



In the USA there are a few different types of synthetic base stocks used in engine oils. We will touch on a few in this tech paper.

1) **GENERALITIES**

The word *Synthetic* is confusing; it describes a process, not a material. For example, White sand is synthesized into glass, but glass is never called “synthetic sand”. Most people *think that ALL Synthetic oils are made of the same base, THIS IS WRONG!* For most of the USA, there are mainly THREE types of synthetic oils (or as we like to say, synthetics are DESIGNER oils).

a) Synthetic GROUP3

- Petroleum oil that is refined to deliver a good base oil. The process and end product is the least expensive of the 3 types of synthetics.
- This type of product was considered a Petroleum oil until a recent legal battle was lost.
- Molecules are not as consistent in their size as in a PAO or ESTER (mentioned below) but are better than a Group 1 and 2 petroleum oil.
- **Advantages of the G3:** cleaner base, a higher Viscosity Index (ability to flow) and better all around performance.

b) Synthetic GROUP4 (PAO)

- PAO, *short for POLY-ALPHA-OLEFINE* -or easier to understand, it is SYNTHESIZED PETROLEUM oil. It is refined in a special process, or in simple words “synthesized”. It still starts out by being pumped out of the ground (petroleum).
- **Advantages of the G4 (PAO):** better than regular petroleum and G3 oils for handling heat, oxidation, low temperature startups and higher film strength.

Drawback PAO, G3, and PETROLEUM:

- Dynamic types of oil: you have to build up oil pressure and have rotation before a film is produced. Better said, you have to HYDROPLANE the engine parts like you hydroplane a car in the rain to create a film! Or, in the case of water-skiing, you have to build speed for the skier to get up and plane on the water.
- PAO's are **NOT REALLY** EXPENSIVE because they are made from *crude oil* and produced in large quantities.



fluid force

c) **Synthetic GROUP5 (Esters)**

GROUP 5 (Diester, POLYMER ESTER, Polyolesters, polyesters and COMPLEX) Motul® uses esters in many of its products.

- ESTERS ARE MOSTLY MADE OF VEGETABLES, minerals and animal fatty acids. Motul's® esters contain a lot of *coconut* and *veggie* derivatives.
- Esters are much more expensive because the ingredients all have to be collected from natural RENEWABLE resources and synthesized (a very expensive process) in smaller quantities.
- **Advantages of the G5 (Esters):** esters have all the advantages of a PAO, plus:
 - ESTERS CAN HANDLE HIGHER TEMPERATURE THAN PAO's
 - WHEN BURNED, ESTERS LEAVE FAR LESS (COKING) DEPOSITS.
 - ESTERS ARE POLAR/STATIC types of OILS : ESTERS are ATTRACTED TO METAL PARTS WITH AN ELECTRO-CHEMICAL BOND. THIS MEANS NO MORE METAL TO METAL START UPS. This also means that A FILM IS THERE BEFORE the oil pressure light goes out PREVENTING PREMATURE WEAR of high-stressed parts like cam lobes. THE FILM CREATED IS up to 5 TIMES STRONGER THAN PETROLEUM OIL.

THE NUMBER 1 REASON TO RUN AN ESTER SYNTHETIC OIL is BOND. The Electro-chemical bond is made because the ESTER MOLECULE IS POLAR! Sort of like a refrigerator magnet! It is attracted to metal and it sticks.

THE PAO MOLECULES ARE NEUTRAL and act like a piece of plastic placed on the Frig. They just fall off. FYI, all *commercial jet planes use an ester synthetic of some type and not a PAO!* You need to run an ester of some sort for maximum protection!

2) WHY HANDLING HIGHER RUNNING TEMPS IS IMPORTANT?

With petroleum oils, there is a much better risk of failure from volatility problems than with synthetics. Why?

HAVE YOU EVER BURNED BUTTER while cooking? YES, everybody has burned butter! The running temp or maximum temp is low. When butter reaches its' maximum running temp it starts to evaporate (*volatility*). Then it carbonizes and finally it sticks to the metal pan. Now, compare butter to VEGETABLE OIL in which you deep fry "French fries". To make vegetable oil hot enough to carbonize, you would almost need a direct flame!

PETROLEUM oil is LIKE BUTTER as far as handling heat! And SYNTHETICS are LIKE VEGETABLE oils. synthetics won't burn up and stick to your engine parts or go out the breather as fast as petroleum oils will. Remember, ESTERS leave almost no DEPOSITS if they do burn.

THIS IS THE SECOND REASON to run a SYNTHETIC OIL: because you're not supposed to have extreme heat problems every day.



3) **BASIC TECH POINTS: MOTORCYCLE OILS VS. CAR OILS**

- Most modern day motorcycles have one filler hole for the engine oil. The oil must do three jobs.
 - a) Lube the ENGINE,
 - b) Lube the TRANSMISSION,
 - c) Clean and cool the CLUTCH.

A car WITH A MANUAL 5 SPEED TRANS. has 3 DIFFERENT COMPARTMENTS, USING TWO DIFFERENT OILS TO DO THE SAME JOB.
- Motorcycles, especially air or oil cooled designs, need lubricants that can handle higher running temps to INCREASE VISCOSITY RETENTION, while reducing consumption and oil film breakdown. It is particularly important since the capacity of oil is only 1~4 quarts.
- Motorcycles use a constant mesh gearbox that shares the engine oil. Because of that, Motul® adds more medium EXTREME PRESSURE (EP) additives such as ZINC and a STRONG EP additive, called a SULFURIZED ESTER to handle the shear / meshing of the constant mesh gearbox.
 - a) EP additives come into play at the instant a medium extreme pressure is applied and high temperatures are created. ZINC lays down a barrier that prevents metal to metal contact and the SULFURIZED ESTER produces a sacrificial film that is destroyed during very strong extreme pressures as it prevents SEIZING. EP additives are generally corrosive especially those used in car gearboxes. WE use this ESTER because it is FAR LESS CORROSIVE and more environmentally safe than others that can do the job.
This is what those TV advertised products forget to tell you when you see them test a ball bearing under 100,000 pounds of pressure.
 - b) To explain it easier, let's take a sandwich wrapped in plastic wrap (the EP additive would be the plastic wrap). If you were to squeeze the sandwich you would contact the plastic wrap with your fingers (your fingers representing the gears) and the sandwich would squish. However, your fingers NEVER made contact with the bread!
- Motorcycles NEED A BALANCED FRICTION MODIFIER PACKAGE, so that the wet clutch functions properly, ring seal stays strong and roller bearings roll and do not slide and flatten.
 - a) Super slick oils (energy conserving II type) are not recommended for today's high powered motorcycles. Clutches will not engage correctly and will take longer to engage or slip and chatter when placed under heavy stress. (i.e. RACING, passenger, trailer, uphill) Moreover, the plates will glaze up from burning/slipping.
 - b) Too much friction reduction will hurt your engine. Rings will skate instead of seal, reducing compression and performance.
 - c) Roller bearings will not roll, but slide causing flattened pins.

NOTE: The SULFURIZED ESTER is a part of this friction reduction package due to its ability to STICK to engine parts (non-ferrous metals).

- Motorcycles need strong ANTI-ACID (BASE, TBN, total base number).
Condensation (the steam that you see coming out of your tail pipe in the morning) is a natural by-product of combustion in an engine. This condensation, which is acidic water, passes by the



rings under compression into the crankcase and mixes with the sulfur, SULFURIC ACID is created. ANTI-ACID (base) neutralizes the acid before it can cause any damage.

- Motorcycles need strong ANTI-FOAM ADDITIVES to handle the design of the motor.
 - a) Motorcycles usually run at higher rpm's (than cars) which aerates the oil more.
 - b) Motorcycles have MORE INTERNAL MOVING PARTS in the crankcase than cars do, foaming up the oil (engine-clutch, clutch basket, gears, shift drum, shift forks).
 - c) Motorcycles lean into turns; this may cause the clutch basket and gears to dip into the oil which causes excessive foam (similar to whisking egg whites in a high speed mixer).

We must pop the bubble before it causes damage! Why?

- a) Foam is air; air is a better insulator than a transmitter of heat. It does not transmit heat from hot metal parts to the oil very well or vice versa.
 - b) Problem - OIL PUMPS DO NOT PUMP AIR!
 - i) Oil pressure can DROP.
 - ii) TEMP'S can RISE due to inefficient heat exchange.
- Motorcycles NEED STRONG DISPERSANTS to suspend the clutch material and combustion by-products which are created and rubbed off during normal operations.

When you are waiting at a traffic light in gear or taking off from one, WHERE DOES THE CLUTCH MATERIAL GO?

RIGHT INTO THE OIL! We want the material to stay in small pieces and stay mixed in the oil, so that the oil filter can do its job. Otherwise the material will drop to the pan and collect in corners waiting for the day that you hit a wild bump and bounce it back into circulation causing a clogged artery to anything it can. Just like a heart attack!

- Motorcycles NEED A STRONG DETERGENT because of more heat generation (more horsepower per cc than cars) trying to fry the oil onto the engine parts, added dirt being dropped into the oil from the clutch and by-products from combustion.
- Motul® SYNTHETICS CAN (if you cannot find your brand) be mixed with MOST high quality mineral, Group3, PAO or ESTER synthetic oils, without major problems. Try to stay close to the viscosity range of the first oil (i.e. 10w40 mixed with 10w40). If you have mixed oils, Motul® recommends an oil change when you get home from a “long” trip that has consumed the oil, since the oil additive and base from our oil is now not balanced.

THESE ARE SOME OF THE MAIN ISSUES THAT MOTUL® LOOKS AT WHEN DESIGNING A MOTORCYCLE OIL.

As discussed earlier, synthetics can handle much higher running temperatures than conventional petroleum oils and can withstand more stress. Many people ask, so what! I don't push my cycle that hard and I change oil every 1000 miles! I don't need an expensive quart of oil in my bike.

This type of thinking is wrong!!!!



The questions we have for you are simple ones: why do you wear a helmet, gloves, boots, and jacket? Why do you buy INSURANCE?

In case of an accident! If within the first fifty (50) miles after an oil change, a rock hits your radiator or the thermostat sticks, the water pump stops pumping or whatever causes a major heat problem in your cooling system, what would you rather have in your engine? A mineral oil that acts like butter, which burns up and evaporates very quickly and also carbonizes? Or an oil that can handle high RUNNING temps like synthetics (325°f to 367°f)?

High quality oils are INSURANCE not only maintenance. The same is true about brake fluids and gear oils.

4) THERE ARE NEW OIL RATINGS FOR MOTORCYCLES, FROM THE JAPANESE STANDARDS PEOPLE: JASO

The JASO people have developed a minimum standard for motorcycle oils.

The current ratings are JASO MA (NON FRICTION MODIFIED) and JASO MB (FRICTION MODIFIED). SOON, there will be new ratings JASO MA1 and JASO MA2

What does this mean? The changes in simple wording are as follows:

- JASO MA must pass a FRICTION test. This is to see if the oil is not too slippery. (WET CLUTCH TEST) If there are cheap FRICTION MODIFIERS used in the oil, it will fail.
- The oil must pass a HIGH TEMP VISCOSITY LOSS (%) TEST.
- The oil must pass a SHEAR STABILITY TEST, cheap bases and additives will fail.
- SULFATED ASH has a maximum content now. (Too high of a TBN can cause this)
- Maximum levels of phosphorus are now going to be required.

THESE ARE SOME OF THE BASIC REAL TESTS THAT A MANUFACTURER MUST PASS TO GET THEIR OIL APPROVED AND RECEIVE A JASO NUMBER.

