



JG Lubricant Services, LLC

P.O. Box 622

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www.jglubricantservices.com

All About Oils

For RV and Tow Vehicle Owners

The following Technical Information is intended for RV and Tow Vehicle owners and covers:

- **Factors affecting useful oil life**
- **Oil properties**
- **How oil properties change with use**
- **Assessing oil life and part wear through oil analysis**



Factors Affecting Useful Oil Life - In any given lubricant (such as engine oil, transmission fluid or gear oil), there are three main factors that influence the "useful life" of the lubricant: Viscosity Stability, Oxidation, and Contamination.

While it is important to understand how these factors affect oil life, it is equally important to realize that none of these factors can be measured or monitored except through a thorough and ongoing oil analysis program.

Viscosity

Viscosity is defined as resistance of an oil to flow at a given temperature. Viscosity is typically measured and reported at two temperature set points: 40C (104F) and 100C (212F).

In order to maintain sufficient viscosity to support heavy loads in gears and bearings, the thickness of the oil film must be greater than the combined surface finish on the bearing balls (or rollers) and the bearing race. Likewise, the oil film

thickness in a gear mesh must be greater than the combined surface finish of the gears in mesh. Under the right conditions (*speed, load, and temperature*) these surfaces never come into contact due to the separating oil film. The ratio between the oil film thickness and the combined surface finishes of the parts is known as "Lambda Factor". Lambda Factor should always be greater than 1.0 in order to minimize wear and maximize part life. Oil film thickness is determined by oil viscosity, oil temperature, applied load and surface speeds. Where speed is insufficient to build an adequate oil film (*Lambda Factor less than 1.0*), the contacting parts are said to be operating under "boundary lubrication". Anti-wear agents and/or Extreme Pressure (EP) additives are included in oil formulations to protect against wear caused by boundary lubrication. These anti-wear agents and EP additives are complex polymers that are designed to decompose, at a predetermined temperature, and form a surface film on the highly stressed parts. These protective films are "sacrificial" as they are consumed over time. This protective film then carries the load without harming the metal parts.

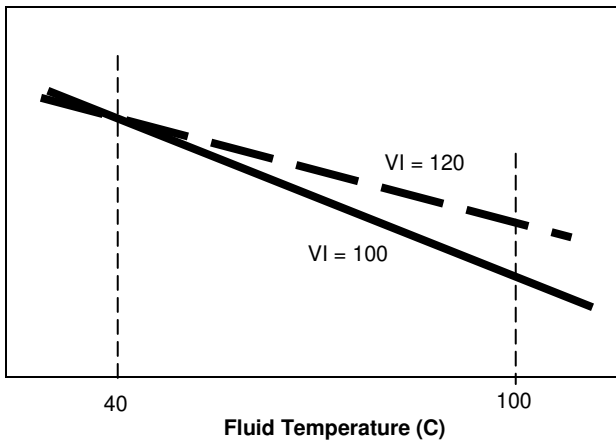
Selecting the correct viscosity for the operating conditions (*speed, load, and temperature*) ensures that gears and bearings remain durable, with very little pitting or other damage, over long periods of time.

In most "multi-grade" lubricants (*engine oils, transmission fluids and gear oils*), the base oils are selected based on their cold temperature properties where equipment is operated at extreme starting conditions. These lighter base oils allow reduced cranking torque since the oil can more easily flow if it exhibits lower viscosity at low temperature. In order to have sufficient viscosity for gears and bearings at operating temperature, formulators add Viscosity Index Improver (VII) additives to the base formulation.

All lubricants exhibit a "Viscosity Index". Viscosity Index indicates the amount the viscosity changes with change in temperature. Viscosity Index is calculated based on two temperature points: 40C and 100C as shown in Figure 1. The base oil, or base oils, used to blend a lubricant will exhibit some measurable Viscosity Index. The higher the Viscosity Index, the less the viscosity changes with temperature. Viscosity Index Improver (VII) additives are used in multi-grade lubricants, such as in SAE¹ 5W-30 or 15W-40 engine oils or in most automatic transmission fluids and gear oils. These VII additives are made up of very long chained polymers. Viscosity Index Improver additives (polymers) are designed to give additional viscosity to the base oil at operating temperature.

¹ SAE = Society of Automotive Engineers

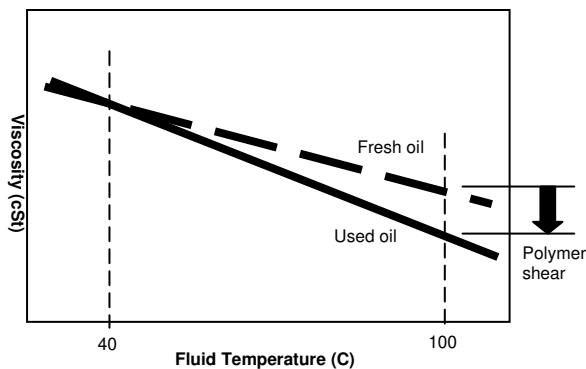
Figure 1: Viscosity Index



Viscosity Index Improvers are very long chained molecules (polymers) that are designed to expand with increased temperature resulting in higher viscosity than would be available with only the base oil.

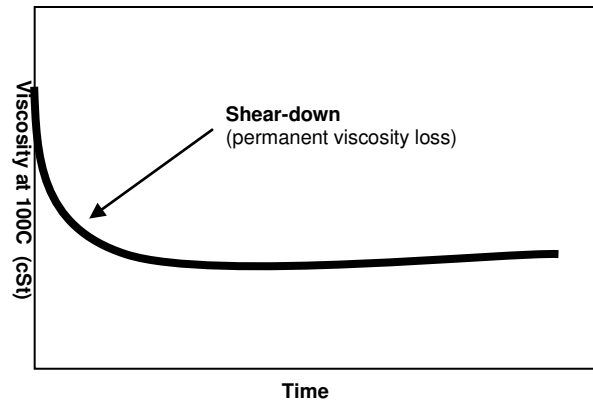
Viscosity Stability - With time these VII polymers are cut-up (*sheared*) as they pass through highly loaded gears and bearings. The process is known as "shear-down" (see Figure 2). Shear-down is permanent and the viscosity is never gained back. Topping off with new oil will temporarily increase the viscosity but the affect is not lasting and soon shearing will again decrease the viscosity.

Figure 2: Shear-down (polymer shear)



Shear-down can progress to the point where there is no longer sufficient viscosity to lubricate gears, bearings and other heavily loaded moving parts and part wear follows. Figure 3 shows a typical curve demonstrating viscosity change (shear-down) with extended use.

Figure 3: Typical Shear Rate



Oxidation

All lubricants oxidize over time. Oxidation rate depends on:

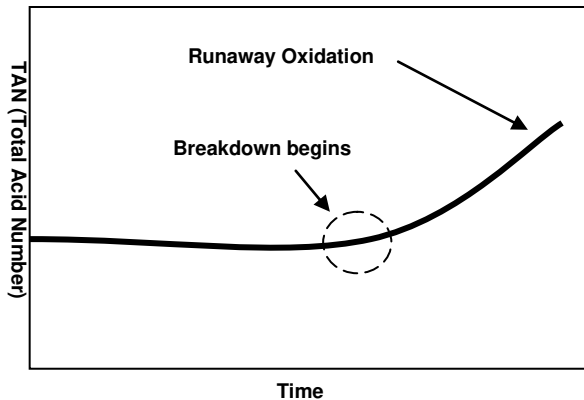
- Initial oil quality
- Total amount of heat the oil absorbs during the change interval

A common "rule of thumb" states that oxidation rate doubles for every 10C (18F) rise in oil temperature.

During the oxidation process, some of the hydrogen bonds in the base oil degrade allowing oil molecules to combine with oxygen from surrounding air. This leads to formation of acids which causes the oil to have increased acidity over time. If the oil is not changed and oxidation is allowed to continue, the oil molecules may degrade to a point where they "cross-link" or bond together to form "viscosity growth" which is the end stage of oxidation.

Left unchecked, the oil will eventually become very thick and viscous and reach a mayonnaise consistency. This is known as "run away" oxidation (see Figure 4).

Figure 4: Typical Oxidation Change

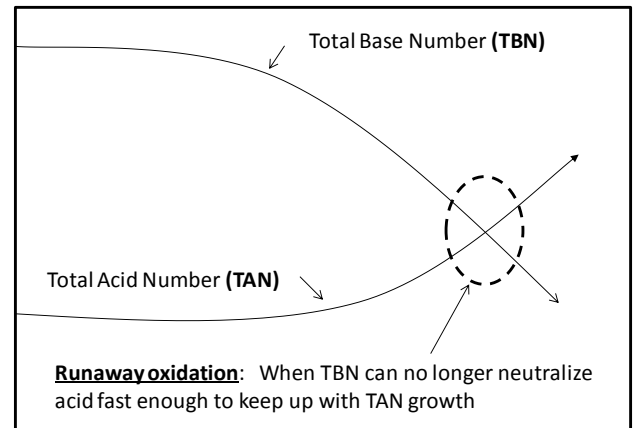


Total Acid Number - Oxidation is typically measured using Total Acid Number (TAN) as defined by ASTM D664. A sample of used oil is titrated with drops of potassium hydroxide (KOH) until the acid is neutralized and the amount added is called the Total Acid Number (TAN) as measured by milligrams of KOH per gram of used oil.

Total Base Number - Basic chemistry tells us that bases neutralize acids. "Blow-by" gases that pass by the rings of an internal combustion engine tend to accelerate the oxidation process, especially if higher sulfur content fuels are used. Because most engines produce some level of blow-by gases, oil companies and additive companies work together to formulate oils to include additives that increase the alkalinity of the virgin (unused) oil. This enables oils to sacrifice these additives over time to "fight off" acid buildup from the oxidation process and piston ring "blow-by" gases. Adding these alkaline type additives to engine oils is called "over basing" the oil. The amount of over basing in a given engine oil is determined by the Total Base Number (TBN) of the unused oil. Therefore, we monitor Total Base Number (TBN) to evaluate the amount of acid buildup in engine oils due to the oxidation process. Typically, TBN can decrease up to 65% before the oil must be changed.

Figure 5 shows a typical plot of TBN and TAN. Notice that TBN goes down over time and TAN goes up over time. When they cross is typically the time to change oil as the alkaline additives in the "over based engine oil can no longer neutralize the acid build up, from the oxidation process, fast enough to avoid runaway oxidation.

Figure 5: TBN vs. TAN



Contamination

We've seen that oils can suffer viscosity loss through shear-down and how they can oxidize with due to time at temperature. Both of these affects can shorten oil life and they can often occur simultaneously depending on initial oil quality. In addition to viscosity change and oxidation, lubricants also tend to collect debris. This debris can be ingested through the breather or introduced at when new oil is put into the system or when the oil is topped off. Debris can also accumulate from wear metals and water from condensation. Most oils contain dispersants to handle some of this debris and keep it in suspension but, as time goes by, the debris tends to build up and begin to block filters. If the debris is from wear metals, this may result in secondary pitting wear in bearings and gear meshes depending upon the size and hardness of the debris.

In summary, oil life is a function of the amount of permanent viscosity loss (shear-down) suffered by the lubricant, the oxidation state of the lubricant, and the amount of debris present. If oils are run too long or get contaminated they will no longer be useful and will lose their ability to provide sufficient lubricating film, oxidation resistance and wear protection.

Remember:

Oil degradation and contamination can only be properly assessed through periodic monitoring through oil analysis.



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Oil Analysis - The main factors that affect oil life can be measured and monitored using oil analysis. Measured parameters include viscosity at 40C and 100C, TAN (Total Acid Number, TBN (Total Base Number), water content, soot content, wear and additive metal contents, and contamination debris through particle count.

JG Lubricant Services offers three (3) levels of oil analysis testing:

- **BASIC**
- **ADVANCED**
- **ULTIMATE**

Kits are available as single kits or in handy 3-packs and can be used to sample engines, transmissions and generators on RVs and Towing Vehicles. Our kits include everything you need to sample these oils and send them in for analysis. JG Lubricant Services has (4) ISO17025A laboratories conveniently located across the US. So, there's one close to you. To learn more about our different test kits, visit our website at www.jglubricantservices.com.

Purchasing Test Kits:

For ease in ordering, we've established a handy "online store" which is located on the web at: www.jglubricantservices.com/online_store.html. We recommend that RV and Tow Vehicle owners purchase a 3-pack to save on shipping costs. The 3-packs include everything you need to get started testing your engine, transmission and (if applicable) generator. The kits can be used to sample any combination of engine, transmission or generator oils. Just tell us on the Component Registration Form about what you've sampled.

Note: *If you don't already have one, you'll need to purchase a reusable Oil Vacuum Pumps (Part Number: JGVP01) which allows you to draw your samples through the engine and transmission dipstick tubes. Sample tubing, in 8' sections, is included with each kit. The Vacuum Pump is a "one time purchase" item and will last for years.*

Questions?

- Call Sales at 877-971-7799 (Ext. 1) or email Sales@jglubricantservices.com.
- Call Technical Support at 877-971-7799 (Ext. 2) or email Technical@jglubricantservices.com.

About the Author

Tom Johnson is President and Co-Owner of JG Lubricant Services, LLC. Tom holds a BS in Mechanical Engineering Technology from Purdue University and has over 30 years of experience in the bearing, automotive and transmission industries.



Prior to forming JG Lubricant Services, **Tom was the Transmission Fluids Engineer for Allison Transmission, Inc.**² Tom served in that capacity for the final 20 years of his long career before retiring in 2009. While serving as the Transmission Fluids Engineer, Tom worked with all of the global oil and additive companies. He wrote most of Allison Transmission's lubricant specifications (*including the ground breaking TES-295 specification*). Tom directed and managed testing and approval of hundreds of transmission fluid formulations for Allison Transmission and served as a member of the GM Engine Oil Committee and was a key member of the GM Automatic Transmission Fluid (ATF) Committee.

Tom was also a key member of the Engine Oil Review Committee for the SAE³ Performance Review Institute⁴ and participated on a multi-OEM panel to review and approve engine oils to US Army specifications. Tom worked closely with the US Army Tank Automotive Command to review military specification oils for use in US Army tactical and combat wheeled and track laying vehicles.

² Allison Transmission is the world's leading producer of heavy duty automatic transmissions and a former division of the General Motors Corporation.

³ SAE = Society of Automotive Engineers

⁴ Also, formerly known as the "Lubricant Review Institute"