

Q. We hear terms like “coefficient of expansion” – “sheer factor” – “viscosity” – “thermal stability and durability” – “anti-oxidants” – “friction modifiers” – “esters” or phosphates.” Can you define these terms and do they describe the characteristics found in every variety of transmission fluid?

A. Some of the terms you have mentioned are used to describe either the properties of the additives, or the additives themselves. Let me expand on this and define these terms and several others key to understanding what they are and why they are so important to ATF quality.

Coefficient of expansion – Expansion in physics is the increase in volume resulting from an increase in temperature. The amount of expansion that any unit of volume undergoes every one-degree rise in temperature, is called its ‘coefficient of expansion’. That’s why it is a well known fact that you are supposed to check the fluid level in an automatic transmission when it is at operating temperature, because the volume of fluid expands as it gets hot. Setting the fluid level when cold could result in overfilling the transmission.

Shear factor – This is a term that is more relevant to measuring the distance a point moves due to shear. For our purposes, **shear stability** is a more relevant property to use when describing transmission fluid.

The operating viscosity of transmission fluid is extremely important to the function of the automatic transmission. Especially critical for the performance in electronically controlled transmission. Any loss in operating viscosity below a critical level will reduce long term durability.

(**Viscosity** is a measure of a fluid’s resistance to flow. It is important to remember that viscosity ratings are always given for a specific temperature. Viscosity will increase when the temperature drops and will decrease when the temperature rises.)

Automatic transmission lubricants experience shear stresses at surfaces inside gear and vane pumps, needle bearings and bushings, planetary gear sets, and clutches and bands. This mechanical shearing breaks the long chain polymers and in time, causes viscosity loss.

Permanent viscosity loss (PVL) occurs after intense shear stress causes unrecoverable degradation of these long chain molecules. **Temporary viscosity loss (TVL)** occurs due to the orientation of the long chain molecules under less intense shear stress (operating at elevated temperatures will do this) with a return to its previous viscosity value indicates the molecules return to their original shape when the stress (lower temperature) is removed. Fluids which do not experience PVL or TVL are defined as **shear stable**.

Thermal stability and durability – A thermally stable transmission fluid is one that has the ability to withstand temperatures without decomposing. Do not confuse thermal stability with **oxidation stability**, where oxygen must be present and

oxidation is occurring instead of thermal decomposition. The transmission fluid durability of course, is seriously affected by the onset of either decomposition or oxidation. Both conditions will eventually result in viscosity loss that will cause failure of the transmission fluid and then shortly thereafter the transmission.

Anti-oxidants – Anti-oxidants are part of the additive package used to formulate automatic transmission fluid. Their purpose is to lengthen fluid life, permit high temperature tolerance, and prevent the formation of sludge and varnish. These additives control oxidation by deactivating chains that start the oxidation that leads to sludge and varnish.

Friction modifiers – Friction modifiers are additives that make the fluid more “slippery” by decreasing the coefficient of static friction.

In other words, the frictional forces between clutches and bands are higher when there is no motion or sliding between the clutches and steels (or band and drum) as lockup occurs. When the clutches and steels (or band and drum) are sliding as lockup occurs, this reduces frictional force.

The smaller the frictional surface on the clutch plates, or band, the greater the requirement for the elimination of slippage to prevent heat generation and wear. This was a requirement of non-friction modified automatic transmission fluid like the Ford Type F. General Motors transmissions require a friction modified or “slippery” fluid to ensure the proper “shift feel” that is so important to G. M. transmissions.

What actually occurs is the coefficient of static friction is less than the coefficient of dynamic friction. As the clutches and bands lockup to complete the shift, there is less engagement feel transmitted to the driver resulting in a more “pleasing” shift. Currently, there is very little difference in the frictional requirements for Ford and G.M. transmissions which is why so many available approved transmission fluids are DEXRON / MERCON approved. Other manufacturers such as Daimler-Chrysler and Toyota have different frictional requirements for their transmission fluids. These differences in frictional requirements are the main reason why there is no universal specification for automatic transmission fluid in place.

Esters – Esters are synthetic lubricants reacted from fats and vegetable oils. An ester is a product of the reaction of an acid (usually organic) and an alcohol. The process of producing an ester is called esterification. Esters have very unique lubrication properties and are the basis for some of the most effective lubrication products available today. LUBEGARD’s Liquid Wax Esters (LXE) are derivatives of seed oils high in erucic acid. Esters can be used as a main base oil or as a quality enhancing additive. Chemical stability and lubricity over a wide range of temperatures are just a few of the beneficial properties of ester based lubricants. The biggest drawback to their wider use is the cost factor. Esters are expensive to use.

Phosphates - Phosphate is a chemical term that is used to describe any of several substances containing phosphorus. How this applies to transmission fluids, is that phosphorus is used in transmission additive packages to enhance wear protection and provide friction modification. It has to a great extent been used in current ATF’s

to replace the zinc that was used with phosphorus in the past for the same purpose. Selection of anti-wear and friction modification additives is very important as interaction with other components must be kept to a minimum to avoid causing corrosion of copper or other metallic components of the automatic transmission.