

VOC ASSESSMENT OF SYNTHETIC ESTER FLUIDS

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THREE OBJECTIVES

- Present data on VOC of synthetic esters
- Present chemical safety and environmental information on synthetic esters
- Briefly discuss the effectiveness and performance expectations of synthetic esters in metalworking fluids and lubricants

WHAT ARE SYNTHETIC ESTERS?

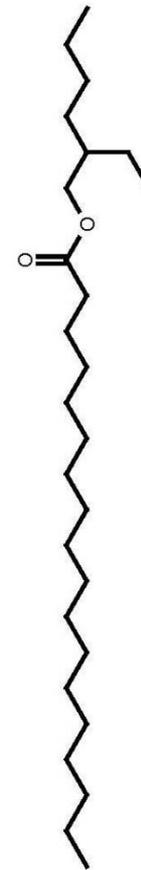
- ◉ Synthesized from organic alcohols and carboxylic acids by esterification
- ◉ Infinite possible combinations
- ◉ Esters designed to suit the application
- ◉ Mr. Potato Head
- ◉ Esters are worker friendly
- ◉ Ester groups tend to reduce volatility
- ◉ API Group V base oils

GENERAL SYNTHETIC ESTER TYPES

- Fatty acid esters
- Diesters
- Polyol esters
- Complex esters

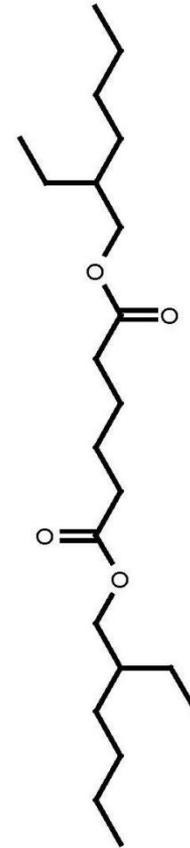
FATTY ACID ESTERS

- ◉ Acid portion comes from natural oils
- ◉ 60-90% renewable chemistry
- ◉ Commonly used in metalworking
- ◉ Viscosity ISO 5 to 15
- ◉ Isopropyl palmitate (IP 16)
- ◉ Isopropyl oleate (IP 18u)
- ◉ Normal butyl stearate (NB 18)
- ◉ Ethylhexyl palmitate (EH 16)
- ◉ Tridecyl stearate (TD 18)



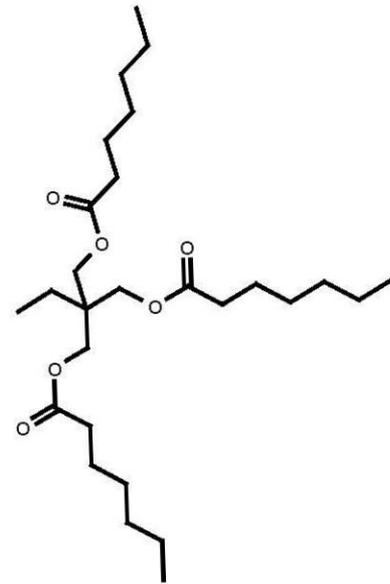
DIESTERS

- ◉ Typically diacid esters
- ◉ Phthalates and adipates
- ◉ Non-volatile solvents/plasticizers
- ◉ Low pour point -60°C
- ◉ Improved oxidative stability
- ◉ Viscosity ISO 7 to 32
- ◉ Ditridecyl adipate (diTDA)



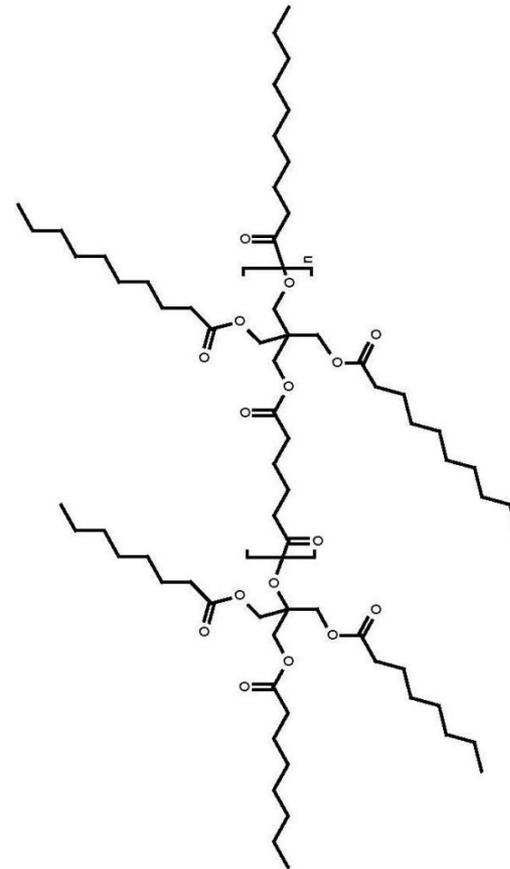
POLYOL ESTERS

- ◉ Three or more ester groups
- ◉ Outstanding oxidative stability
- ◉ Viscosity ISO 15 to 320
- ◉ Trimethylolpropane caprylate caprate (TMP 8-10)
- ◉ Trimethylolpropane oleate (TMP 18u)
- ◉ Dipentaerythritol mixed C5-10 (DPE 5-10)



COMPLEX POLYOL ESTERS

- ⦿ Capped polymeric ester
- ⦿ Structure leads to high VI
- ⦿ Additive providing tack and boundary lubrication
- ⦿ Viscosity ISO 68 to 3200+
- ⦿ Chose to evaluate lowest viscosity member
- ⦿ Complex Ester ISO 68 (68 CPE)



VOC METHODOLOGY

- Contracted with Edison Labs in New York to do the VOC assessment according to ASTM E1868-10 under conditions specified by SCAQMD Rule 1144
- Expect VOC to be related to number of carbons and number of ester groups similar to viscosity
- Expect some correlation with flash point

VOC RESULTS

Synthetic Ester	Viscosity 40 °C	Flash Point	Specific Gravity	VOC
IP 16	5 cSt	165 °C	0.85 at 25 °C	38 g/L
IP 18u	5	175	0.85	24
NB 18	6	195	0.85	7
EH 16	9	220	0.86	1
TD 18	17	230	0.86	5
Di TDA	27	240	0.91	2
TMP 8-10	19	250	0.94	<1
TMP 18u	49	320	0.91	<1
DPE 5-10	68	290	0.99	<1
68 CPE	68	290	0.98	<1

HSE METHODOLOGY

- ◉ Renewable carbons come from natural oils
- ◉ Synthetic feedstocks provide higher stability
- ◉ Biodegradability tested by OECD 301B (Modified Sturm Method)
- ◉ Acute oral toxicity (LD 50) results mostly found no negative effects and are reported as “greater than”

EWG EXPLANATION

- ◉ The Environmental Working Group sponsors the Skin Deep Cosmetics Database
- ◉ Many synthetic esters are included because they are used in cosmetics
- ◉ Grading scheme 0 to 10 with 0 being the safest
- ◉ Grade based on published data concerning acute and chronic toxicity, environmental effects, and physical hazards
- ◉ Online database at www.ewg.org

HSE RESULTS

Synthetic Ester	Renewable carbon	Bio-degradability	LD 50	EWG grade (0-10 scale)
IP 16	84%	Readily (>70%)	64 g/kg (6.4%)	0
IP 18u	86	Readily	Nd	0
NB 18	82	Readily	>32	0-1
EH 16	67	85%	>5	0-1
TD 18	58	Readily	Nd	0
Di TDA	0	58.5	16	1
TMP 8-10	82	65.5	>5	-
TMP 18u	90	80.7	Nd	-
DPE 5-10	0	47.1	>5	0
68 CPE	50	84.8	>2	-

SYNTHETIC ESTERS IN INDUSTRY

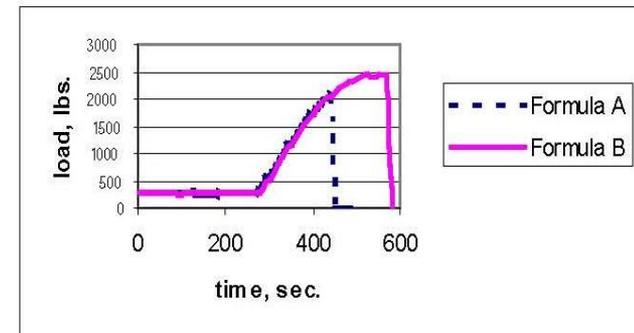
- Metalworking
 - Soluble oils
 - Straight oils
- Textile lubricants
- Hydraulic fluids
- Compressor/turbine oils
- Automotive
- Gear and chain lubricants
- Grease
- Cosmetics
- Lubricity
- Boundary film formation
- Worker friendly
- High flash point
- Additive solubility
- Extended fluid life
- Solvency/ cleanliness
- High temperature stability
- Low VOC

Applications

Benefits

PERFORMANCE IN SOLUBLE OILS

Formula	A (no ester)	B (ester)
Add Pack	60	60 (same)
Naphthenic 100 SUS	20	15
EH 16	0	2.5
460 CPE	0	2.5
Water	20	20
Dilution	20:1	20:1
D 3233A failure load	3,000 lbs	4,000 lbs
Failure	Pin breaks	Wear
Appearance	Severe weld	Striations



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 - Contact thousel@inolex.com (www.inolex.com)
- Edison Analytical Labs of Latham, NY
 - Generated VOC data by Rule 1144 protocol
- American Chemistry Council High Production Volume (HPV) Chemical Challenge Program
 - Primary source for biodegradability and LD 50 data