

## IB007. SYNTHETIC OILS

*“ To maximize the value from using a higher-priced synthetic oil, the user must always ensure that he is utilizing the potential improved performance of the synthetic products by understanding the conditions that allow the synthetic products to provide that value. ”*

Opt-Max lubricants are engineered blends of base oil and additives. The base oils can be classified under five different API groups. The first three groups are refined from petroleum crude oil which are named as Mineral base oils. Group IV base oils are full synthetic (polyalphaolefin) oils whereas Group V is for all other base oils not included in Groups I through IV.

**API Base Oil Categories**

	<b>Base Oil Category</b>	<b>Sulfur (%)</b>		<b>Saturates (%)</b>	<b>Viscosity Index</b>
Mineral Base Oil	Group 1 (solvent refined)	>0.03	and/or	<90	80 to 120
	Group II (hydro-treated)	<0.03	and	>90	80 to 120
	Group III (hydrocracked)	<0.03	and	>90	>120
Synthetic Base Oil	Group IV	PAO Synthetic Lubricants			
	Group V	All other base oils not included in Group I,II,III or IV			

## Mineral base oils

Mineral base oils are mixtures of a wide range of hydrocarbons that can be derived from solvent refining, hydrocracking and distillation processes.

The three basic classes of refined mineral oils are:

- Paraffinic oils, based on n-alkanes
- Naphthenic oils, based on cycloalkanes
- Aromatic oils, based on aromatic hydrocarbons

Mineral base oil based lubricants make up the majority of the commercially available lubricants in the marketplace today considering their value and performance when it comes to meeting the typical operating conditions.

## Synthetic base oils

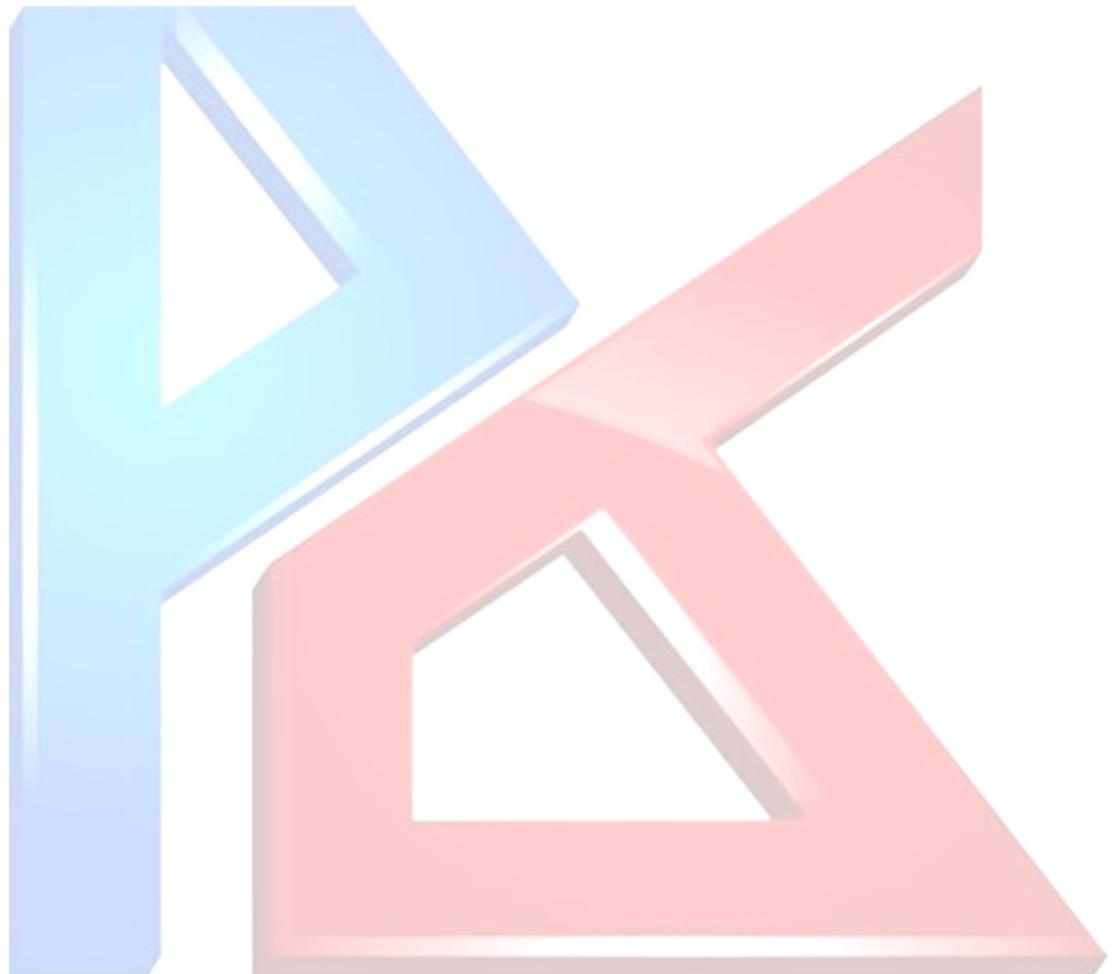
Contrary to mineral base oils, synthetic base oils are artificially made (synthesized). They are synthesized from hydrocarbon intermediates or other kind of raw material. The synthetic base oils have a controlled molecular structure and therefore predictable properties. They can offer enhanced characteristics such as a much broader operating temperature range, that can be used for specific conditions where mineral-oil based lubricants might not be suitable.

### Synthetic Base Oils Properties:

Synthetic base oils	Properties	Disadvantages	Applications
<b>Polyalphaolefins (PAO)</b>	<ul style="list-style-type: none"><li>• Similar to pure hydrocarbons of branched paraffins</li><li>• High Viscosity Index (above 135°C)</li><li>• Excellent low temperature fluidity</li><li>• Very low pour point (-40°F)</li><li>• Excellent shear resistance</li><li>• Good oxidation and thermal stability</li><li>• Low Volatility</li><li>• Excellent hydrolytic stability</li></ul>	<ul style="list-style-type: none"><li>• Limited additive miscibility</li><li>• Require suitable anti-oxidant additives to resist oxidation</li><li>• Tend to shrink rubber seals and hoses</li><li>• Limited properties on boundary lubrication</li></ul>	<ul style="list-style-type: none"><li>• Engine Oils</li><li>• Automotive Gear Oils</li><li>• Industrial Gear and Bearing Oils</li><li>• Hydraulic Fluids</li><li>• Wide temperature range and severe application greases</li></ul>

Synthetic base oils	Properties	Disadvantages	Applications
<b>Phosphate Esters</b>	<ul style="list-style-type: none"> <li>• Good thermal stability</li> <li>• Excellent fire resistance</li> <li>• Low volatility</li> <li>• Pour Point ranges from -25° C to -5°C</li> <li>• Excellent boundary lubrication properties</li> </ul>	<ul style="list-style-type: none"> <li>• Low viscosity index (VI) from 60°C to -30°C</li> <li>• Limited capabilities at high temperature</li> <li>• Poor compatibility with mineral oils</li> <li>• Corrosive decomposition by products</li> </ul>	<ul style="list-style-type: none"> <li>• Fire-resistant hydraulic fluids on marine vessels, aircraft, power plants and etc.</li> <li>• Can be used as turbine bearing lubrication systems</li> <li>• Can be used as wear and friction reducing additives in greases</li> </ul>
<b>Diesters and Polyol esters</b>	<ul style="list-style-type: none"> <li>• High viscosity index (VI)</li> <li>• Non toxic</li> <li>• Good low temperature properties</li> <li>• Fast biodegradable</li> <li>• Unlimited miscibility with mineral oils</li> </ul>	<ul style="list-style-type: none"> <li>• Low viscosities</li> <li>• Limited seal compatibility</li> <li>• Bad hydrolytic stability</li> <li>• Paint compatibility</li> </ul>	<ul style="list-style-type: none"> <li>• Compressor oils</li> <li>• Refrigeration oils</li> <li>• Construction industry</li> <li>• Metal industry</li> <li>• Forestry</li> </ul>
<b>Polyphenyl Ethers</b>	<ul style="list-style-type: none"> <li>• High thermal</li> <li>• High radiation stability</li> <li>• Oxidative stability</li> <li>• High chemical stability</li> <li>• High hydrolytical stability</li> </ul>	<ul style="list-style-type: none"> <li>• Low Viscosity Index (negative)</li> <li>• Moderate seal compatibility</li> <li>• Paint compatibility</li> <li>• Poor cold-flow temperatures</li> </ul>	<ul style="list-style-type: none"> <li>• Ultra-high temperature air and spacecraft applications</li> <li>• Nuclear reactor lubes</li> </ul>
<b>Polyalkylene Glycols</b>	<ul style="list-style-type: none"> <li>• High Viscosity Index (VI)</li> <li>• Excellent Lubricity</li> <li>• Fast biodegradable</li> <li>• Non toxic</li> <li>• Water Soluble</li> </ul>	<ul style="list-style-type: none"> <li>• Marginally miscible with additives</li> <li>• Not miscible with mineral oils</li> <li>• Limited seal compatibility</li> <li>• Paint compatibility</li> </ul>	<ul style="list-style-type: none"> <li>• Fire resistant hydraulic fluids in marine applications, factories and mining</li> </ul>

Synthetic base oils	Properties	Disadvantages	Applications
<b>Fluorocarbons</b>	<ul style="list-style-type: none"> <li>• High chemical stability</li> <li>• Extreme temperature range</li> <li>• High radiation stability</li> <li>• Oxidative stability</li> <li>• Fire resistant</li> <li>• Good seal/paint compatibility</li> </ul>	<ul style="list-style-type: none"> <li>• Low Viscosity Index (VI)</li> <li>• Moderate corrosion protection</li> <li>• Not miscible with mineral oils, additives</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme fire-resistant hydraulic fluids such as nuclear reactors lubricants and military aircraft</li> </ul>
<b>Silicones</b>	<ul style="list-style-type: none"> <li>• High Viscosity Index (VI)</li> <li>• High thermal</li> <li>• Oxidative stability</li> <li>• High chemical stability</li> <li>• Good electrical properties</li> <li>• Excellent seal compatibility</li> </ul>	<ul style="list-style-type: none"> <li>• Poor mixed and boundary film lubrication properties</li> <li>• Not miscible with mineral oils, additives</li> </ul>	<ul style="list-style-type: none"> <li>• High temperature hydraulic fluids</li> </ul>



## When to Choose a Synthetic Products?

### Advantages & Disadvantages of Synthetic Products:

	PROPERTIES	PROPERTY'S FUNCTION
<b>POSSIBLE ADVANTAGES</b>	Higher flash point	Improved fire resistance and thermal stability
	Lower pour point	Improved low temperature pump ability/lubrication
	Oxidation stability	Extended oil drains, resists severe conditions
	High viscosity index	Functions as a multi-grade oil
	Fire resistance	Good for high-risk hydraulic applications
	Lower friction	Reduced energy consumption costs
	Natural detergency	Helps keep surfaces clean of deposits
	Thermal stability	Oil doesn't degrade or thicken at high temperatures
	High shear strength	No viscosity thinning unlike multi-grade mineral oils
<b>POSSIBLE DISADVANTAGES</b>	Higher cost	Synthetic can cost 4 to 15 times more than mineral oils
	Mixability	Sine are unmixable with other fluids (incompatible)
	Toxicity	Phosphate esters may be a toxicity risk
	Hazardous disposal	Phosphate esters are costly to dispose off
	Hydrolytic stability	Ester base synthetic may degrade in the presence of water
	Seal compatibility	Some seals may shrink or swell with synthetics

Both mineral and synthetic type lubricants had their own properties and functions, thus it is important for the end-user to select the most suitable type of lubricants to deliver the best lubricating solution at the most appropriate value.

Below is a simple guide to determine when to choose a synthetic products for an application.

- When equipment-performance requirements exceed the capabilities of mineral-based fluid
- When synthetic oil properties can become problem-solvers
- When life-cycle cost savings can be realized
- When safety and environmental issues can be enhanced