

Zschimmer & Schwarz

**Synthetic Ester Selection for
High-Performance Industrial Lubricants
and Metalworking Fluids**

lexolube
synthetic esters

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UNITI- 2023





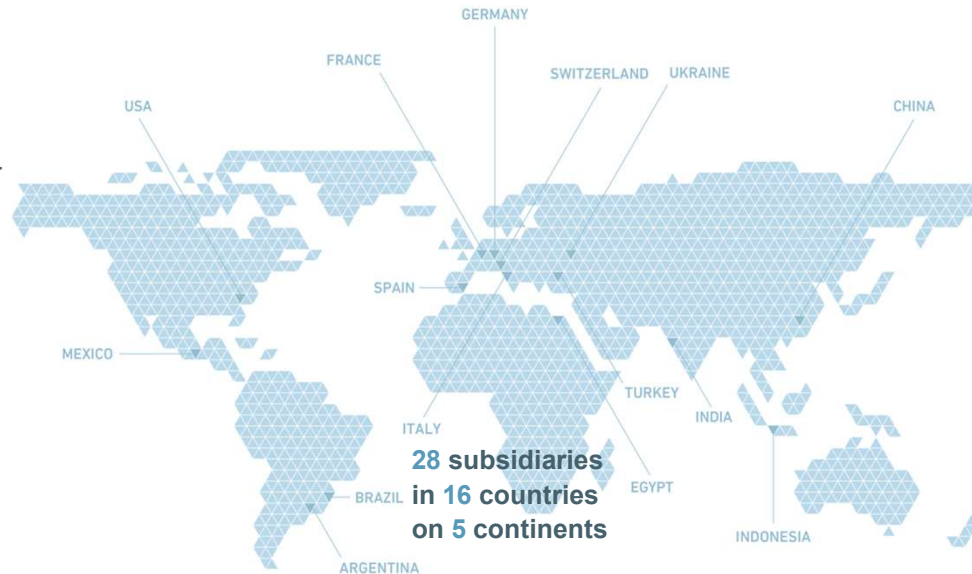
ZSCHIMMER & SCHWARZ



Zschimmer & Schwarz – Company Profile

Key figures 2022

	Turnover	€M 834
	Number of employees	1,568



- ▼ Ceramic Auxiliaries
- ▼ Leather Auxiliaries
- ▼ Textile Auxiliaries
- ▼ Fibre Auxiliaries
- ▼ Personal Care
- ▼ Cleaning Specialties
- ▼ Industrial Specialties
- ▼ Paints & Coatings
- ▼ Lubricants



1894

Foundation of the company in Chemnitz, Germany

First in-house production

1909



1959 - 2019

New company headquarters in Oberlahnstein & Rapid growth and increasing globalisation



125th anniversary and construction of new company headquarters

2019



2020

Restructuring of business divisions



What are synthetics?

- ▶ Synthetic is a marketing term that signifies higher performance and generally denotes the base oil is made by chemical synthesis
- ▶ The American Petroleum Institute (API) defines 4 categories of hydrocarbons used in lubricants

	Base Oil Category	Sulfur [%]		Saturates [%]	Viscosity Index	Total Production [%]	Relative Cost
<div> <div>Synthetic</div> <div>Mineral</div> </div>	Group I (solvent refined)	> 0.03	and/or	< 90	80 to 120	46	1
	Group II (hydrotreated)	< 0.03	and	> 90	80 to 120	47	1.05
	Group III (hydrocracked)	< 0.03	and	> 90	> 120	3	1.5
	Group IV	PAO Synthetic Lubricants				2	2.5 to 3
	Group V	All other base oils not included in Groups I, II, III or IV				1.6	5 to 10+

From: <https://www.machinerylubrication.com/Read/618/new-lubes>



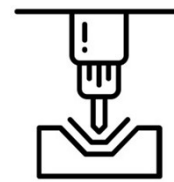
Base Stock or Lubricity Additive

Does the application require performance that a petroleum oil cannot deliver?



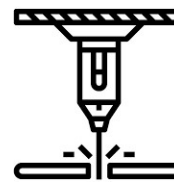
- Biogenic content
- EcoLabel compliance
- Biodegradability
- VGP/VIDA aquatic safety
- Incidental Food Contact
- Fire resistance
- High VI for energy efficiency

Is friction reduction required as part of the antiwear and extreme pressure additive package?



— Metal Forming

- Rolling
- Stamping



— Metal Removal

- Cutting
- Grinding



Esters are unique

- ▶ The ester bond structure links an organic acid and alcohol
 - Very good control of the molecular structure
- ▶ Many starting materials available - many possible combinations
- ▶ Permanent dipole moment of 1.7 Debye
 - More polar than hydrocarbons
- ▶ Choose the feedstocks based on the demands of the application
- ▶ Esters are designed to be fit for purpose



Huge Solution Space

Space		Valeric Acid Heptanoic Acid Pelargonic Acid Isononanoic Acid Caprylic-Capric Acid Lauric Acid Palmitic Acid Coconut Fatty Acid Topped Palm Kernel FA Oleic Acid Isostearic Acid Stearic Acid Adipic Acid Sebacic Acid Azelaic Acid Dimer Acid Phthalic Acid Terephthalic Acid Trimellitic Acid Pyromellitic Acid																			
		Monoacids												Diacids				Aromatic Acids			
Methanol	Monoalcohols	1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	321	341	361	381
Ethanol		2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	322	342	362	382
Propanol		3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	323	343	363	383
Butanol		4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	324	344	364	384
Octyl-Decylalcohol		5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	325	345	365	385
Isobutanol		6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	326	346	366	386
2-Ethylhexanol		7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	327	347	367	387
2-Propylheptanol		8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	328	348	368	388
Isotridecanol		9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	329	349	369	389
Dodecanol		10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	330	350	370	390
Neopentylglycol	Di- and Polyfunctional Alcohols	11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	331	351	371	391
Trimethylolpropane		12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	332	352	372	392
Pentaerithrytol		13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	333	353	373	393
Dipentaerythrytol		14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	334	354	374	394
Glycerine		15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	335	355	375	395
Diglycerine		16	36	56	76	96	116	136	156	176	196	216	236	256	276	296	316	336	356	376	396
Sorbitol		17	37	57	77	97	117	137	157	177	197	217	237	257	277	297	317	337	357	377	397
Ethylene Glycol		18	38	58	78	98	118	138	158	178	198	218	238	258	278	298	318	338	358	378	398
Propylene Glycol		19	39	59	79	99	119	139	159	179	199	219	239	259	279	299	319	339	359	379	399
Hexanediol		20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400



Monoesters



- **60 – 90% renewable carbon**



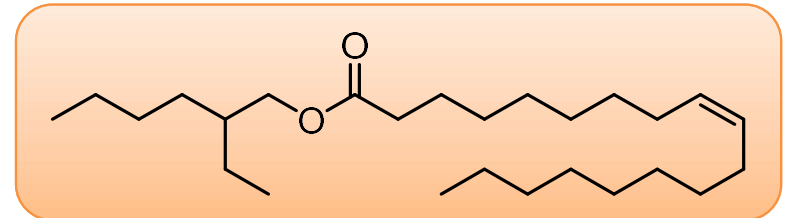
- **biodegradable**



- **Low viscosity**



- **Low odor and colour**
- **Excellent lubricity**
- **Environmentally and Worker friendly**



Typically made from natural fatty acids and mono-alcohols



- **Metalworking**
- **Textile lubricants**
- **Aerosol products**
- **Adjuvants**
- **Biobased lubricants**
- **HX1 grades available**



Diesters



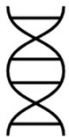
- Typically no biobased content



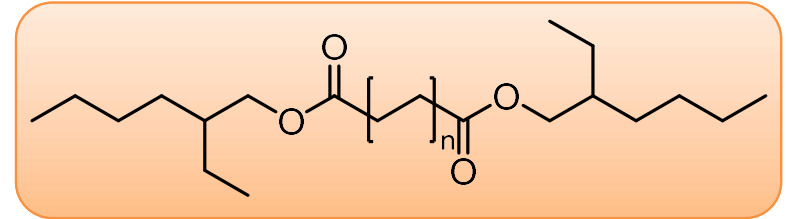
- biodegradable



- Low viscosity
(2-5 cSt at 100°C, ISO VG 10-22)



- Low volatility
- Excellent cold flow, wide temp. range
- Oxidative stability



Two ester groups derived from
dibasic acid + alcohols



- Engine oils
- Compressors oils
- Hydraulic fluids
- Grease
- Bearings
- Seal swell additives



Polyol esters



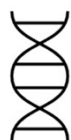
- many are biobased



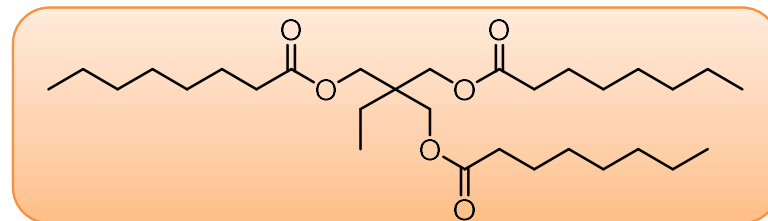
- biodegradable



- higher viscosity
(2-25 cSt at 100°C, ISO VG 15-320)



- Low volatility
- High Flashpoint
- Oxidative stability



Stabilized at the β -carbon



- Compressor oil
- Fire resistant hydraulic fluids
- Oven Chain oils
- Aviation turbine engine oils
- Gear oils
- HX-1 products available



Complex esters



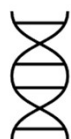
- **Can be biobased**



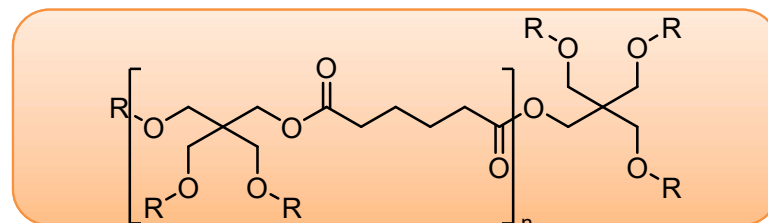
- **Can be biodegradable**



- **Very high viscosity possible**



- **Low volatility/High Flashpoint**
- **High Viscosity Index**
- **Antiwear/Extreme pressure**



Capped polymeric ester



- **Compressor oil**
- **Gear oils**
- **Grease**
- **Thickening**
- **Metal protection**
- **HX-1 products available**



Aromatic esters



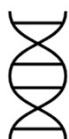
- **Not biobased**



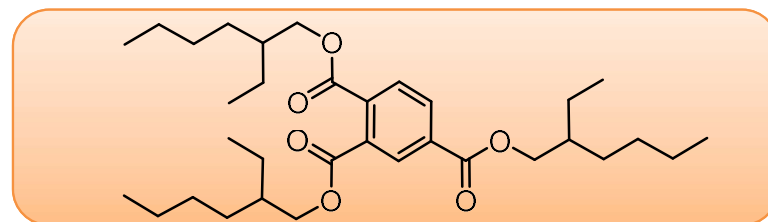
- **Can be biodegradable**



- **High viscosity**



- **Low volatility/High Flashpoint**
- **Reduced varnish deposits**
- **Stable against oxidation & hydrolysis**



Made from aromatic anhydrides
and mono-alcohols

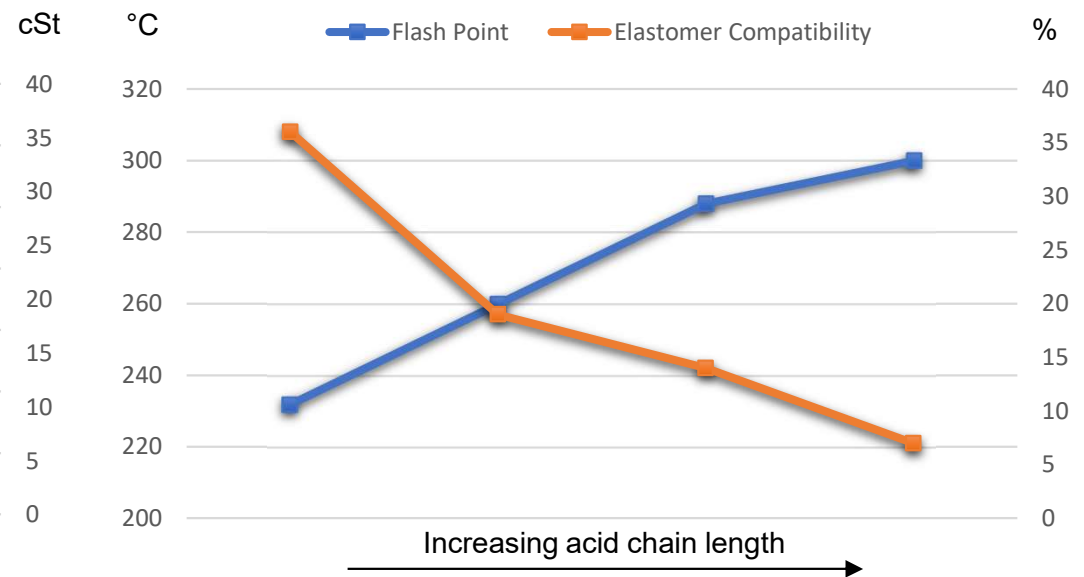
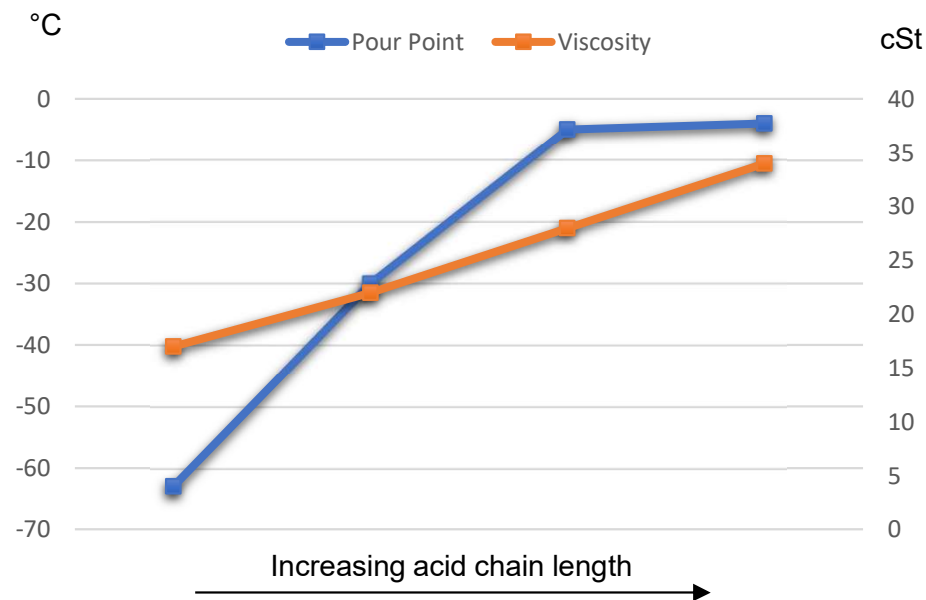


- **Compressor oil**
- **Gear oils**
- **Grease**
- **Oven chain lubricants**
- **Plasticizers**



Not always synergistic effects

► There is not the one fits all solution...



... properties need to be balanced to the intended application



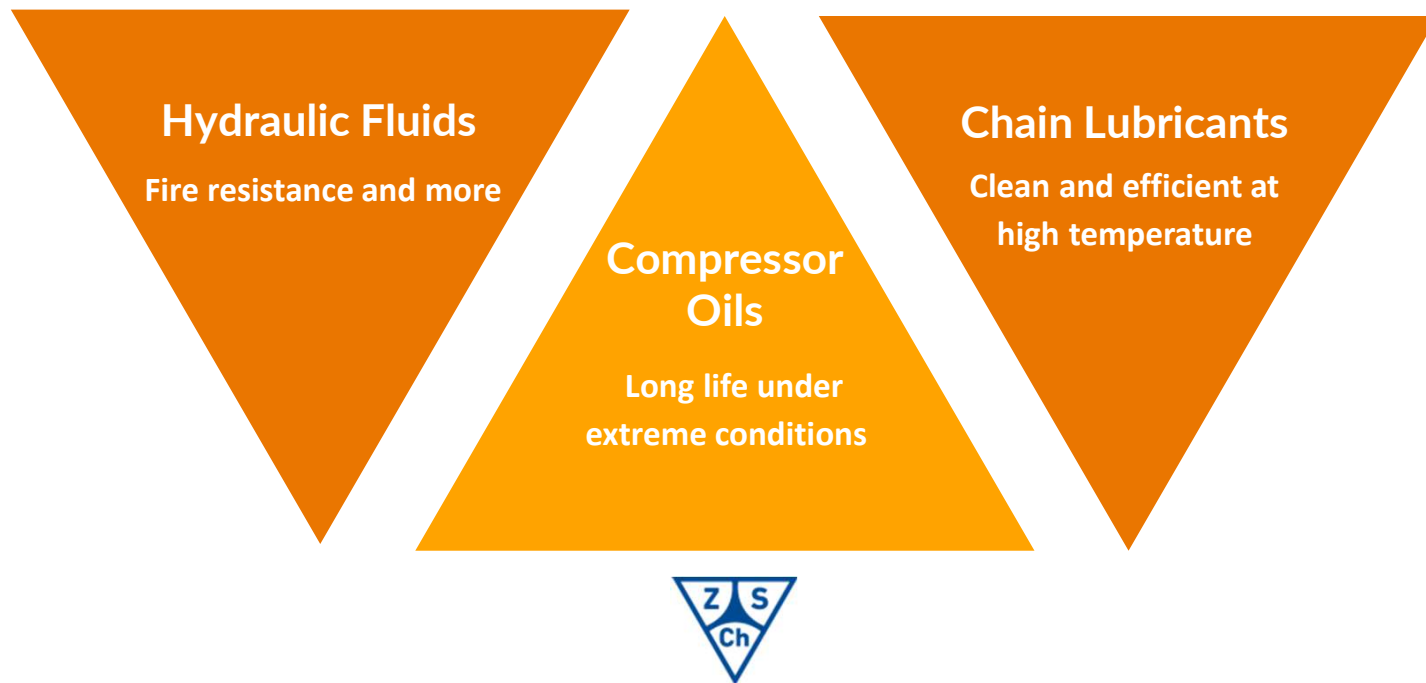
Esters are used to formulate the highest performance fluids

- ▶ Hydraulic fluids
- ▶ Oven chain oils
- ▶ Grease
- ▶ Compressor fluids
- ▶ Transformer oils
- ▶ Metalworking fluids
- ▶ Environmentally sensitive applications
- ▶ Engine oils
- ▶ Transmission fluids
- ▶ Gear oils
- ▶ Drilling mud lubricants
- ▶ H1 Food Grade lubes
- ▶ Fiber finish lubricants
- ▶ Jet turbine engines
- ▶ Dielectric Coolants



Designed for Diverse Applications

- ▶ Synthetic Esters can be designed to perform under the specific conditions the application demands
- ▶ Work with an expert to make sure you have the right tailor-made ester for the job



Hydraulic Fluids

- ▶ **Low sludge - clean, long life**
- ▶ **High viscosity index - energy efficient**
- ▶ **Environmentally friendly**
- ▶ **Marine (VGP/VIDA), mining, forestry, agriculture**
 - Biobased, biodegradable esters
- ▶ **Fire Resistant- FM Approved/HFD**
 - Polyol ester oleates
- ▶ **Food processing plants**
 - NSF H1 Polyol ester-based fluids



Performance under
pressure

Hydraulic Fluids

Ester based HF ISO 46	ASTM	Typical
Flash point	D-92	320°C
Fire point	D-92	360°C
Pour point	D-97	-40°C
Viscosity index	D-2270	210
FZG gear test	D-5182	Stage 12
Vane Pump Test	D-2882	<5 mg wear
Copper Corrosion	D-130	1a
Rust prevention A/B	D-665	Pass
Biodegradability (OECD)	301B	Readily

Data courtesy Zschimmer & Schwarz



High performance,
Factory Mutual fire resistant,
Environmentally friendly,
H1 (Use in food plants)



Photo courtesy US Navy

Compressor Lubricants

- ▶ **Low volatility - less lubricant carryover**
- ▶ **Low varnish - no sticking valves or deposits**
- ▶ **Compatibility with HFC refrigerants**
- ▶ **Reciprocating and rotary vane compressors**
 - Diesters for lubricity and solvency
- ▶ **Rotary screw and centrifugal compressors**
 - Polyol esters for oxidation stability
- ▶ **Food processing applications**
 - NSF H1 polyol ester-based fluids

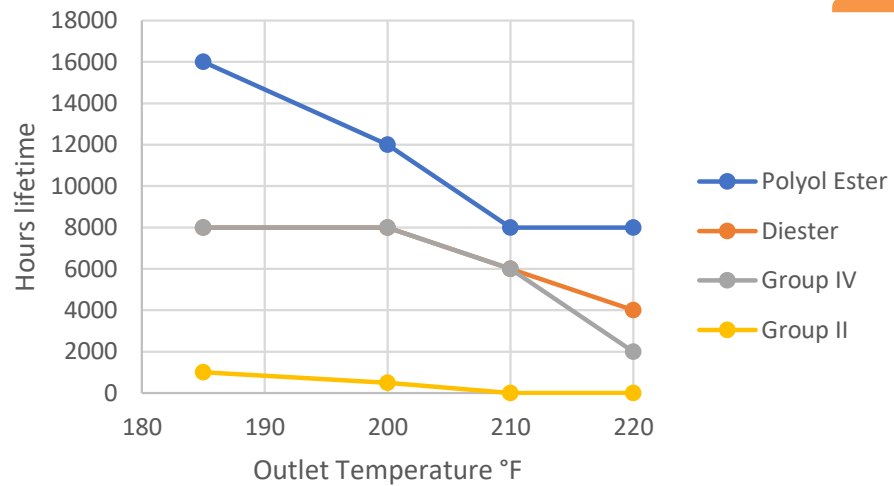


Reliability and long life



Compressor Lubricants

Lubricant Life Based on Temperature



Graph courtesy Ray Thibault, Consultant

2X

Polyol Esters can give double the life of other synthetics in compressor applications

20 hours at 260°C/500°F

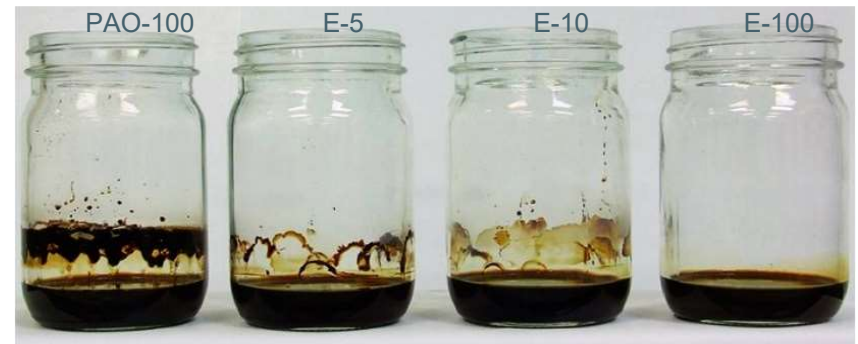


Photo courtesy Zschimmer & Schwarz



Oven Chain Lubricants

- ▶ **Low volatility- long relubrication intervals**
- ▶ **Low varnish- links move freely**
- ▶ **Surface lubrication- thin film wear prevention**
- ▶ **Industrial oven chains**
 - POE/aromatic esters optimum clean
- ▶ **Bakery tunnel ovens**
 - H1 POE for clean and safe lubrication
- ▶ **Food conveyors**
 - Biobased H1 POE- synthetic vegetable oil



Clean lubrication above
250°C



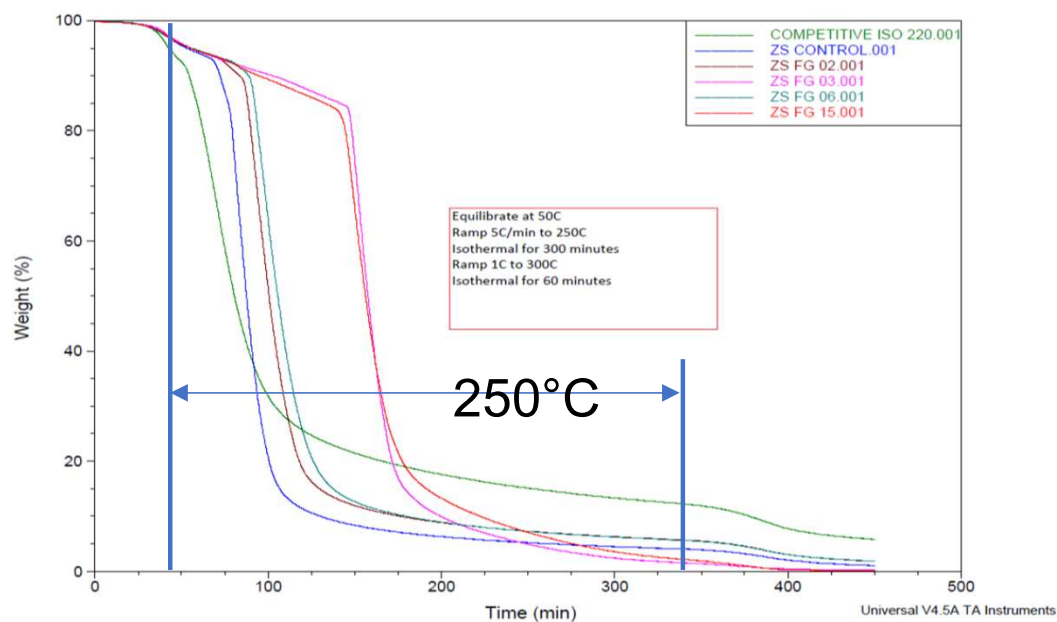
Oven Chain Lubricants

200°C+ Esters are the best option for high temperature chains

89 hours at 240°C/464°F



TGA Isothermal 6 hours at 250°C



Environmentally acceptable lubricants (EAL)

- ▶ Synthetic Esters are environmentally friendly
 - Marine
 - Mining
 - Forestry
 - Agriculture
 - Transformers
 - Wind turbines
- ▶ Performance is as good or better than petroleum oils

- ▶ Most esters meet USA EPA Marine (VGP) Vessel General Permit standards



- ▶ Many esters are renewable, sustainable, and have USDA BioPreferred status

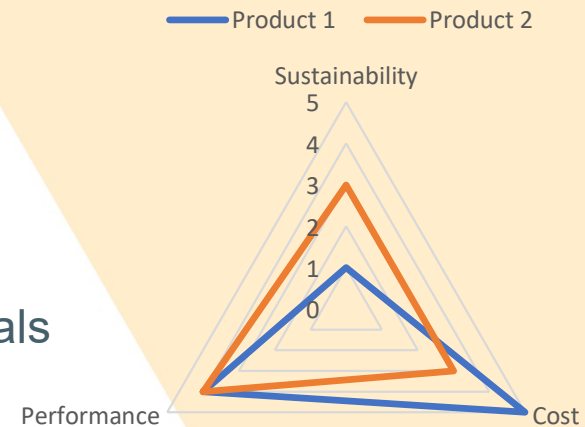


- ▶ Wide variety of synthetic esters on LuSC list achieve EU Ecolabel status



Synthetic Ester Design Considerations

- ▶ Determine critical application performance requirements
 - **Low cost** – Oleates, natural fatty acids, commodity raw materials
 - **High viscosity** – Dipentaerythritol, complex esters
 - **High viscosity index** – Linear structures, long chain fatty acids
 - **Thermal stability** – Polyols, branched acids, fully saturated components
 - **Biodegradability** – Natural fatty acids, less branching
 - **Food contact** – Ingredients with detailed information on toxicity, NSF listed
- ▶ Build the ester from components that will give the desired properties



Thank you.

For More Information Visit:

ZSLubes.com

zschimmer-schwarz.com



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