

What is the difference between synthetic and conventional oil?

Oil, whether synthetic or petroleum-based, consists of molecular chains of hydrogen and carbon atoms, referred to as hydrocarbons. Petroleum crude oil is a thick, highly flammable dark-brown or greenish liquid with high energy densities. Many contaminating elements exist in this complex mixture of hydrocarbons, including sulfur, nitrogen, oxygen and metal components such as nickel or vanadium. Petroleum crude oil is the raw material used for a wide variety of petrochemicals, including solvents, fertilizers, plastics and lubricants.

The oil refining process separates the various types of molecules in the oil by weight, resulting in a concentrated batch suitable for today's uses such as gasoline, LPG, kerosene or base oils for lubricants. The chemical composition of conventional motor oil can vary substantially and depends on the raw crude oil refining process.

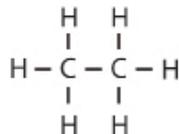
While petroleum base oils are refined, synthetic base oils are manufactured and can achieve a higher performance level. Synthetic oil is chemically engineered for a certain molecular composition with a tailored and uniform structure. Such fine-tuned control over the final molecular composition of synthetic oils is the key to the superior performance properties of these fluids. Designing molecular structures in a planned and orderly fashion results in molecules, and an end-product, that are far more stable than their refined petroleum counterparts.

Base Oil Groups

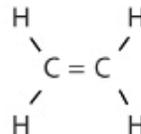
The entire range of base oils, including conventional petroleum products, are divided into five groups based on the level of saturates (saturated molecules), sulfur and viscosity index. In general, the chemical composition and performance properties of the base oil categories improve with advancing group number. For instance, Group I has a lower concentration of saturates than Group II, while Group II has a lower concentration of saturates than Group III base oils. Today, Group III, Group IV and Group V base oils are considered synthetic.

Base Oil Categories				
Group	Manufacturing Process	Saturate Level	Sulfur Level	Viscosity Index
Group I	Solvent freezing	< 90%	> 0.03%	80 - 120
Group II	Hydroprocessing and refining	≥ 90%	≤ 0.03%	80 - 120
Group III	Catalytic dewaxing	≥ 90%	≤ 0.03%	≥ 120
Group IV	Chemical reactions	100% PAOs (polyalphaolefins)		
Group V	As indicated	All others not included in Groups I, II, III or IV		

Saturated molecules contain a higher percentage of carbon-hydrogen (CH) bonds, which limits the available sites to which other, harmful molecules can attach. When other molecules, like oxygen, attach to oil molecules, they break down the molecular composition of the oil and weaken its performance. Saturated molecules are beneficial in lubricating fluids because they remain stable longer, resulting in a more durable lubricant. Unsaturated molecules have fewer single carbon-hydrogen bonds and are therefore less stable.



Saturated CH Bonds



Unsaturated CH Bonds

Sulfur is a naturally occurring, inorganic element that readily reacts with oxygen molecules and is detrimental to oil performance. Synthetic base oils have less sulfur than conventional base oils.

Viscosity index refers to the temperature-viscosity relationship of lubricating fluids. Oils with a high viscosity index (VI) are less affected by temperature; those with low VI are affected more. Oils with a VI less than 120 (Groups I & II) are more susceptible to viscosity variance due to temperature. The viscosity index of synthetic base oils is higher than that of conventional petroleum base oils.

Pure, Uniform Molecules Form Strong, Stable Lubricants

Petroleum oils have molecular structures that are randomly organized and, consequently, have limited performance abilities. Their varied and inconsistent molecular structure results in less film strength and lubricity. Their paraffinic wax content also makes them more susceptible to viscosity variance and cold-temperature flow problems.

On the other hand, synthetic base oil molecules are chemically controlled, which provides increased film strength and lubricity over petroleum oils.

The performance qualities of base oils have a marked impact on the performance qualities of the finished product. Synthetic base oils provide key features and customer benefits including better wear protection, more horsepower, increased engine cleanliness, improved fuel economy, easier cold starts and longer oil life.

What roles do additives play in motor oil performance?

Most lubricating oils have other chemicals added to improve the overall performance of the fluid. Chemical additives are used to enhance the beneficial properties of the base oil or to make up for oil deficiencies. For passenger-car motor oils, base oil makes up 70 to 80 percent of the final product; the other 20 to 30 percent is comprised of additive chemistry.

Additives help lubricants stand up to extreme operating environments. Even the best base oil would not be able to protect as well against the effects of heat, shearing forces, chemical and water dilution, corrosion and wear particles. In short, additives make good base oils even better. They give good base oils the performance benefits consumers have come to expect, like multi-grade performance, extended drain intervals and extreme-pressure performance.

Anti-wear Agents chemically react to form a film barrier that prevents metal-to-metal contact and wear.

Antioxidants reduce the tendency for oil to react with oxygen and reduce sludge buildup.

Dispersants help to suspend and disperse contaminants in the oil to keep engine surfaces free of sludge and deposits. They fight the build-up of corrosive acids and are most efficient at controlling low-temperature deposits.

Detergents help to suspend and disperse contaminants in the oil to keep engine surfaces free of sludge and deposits. They are most efficient at controlling high-temperature deposits.

Extreme-Pressure Additives coat metals surfaces to prevent close-contact components from seizing under extreme pressure. They are activated by high temperatures and high loads to react with the metal's surface to form a sacrificial wear layer on components.

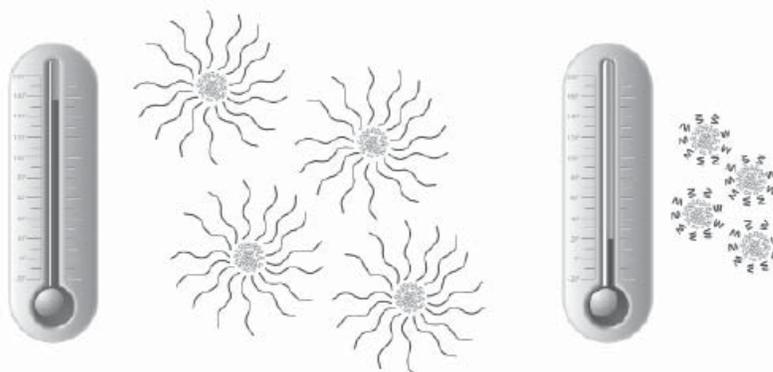
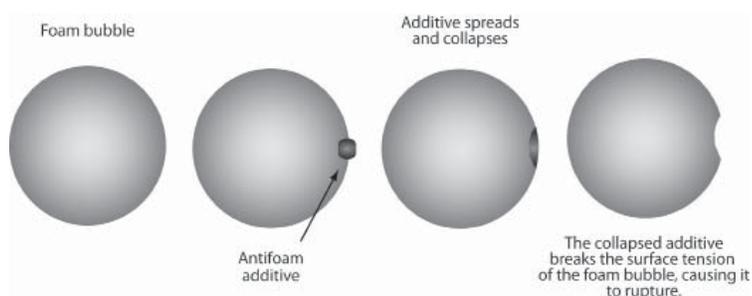
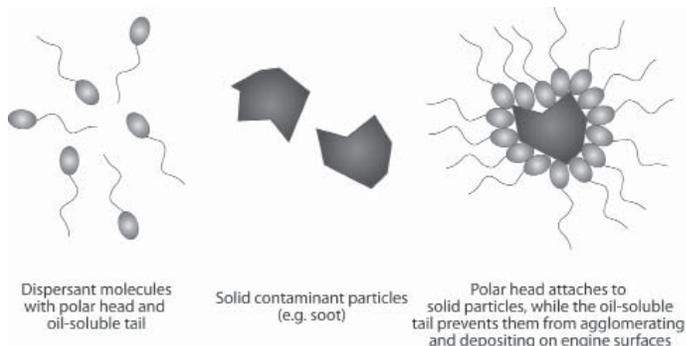
Foam Inhibitors reduce the surface tension of air bubbles, which causes them to collapse.

Friction Modifiers can be used to give oil more 'slippery' characteristics. In engine oils, friction modifiers are used to increase the oil's lubricity for the purpose of reducing friction and improving fuel economy.

Pour Point Depressants give high-viscosity oils good low-temperature properties. Pour point depressant polymers inhibit the formation of crystals to minimize low-temperature viscosity increase.

Rust & Corrosion Inhibitors form a protective barrier over component surfaces to seal out water and contaminants. While most rust and corrosion inhibitors work by forming a physical barrier, some rust inhibitors function by neutralizing acids.

Viscosity Index Improvers are long-chain polymers that help control the viscosity of multi-grade engine oils. They expand and contract as temperatures vary. High temperatures cause VI improvers to expand and reduce oil thinning; low temperatures cause the VI improvers to contract and have little impact on oil viscosity.



This viscosity-index-improver polymer grows as oil temperature increases. Its increased mass raises the internal friction of the fluid, causing an increase in viscosity.