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These days, equipment is running faster and hotter than ever to meet productivity demands—*and higher performance lubricants are required to meet these demands*. Synthetics offer that level of performance.

Synthetics aren't new; they've been around for 70 years. Esters were used in WWII by both Germany and the U.S. to keep equipment running under harsh conditions. Only in the last 20 years, however, have end users throughout industry really recognized the cost benefits of synthetics. Now, more and more uses are being found for these formulations and they are experiencing significantly high growth rates.

Synthetics are formulated by combining low molecular-weight materials in a chemical reaction to produce higher molecular-weight materials. These reactions are controlled to produce products with uniform consistency and targeted performance properties. Mineral-based lubricants don't exhibit the consistency and uniformity that synthetics exhibit, nor do they have the performance properties.

Synthetic classifications There are many types of synthetic fluids. Within the scope of this particular article, we will deal with the most common.

Synthetics are classified into the following major groups:

- Synthetic Hydrocarbons
- Polyalphaolefins (PAO)
- Alkylated Aromatics
- Polybutenes

- Esters
- Diesters
- Polyol Esters
- Phosphate Esters

- Others
- Polyglycols
- Silicones

PAOs are the largest synthetic group, followed by esters and PAGs. Most of the discussion will focus on these three synthetic types.

Fig. 1. Overall advantages of synthetics as a class. Not all synthetics have all of these advantages, and some have more than others.

Fig. 2. Some disadvantages of synthetics as a class

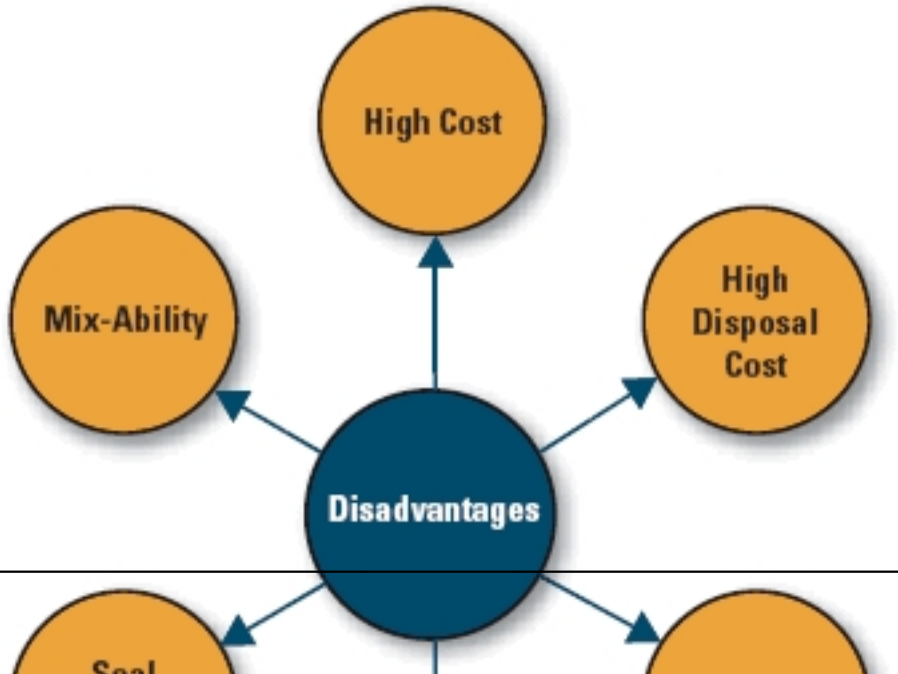

Table I. High- & Low-Temperature Capabilities of Synthetics

Synthetic Type	Effective Temperature Range
Polyalphaolefins (PAO)	-65 F to 300 F
Polyalkylene Glycol (PAG)	-30 F to 400 F
Diester	-50 F to 300 F
Polyol Ester	-40 F to 425 F
Mineral Oil	-15 F to 200 F

Table II. Some Typical Viscosity Grades

Viscosity,cSt				
100 C	4cSt	6cSt	8cSt	100cSt
40 C	18cSt	31cSt	46cSt	1400cSt

$$1\text{-}C_{10} \xrightarrow[\text{Catalyst A}]{} C_{20} + C_{30} \cdots + C_{60} \xrightarrow[\text{Catalyst B}]{} C_{20} + C_{30} \cdots + C_{60}$$

$$\text{Dibasic Acid} + \text{Mono-functional Alcohol} \rightleftharpoons \text{Diester} + \text{Water}$$

Table III. Ethylene Oxide/Propylene Oxide Ratio & Properties

100% EO	75/25	60/40	50/50	100% PO
Totally water soluble Used in metalworking Highest pour point	High water solubility Thickening agent for water glycol fluids	Low gas solubility Used in flooded screw compressors	Most common grade High VI Used as gear lubricants Hyper compressors	Oil soluble Used in air compressors Anhydrous hydraulic fluids Lowest pour point

Table IV. Strengths & Weaknesses Of Several Major Synthetics

Base Stock	Strengths	Weaknesses
Mineral Oil	Cost and availability	High and low temperature properties
Polyalphaolefin	Wide operating temperature range	Additive solubility and lubricity Need to be blended with ester
Diester	Solvency and detergency Lubricity and biodegradability	Seal and paint compatibility
Polyol Ester	Thermal and oxidative stability Lubricity and biodegradability	High cost
Polyalkylene Glycol	Water versatility Low hydrocarbon solubility High VI No deposit formation	Compatibility with mineral oil and other synthetics Paint compatibility

Key properties

[illegible] functional alcohol with a

Neo Alcohol + Carboxylic Acid ⇌ Ester + Water

[illegible] which results in the following key properties:

[illegible] which allows for a wide variance

Ethylene oxide + Initiator (water or alcohol)
Propylene oxide → Polyalkylene Glycol

[illegible]

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