

THE IMPORTANCE OF THE ADDITIVE PACKAGE

Although the basestock of an oil will be a major determining factor in the lubrication quality of an oil, chemical additives play a major part in making sure that it does all that it is supposed to do. The chemical additive package of an oil is just as important to insuring the quality of a lubricant as is the particular basestock used.

The chemical additive package of an oil is designed to perform a number of tasks and each task is performed by a particular type of chemical. The quality of the chemicals used and the manner in which they are blended plays a large part in determining how well the additive package does its job.

As the quality of the additive chemicals increases, so does the price. In addition, proper blending takes a great deal of research. This requires much time and, again, money. Therefore, manufacturers will, of course, charge more for motor oils which contain a high quality additive package than those with lower quality additive packages. They simply can't afford not to.

Each chemical within an oil's additive package plays a different role in boosting the beneficial properties of its host lubricant (basestock).

The additive package must perform the following roles:

IMPROVE VISCOSITY CHARACTERISTICS

Basestock lubricants have a certain temperature range over which they will flow adequately. The wider this temperature range the better. Cold temperature starting requires an oil that will flow well at low temperatures. The higher engine temperatures of today's smaller, higher revving engines requires an oil that will perform well under high temperature conditions.

Pour Point Depressants

In order to improve the flow characteristics of a lubricant basestock at low temperatures additives called pour point depressants are used. Because synthetic basestocks have inherently better low temperature flow characteristics, pour point depressants are typically unnecessary. Therefore, they are normally only used in conjunction with petroleum basestock lubricants.

Waxy contaminants within petroleum basestocks tend to crystallize in low temperature conditions. These crystallized structures absorb oil and increase in size. This leads to oil thickening and poor low temperature flow characteristics. Pour point depressants do not inhibit this crystallization, as is thought by many. Instead, the pour point depressants are absorbed into the crystals instead of the oil, thereby lowering the volume of the crystals in proportion to the volume of the free flowing oil. This helps maintain the low temperature flow characteristics of the base oil even when crystallization occurs.

Higher quality petroleum basestocks have less need for pour point depressants because they have lower levels of wax contamination. However, complete dewaxing of a petroleum basestock is not very economical, so all petroleum basestocks require at least some level of pour point depressant.

Viscosity Index Improvers

As a lubricant basestock is subjected to increasing temperatures it tends to lose its viscosity. In other words, it thins out. This leads to decreased engine protection and a higher likelihood of metal to metal contact. Therefore, if this viscosity loss can be minimized, the probability of unnecessary engine wear will be reduced.

This is where viscosity index (VI) improvers come in.

VI improvers are polymers that expand and contract with changes in temperature. At low temperatures they are very compact and affect the viscosity of a lubricant very little. But, at high temperatures these polymers "expand" into much larger long-chain polymers which significantly increase the viscosity of their host lubricant.

So, as the basestock loses viscosity with increases in temperature, VI improvers "fight back" against the viscosity drop by increasing their size. The higher the molecular weight of the polymers used, the better the power of "thickening" within the lubricant. Unfortunately, an increase in molecular weight also leads to an inherent instability of the polymers themselves. They become much more prone to shearing within an engine.

As these polymers are sheared back to lower molecular weight molecules, their effectiveness as a VI improver decreases. Unfortunately, because petroleum basestocks are so prone to viscosity loss at high temperatures, high molecular weight polymers **must** be used. Since these polymers are more prone to shearing than lower molecular weight polymers, petroleum oils tend to shear back very quickly. In other words, they lose their ability to maintain their viscosity at high temperatures.

Synthetic basestocks, on the other hand, are much less prone to viscosity loss at high temperatures. Therefore, lower molecular weight polymers may be used as VI improvers.

These polymers are less prone to shearing, so they are effective for a much longer period of time than the VI improvers used in petroleum oils. In other words, synthetic oils do not quickly lose their ability to maintain viscosity at high temperatures as petroleum oils do.

In fact, some synthetic basestocks are so stable at high temperatures they need NO VI improvers at all. Obviously, these basestocks will maintain their high temperature viscosities for a very long time since there are no VI improvers to break down.

MAINTAIN LUBRICANT STABILITY

Lubricating oils are not only prone to viscosity loss over time. They are also susceptible to breakdown due to contamination and/or oxidation which decreases the useful life of an oil. Additives are often used in order to inhibit the susceptibility of a basestock to this breakdown over time.

Detergents and Dispersants

Contamination due to sludge and varnish build-up within an oil can often be one of the limiting factors in determining the useful life of an oil. If this build-up can be minimized and contained, the life of the lubricating oil can be increased. Detergent and dispersant additives are utilized for this purpose.

There is some debate as to whether those additives considered to be detergents actually "clean" existing deposits, but at the very least they aid dispersants in keeping new deposits from forming. Detergent and dispersant additives are attracted to sludge and varnish contaminants within a lubricant. They then contain and suspend those particles so that they do not come together to form deposits. The more contamination within the oil, the more additive that is used up.

Since synthetic oils are less prone to leave sludge and varnish, these additives are used up much more slowly within a synthetic lubricant.

Some oils use ashless dispersants which are more effective at controlling sludge and varnish contamination than metallic dispersants. In addition, some ashless dispersants are

actually long chain polymers that serve a dual purpose as VI improvers in multi-grade oils.

Detergents are all metallic in nature.

Anti-Foaming Agents

Although necessary for engine cleanliness, detergents and dispersants can have a negative effect on the lubricating fluid within your engine as well. Sometimes, these oil additives can play a part in oil foaming. In other words, air bubbles are produced within the oil. These air bubbles, if not neutralized, will reduce the lubricating qualities of the motor oil. Anti-foaming agents such as small amounts of silicone or other compounds are used to control this phenomenon.

Oxidation Inhibitors (antioxidants)

Oxidation inhibitors are additives that manage to reduce the tendency of an oil to oxidize (chemically react with oxygen). They are also called antioxidants.

The antioxidant reacts with the peroxides in the oil. These peroxides are involved in the process of oxidation. Reaction with the antioxidant removes them from the oxidation process, thereby lessening the chance of motor oil oxidation.

Oxidation inhibitors also serve one more very important purpose. They protect against bearing corrosion. Bearing corrosion is caused by acids within your motor oil. These acids come from combustion by-products, but they can also be the result of oxidation. So, by inhibiting motor oil oxidation, antioxidants also protect against bearing corrosion.

Corrosion Inhibitors

Although antioxidants prevent the acids caused by oxidation, they do nothing to neutralize the acids caused by combustion by-products. Therefore, other additives must be used in order to keep these acids in check and to protect engine components from their effects.

Some corrosion inhibitors are designed to protect non-ferrous metals by coating them so they cannot come in contact with acids within the oil. Other corrosion inhibitors are designed to actually neutralize the acids within the oil.

Anti-Wear Agents

Even with the best of oils there is always the possibility of metal to metal contact within an engine, however slight. Some oils (especially ester synthetics) will cling to metal surfaces better than others, but engines that are left to sit for any period of time may have very little lubricant protection at start-up.

This is especially true in cold conditions when petroleum oils do not pump well. To minimize the engine component wear caused by these situations, anti-wear additives are used. Additives such as zinc and phosphorus will actually coat metal surfaces forming a protective barrier against wear. They do not eliminate the metal to metal contact. They simply minimize the wear that occurs during those instances.

ALLEVIATE COMPATIBILITY ISSUES

Some additives are included in an oil to deal with compatibility issues between the oil and certain engine components. For instance, there are certain types of lubricant basestock that will cause seals and gaskets to swell or to shrink. These effects have to be minimized. Sometimes basestock blending will alleviate the issue, but in other cases additives might be used.

Depending upon the particular application the oil will be used for, some additives may be

left

out while others may be left in. For instance, in order to meet API SL fuel economy requirements, oils are now formulated with special friction modifiers. However, these friction modifiers can cause clutch slippage if used within motorcycle oils. So, motorcycle specific oils do not contain these friction modifier additives.

When considered as a whole, Engine oils are comprised mainly of basestock fluids. Only a small percentage of the oil is comprised of additive chemicals. However, additives can play as important a role as the basestock fluid itself.

A high quality basestock blended with a cheap additive package will be poor oil. A high quality additive package added to a cheap basestock is no better.

Of course, a motor oil as a whole is far greater than the sum of its parts. In other words, even a high quality basestock combined with a high quality additive package isn't necessarily going to yield a great oil. The company manufacturing the oil has to know how to correctly blend those basestocks and additives so that they perform well together.