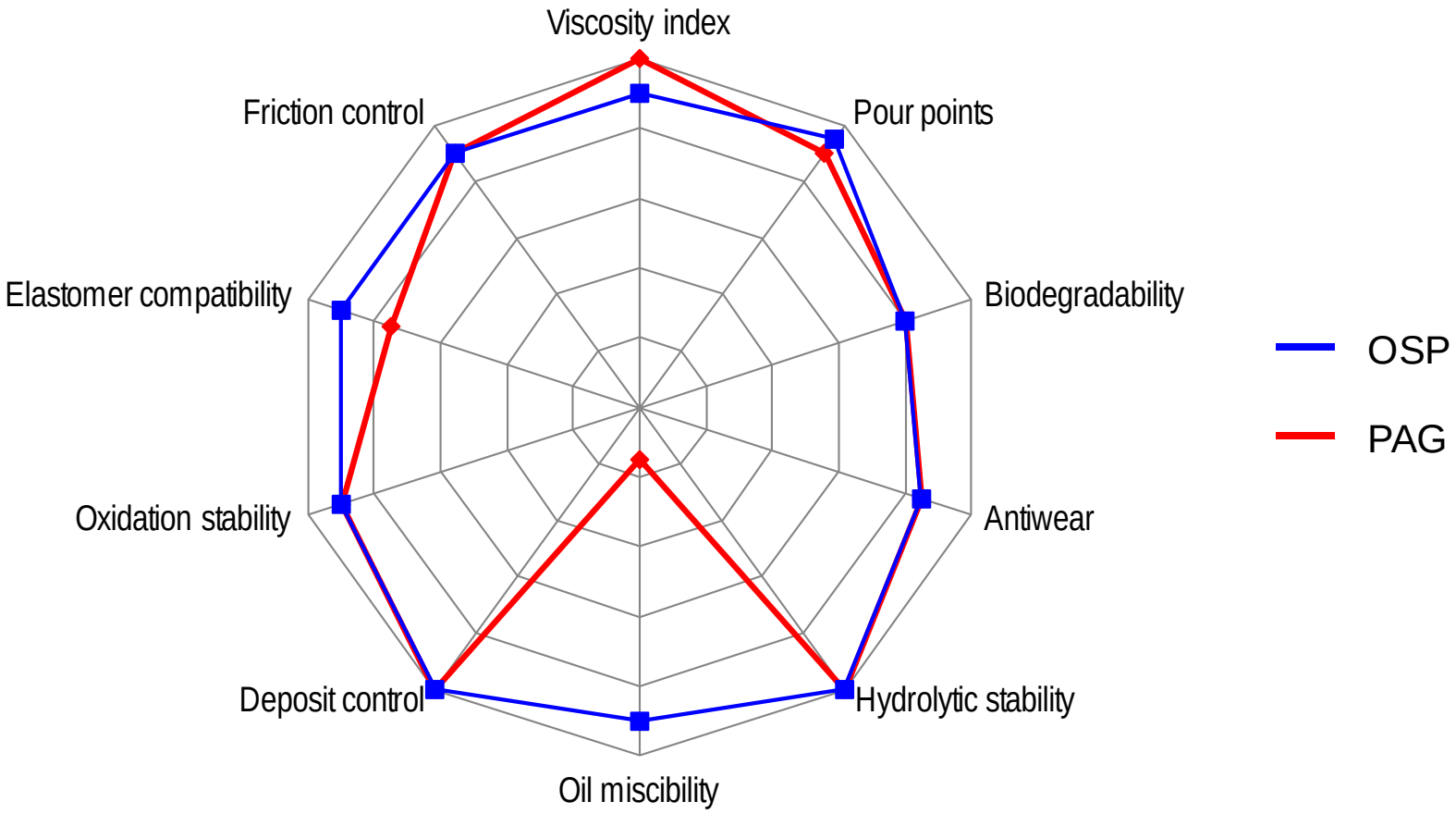
- High performance synthetic lubricants
- Solve problems that mineral oils cannot
- Synthesized from ethylene oxide and propylene oxide
- Flexible chemistry – polymers can be tailor designed to meet many requirements
- Extensively researched over 60 years

Types of PAGs by chemical family



PAGs can be designed to have a wide range of molecular weights, viscosities and functional performance

Attributes of OSPs versus Traditional PAGs



Oil Soluble PAGs offer formulators greater flexibility and especially as performance BASE FLUIDS in hydrocarbon lubricants & GREASES

New Oil Soluble PAGs – Typical Properties

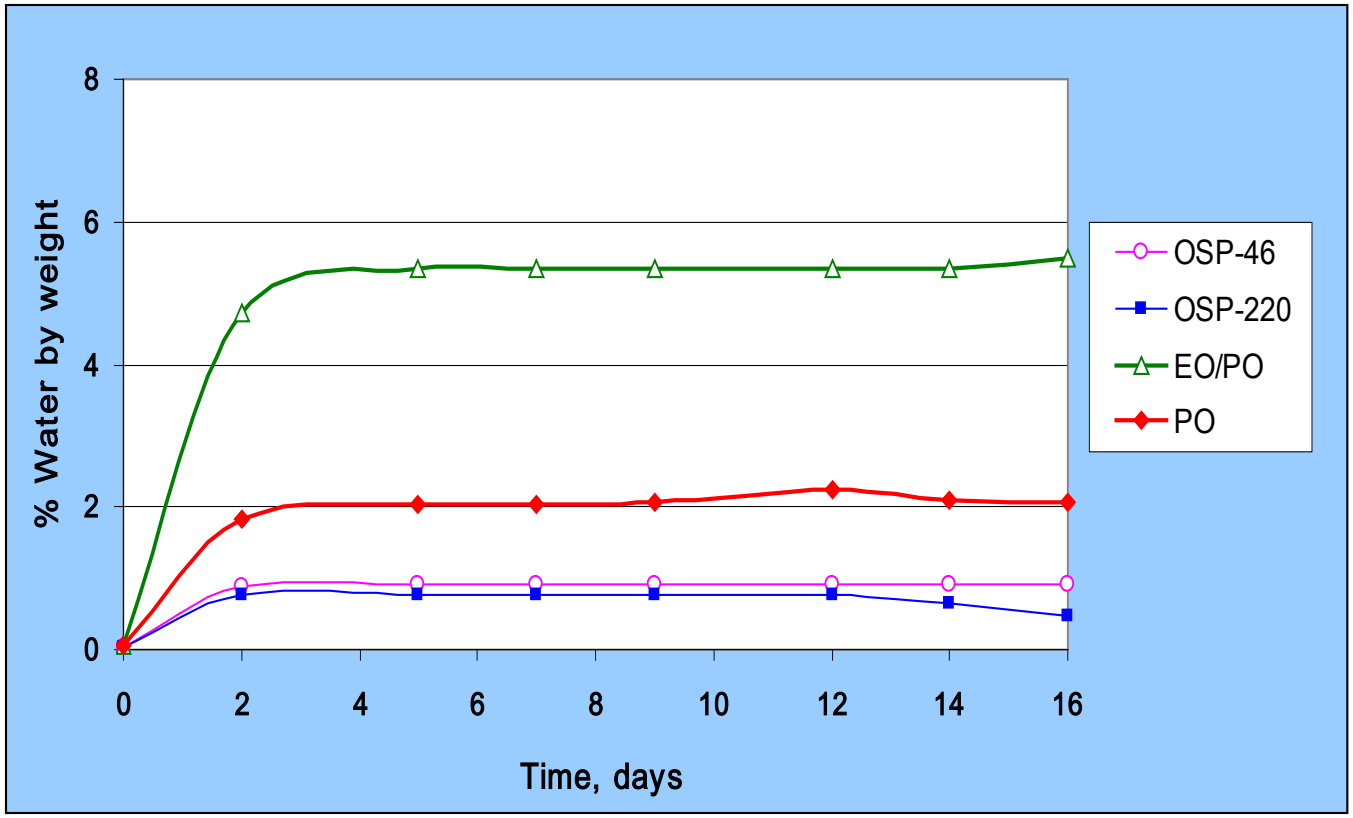
OSPs derived from downstream derivatives of butylene oxide

	KV40 cst	KV100 cst	Viscosity Index	Pour Point °C	Flash Point, °C	Aniline Point, °C
	ASTM D445	ASTM D445	ASTM D2270	ASTM D97	ASTM D92	ASTM D611-01
OSP-A	18	4	123	-41	204	n/d
OSP-B	32	6.5	146	-57	216	<-30
OSP-C	46	8.5	164	-57	210	<-30
OSP-D	68	12	171	-53	218	<-30
OSP-E	150	23	186	-37	228	<-30
OSP-F	220	32	196	-34	226	-22
OSP-G	320	36	163	-37	230	<-30
OSP-H	460	52	177	-35	235	<-30
OSP-I	680	77	196	-30	243	<-30

Practical Examples of Using OSPs

- Lower Hygroscopicity
- Friction control in hydrocarbon oils
- Hydrolytic stability additive in esters
- Corrosion Protection Enhancement in PAG
- Solvent Power and Low Aniline Point additive for base oils for greases

OSPs Hygroscopicity vs. PAG structures



Test conditions:
50°C, 80% relative humidity
250ml sample in a 400ml glass beaker (diameter. 8cm)

EO/PO = EO/PO random copolymer and ISOVG-46

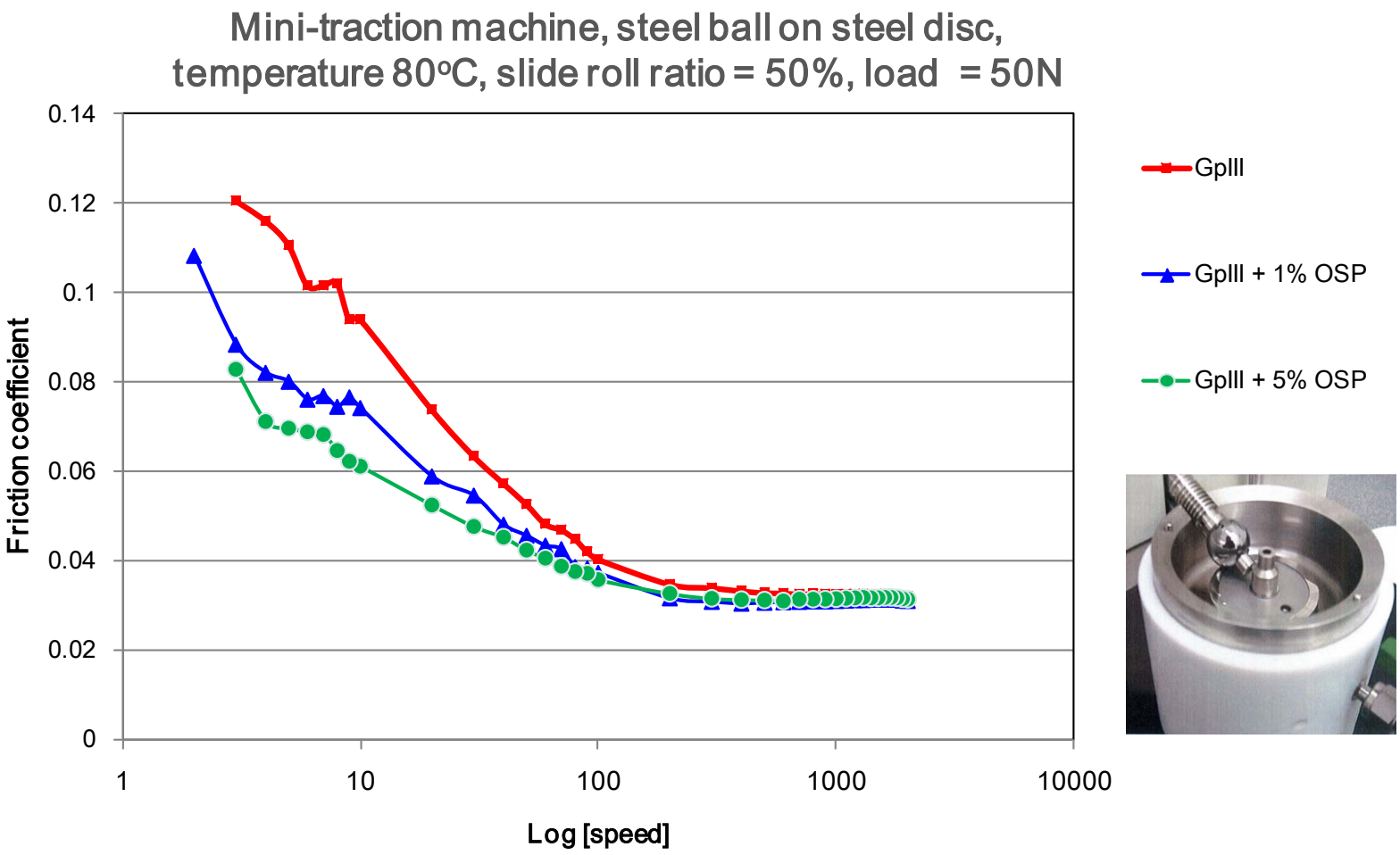
PO = PO homo-polymer and ISOVG-46

OSP-46 and 220 are new oil soluble PAGs containing BO

- Hygroscopicity of oil soluble PAGs is significantly lower than conventional PAGs
- PAGs act as polymeric sponges binding water within the structures (water is not free at levels of several thousand ppm)

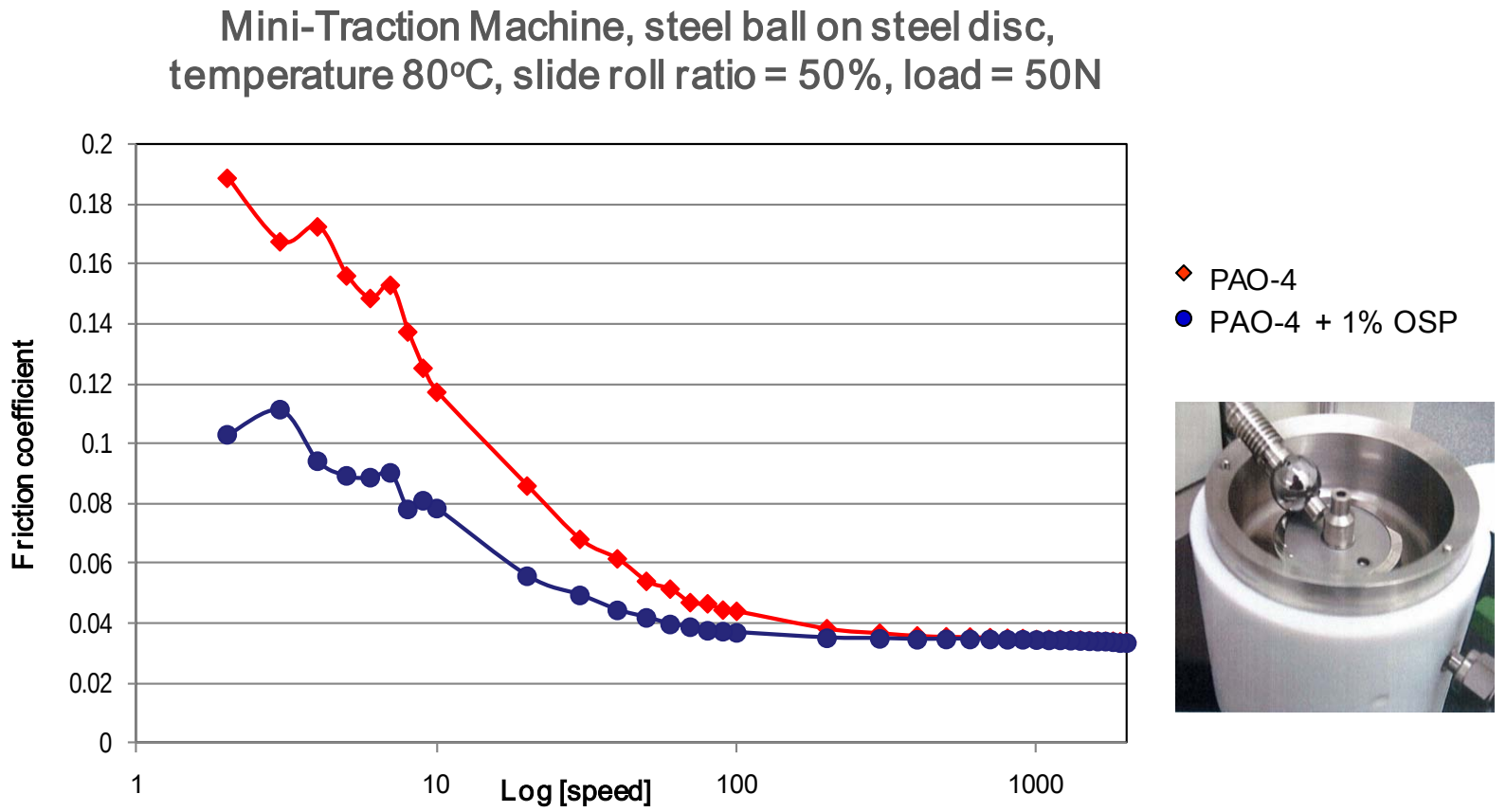
Friction Control of OSPs

In a Group III Base Oil



Friction Control of OSPs

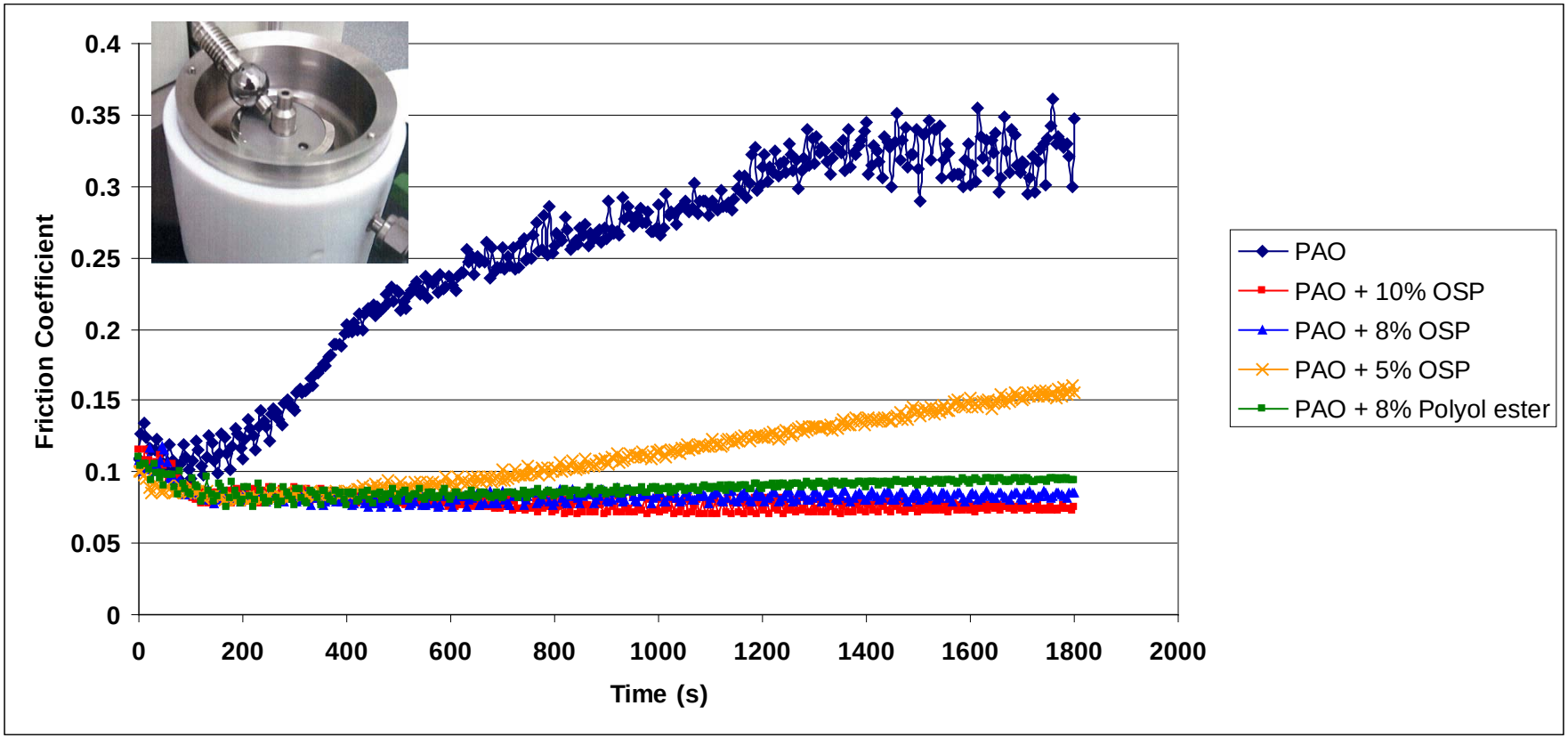
In a PAO-4 Base Oil



Evidence of friction control behavior in Group III and IV hydrocarbons

Friction Performance as Additives in PAOs

Mini-traction machine, steel ball on steel disc, temperature 80°C, speed 15 mm/sec, Slide roll ratio = 10%, Pressure = 0.9GPa



Polyalphaolefin is a PAO-8 base oil (un-additized)

OSPs may offer another choice to esters and other surface active additives

OSPs and Hydrolytic Stability

Hydrolytic stability: Modified ASTM D2619 – extended time

		Vegetable Oil	Vegetable Oil + 10% OSP-C		Synthetic Polyol ester	Synthetic polyol ester + 10% OSP-C
KV_{40}	mm^2/sec	32	34.5		22.9	23.9
Viscosity index		225	220		144	151
TAN change	mg KOH/g	0.4	0.1		0.07	0.05
Total acidity of water layer	mg KOH/g	7.3	1.2		3.2	1.2
Copper appearance		3a	1b		2c	1b
KV_{40} change	%	+4.0	+ 4.0		-4.9	0.9

OSP appears to act as a polymeric sponge for water, rendering it less active

OSPs and PAG Corrosion Protection

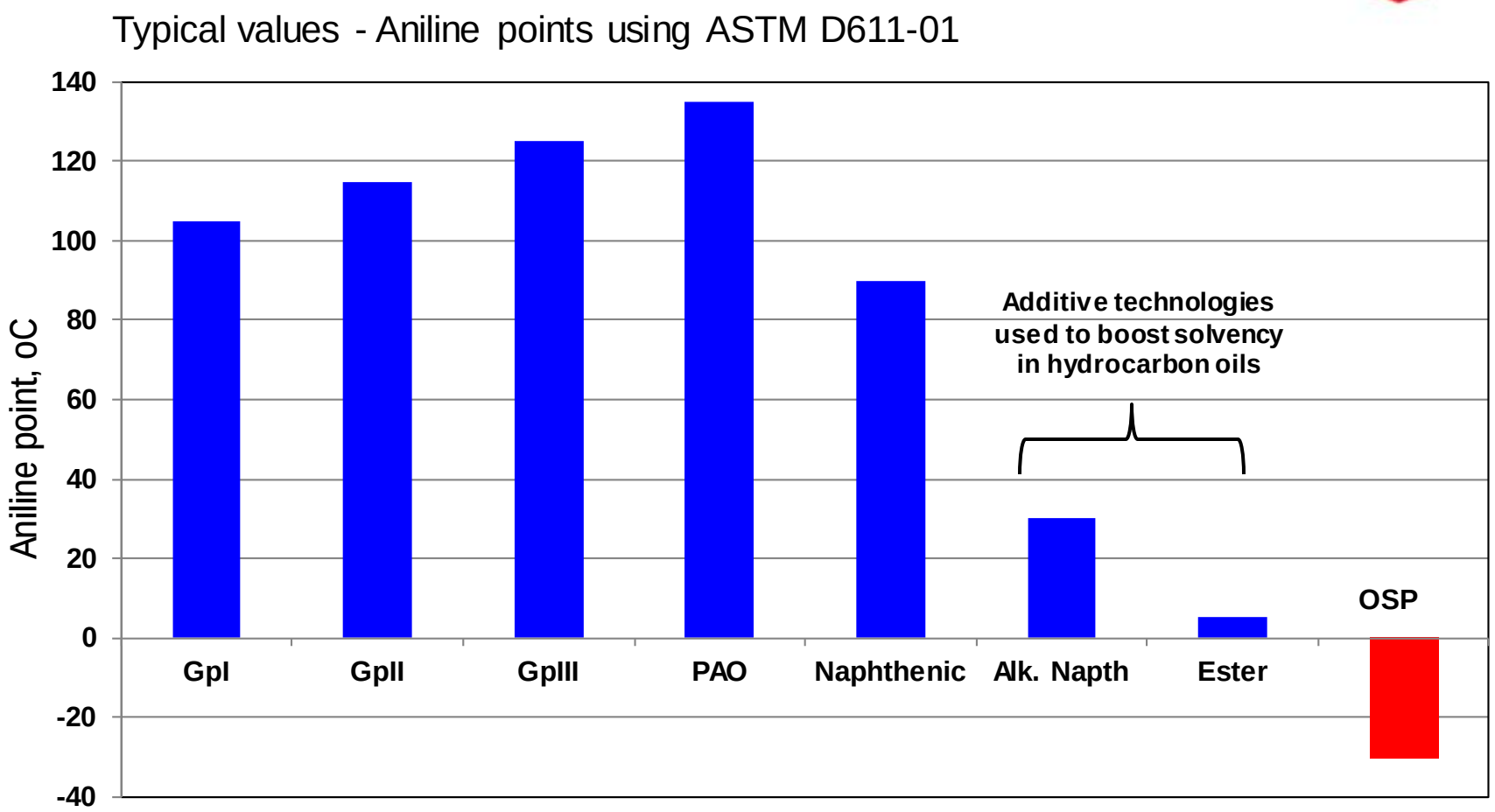
	%
PAG (EO/PO random copolymer)	97.0
Additive package	2.75
Sodium dialkylnaphthalene sulphonate*	0.25

	%
PAG (EO/PO random copolymer)	92.0
OSP-46	**5.0**
Additive package	2.75
Sodium dialkylnaphthalene sulphonate*	0.25

* Corrosion inhibitor

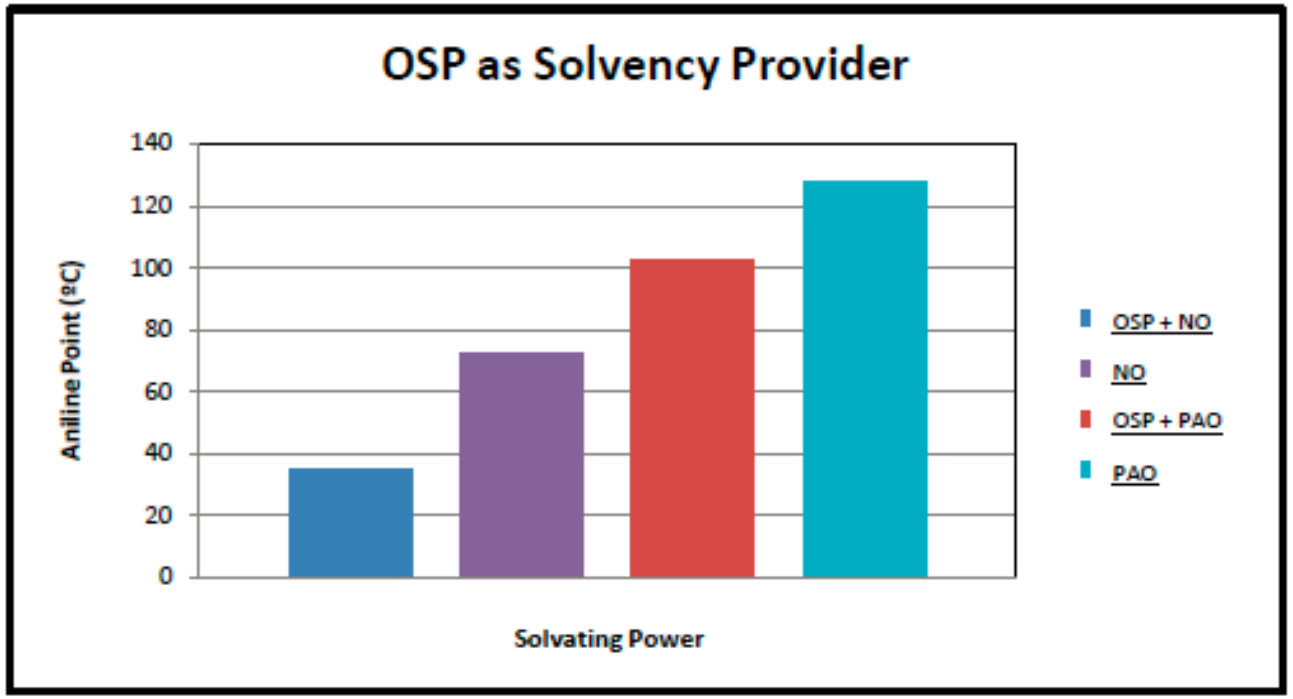
24 hours ASTM D665 A and B

Comparison of Aniline Points



Oil Soluble PAGs can provide formulators another option for adding back some solvency power to Group II, III and IV base oils

OSP- Solvency Enhancement

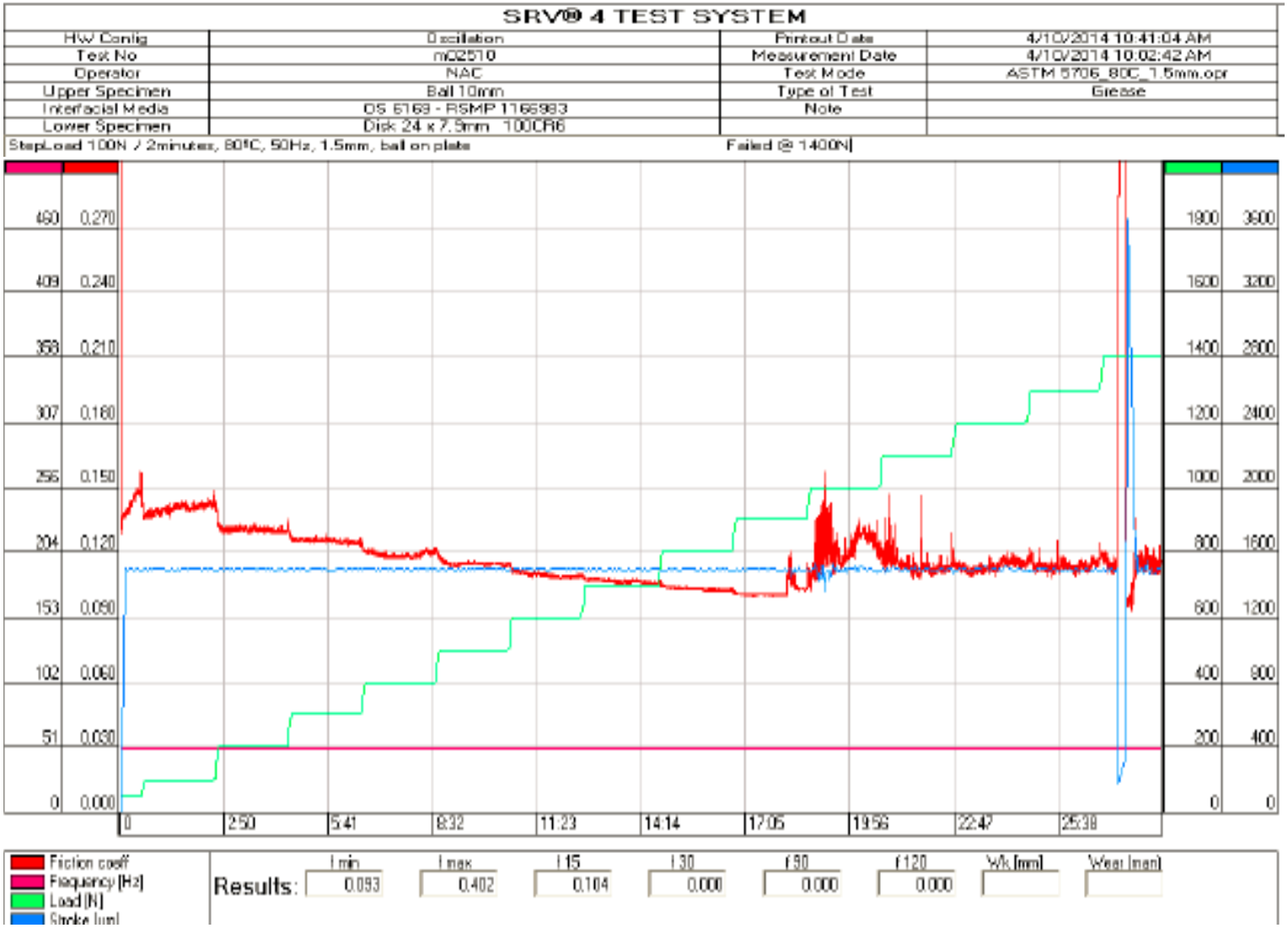


NO: Typical Naphthenic Oil
PAO: Typical Poly alpha Olefin

Typical Properties: OSP- OBCS Complex Grease

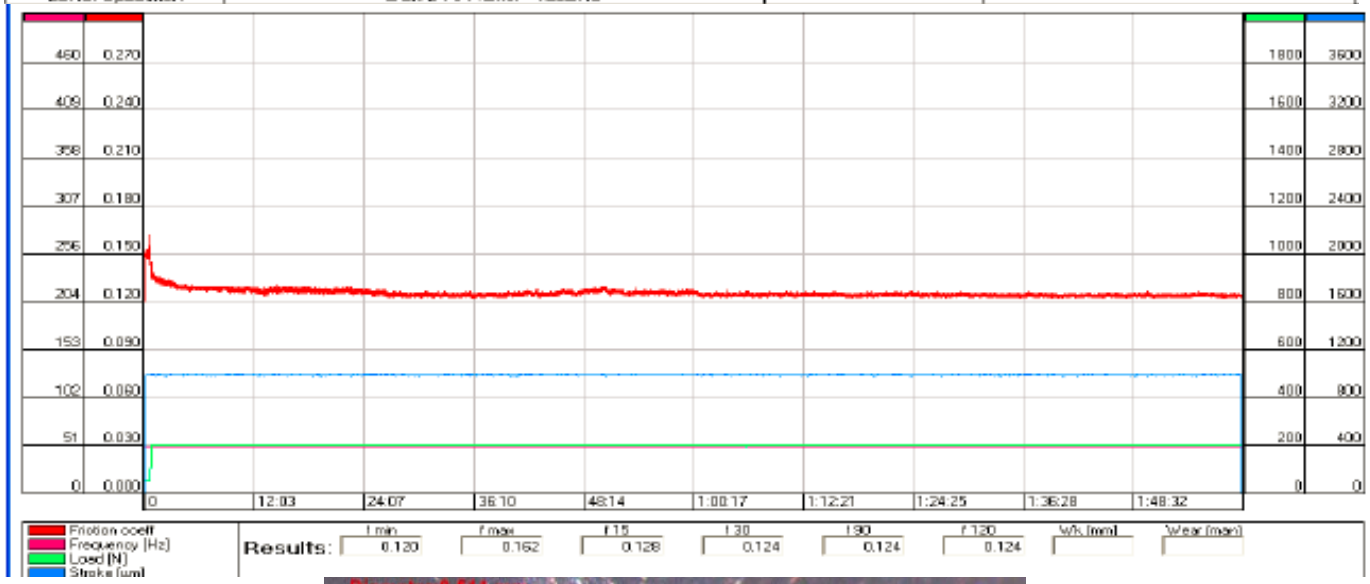
Penetration @25ºC (77ºF), mm/10	ASTM D 217	
Worked 60 Strokes		285
Shear Stability, Δ,W100K, No Significant Change	ASTM D 217	-3
Dropping Point, ºF (ºC)	ASTM D 2265	>640(>338)
4 Ball Wear Test, mm Scar Diameter	ASTM D 2266	0.40
4-Ball Weld, Kg	ASTM D 2596	400
Water Washout, @ 175ºF (79ºC), % Loss	ASTM D 1264	0.7
Timken OK load, lbs	ASTM D 2509	55
Water Corrosion - Rust Preventative Properties of Greases	ASTM D 1743	Pass
Oxidation Stability-Pressure Vessel Oxidation	ASTM D 942	
Δ P, psi ,100 hours		1
PDSC,180ºC, Minutes	ASTM D 5483	145
Salt Fog Test	ASTM B 117	500+ hours
SRV : Friction & Wear properties:	ASTM D 5707	
Scar Diameter, mm	Fig	0.511
Coefficient of Friction	Fig	0.125
SRV: EP Properties	ASTM D 5706	
Pass Load, N	Fig 4	1400
Base Oil Characteristics		
Viscosity @ 40ºC cSt	ASTM D 445	334
Viscosity @ 100ºC cSt	ASTM D 445	44
Viscosity Index	ASTM D 2270	189

EP Property OSP-OBCS Complex Grease, ASTM D 5706

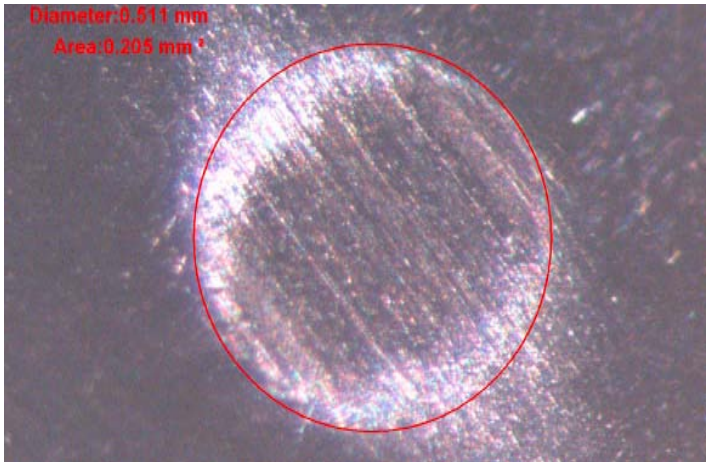


Friction Profile OSP- OBCS Complex Grease, ASTM D 5707

SRV® 4 TEST SYSTEM			
HW Config	Oscillation	Printout Date	4/10/2014 10:30:02 AM
Test No	m02506	Measurement Date	4/9/2014 11:12:46 AM
Operator	NAC	Test Mode	ASTM 5707_100C.opr
Upper Specimen	Ball 10mm	Type of Test	Grease
Interfacial Media	OS 6169 - RSMP 1166983	Note	
Lower Specimen	Disk 24 x 7.9mm 100CR6		

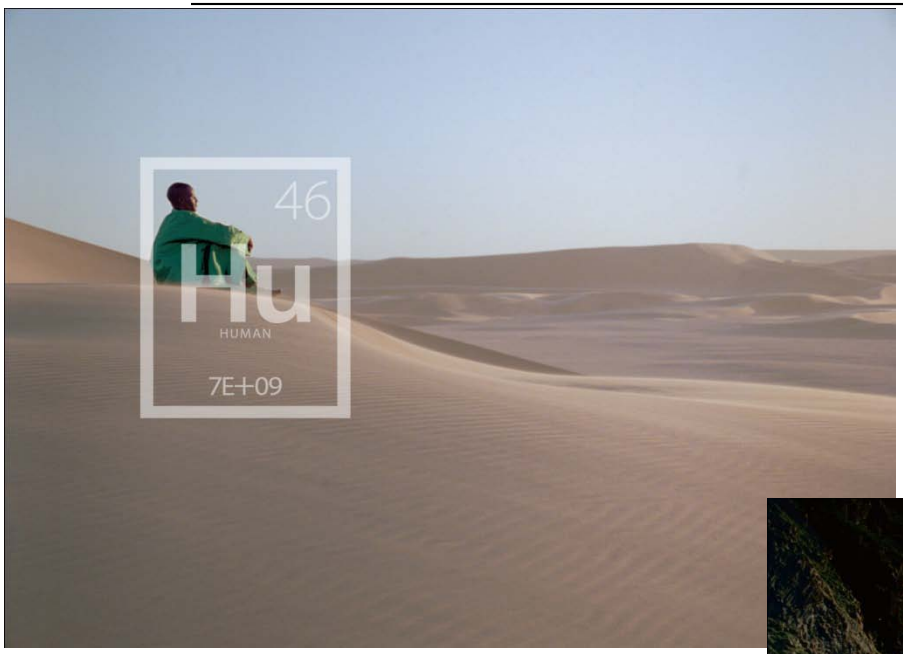


Results:	f min	f max	f 15	f 30	f 90	f 120	Wk [mJ]	Wear [mm]
	0.120	0.162	0.128	0.124	0.124	0.124		



Conclusions

- New OSP technology offers many benefits in grease formulations
- OSPs offer options to upgrade hydrocarbon oils, naphthenic oils and synthetic base fluids to boost solvent power and improve additive compatibility
- OSP-based OBCS Complex Grease provides significantly higher drop point & EP characteristics
- OSP with higher solvency, inherent hydrolytic stability, high VI, and low friction coefficient offers formulators an option to formulate stable OBCS Complex grease



THANK YOU