

## Refined Base Oils Versus Synthesized Base Oils

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To understand the difference in synthetic hydrocarbon (PAO) base stocks and petroleum (Group I, Group II, Group III) base stocks you have to focus on the structure of the molecules and their effect on the lubricant:

### **Good Actors**

Saturated branched paraffins – long life, high viscosity index, low pour point

### **Bad Actors**

Nitrogen, Sulfur, Chlorine – reduces the life of the oil

Aromatics – reduces the life of the oil

Naphthenics – reduces the life of the oil

Unsaturated paraffins – reduces the life of the oil

Long chain paraffins – high pour point

**Synthetic Hydrocarbon (PAO)** – These lubricant base stocks are 100% synthesized molecules resulting in all saturated branched paraffins (good actors). This means that the content of bad actors listed above is absolutely zero.

**Group I Petroleum** – As crude oil contains all of the above listed good and bad actors, the purpose of refining is to remove as much of the bad actors as possible or convert them to good actors. Group I refining typically removes a large portion of impurities (nitrogen, sulfur, chlorine) as well as a significant amount of aromatics and long chain paraffins. The base stock, however, can still have the following typical values:

Impurities	5000 ppm
Aromatics	30%
Napthenics	30%

Unsaturated paraffins and long chain paraffins are also still present. The Group I base stocks are typical of petroleum oil base stocks that have been used for a number of years.

**Group II Petroleum** – The refining process used to produce Group II base stocks typically include reactions with hydrogen to remove the impurities and aromatics. The final base stocks are virtually free of impurities (resulting in a colorless appearance) as well as unsaturated paraffins and aromatics but still contain about 30% naphthenics that can reduce the life of the oil. A conversion process also removes some of the long chain paraffins but enough remain to keep the pour point well above a synthetic hydrocarbon. Note that these products are made using a combination of refining and conversion processes, as opposed to total synthesis.

**Group III Petroleum** – Finally, Group III refining includes a process to remove about half of the remaining naphthenics. Of the original bad actors, about 17% of the naphthenics and a significant amount of long chain paraffins remain. This can keep the life expectancy and pour point from meeting the properties of the synthetic hydrocarbon (PAO). While some of the Group III base stocks are marketed as “synthetics”, the combination of refining and conversion used in the manufacture of these products differentiate them from the strict definition typically used in the industry when describing synthetic hydrocarbons.

In summary, the goal of petroleum base stocks has been and continues to be to match the performance properties of synthetics. While the manufacturing techniques for petroleum base stocks have resulted in enhanced performance, there are still enough “bad actors” remaining in the base stock to keep them from duplicating the properties of a “true” synthetic.