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Recommended Citation
"SP399-B-Facts about Engine Oils," The University of Tennessee Agricultural Extension Service, SP399B-1M-11/98(Rev) E12-2015-00-066-99, http://trace.tennessee.edu/utk_agexmach/5

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Agricultural Extension Service
The University of Tennessee

SP399-B

Agricultural Engineering

Facts about Engine Oil

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Purposes of Engine Oils

The four primary functions of an engine-lubricating oil are:

1. **To lubricate** — This requires the maintenance of a slippery surface between moving parts. It is often referred to as "oiliness." This oil film must adhere very tenaciously to metal surfaces. It must "stay-put" and resist being shoved away when either hot or cold, even though it is subjected to high pressures. Unfortunately, there is no laboratory procedure to fully measure these properties. Actual use in the engine is the only way to evaluate the oil's ability to lubricate.

2. **To seal** — Immediately following the burning of fuel in the combustion chamber of the engine, the gases formed are under high pressure. It is the pressure of these gases on the piston-head which is transmitted to working horsepower. It is necessary to keep these gases from leaking past the pistons and valves. The oil acts as a sealant. If the oil thins out too much, the gases blow by. The oil must resist excessive thinning.

3. **To cool** — Although the cooling system removes much of the heat from an engine, the oil must also remove a large quantity of heat. Oil removes heat from the bearings and moving parts of the engine. The oil can reach a higher temperature than the cooling system fluid.

4. **To clean** — A variety of waste products are formed as fuel is burned in an engine. The type of fuel and the conditions of combustion influence the nature and quantity of these waste materials. Some of the most troublesome waste materials include water, soot, carbon, lead salts and acids. Many of these materials tend to remain in the engine and contaminate the oil. Unless these contaminants can be held in a state of dispersion — so they may be removed when the oil is drained — they will contribute to the formation of harmful and power-robbing deposits. Helping to keep an engine clean is a very important function of an oil.

Oil Specifications and SAE Grades

The **Society of Automotive Engineers (SAE)** has established crankcase oil SAE grades based on centistoke viscosity units measured at 100 degrees (212 F) and centipoise viscosity units measured at the prescribed temperature below 0 degrees (32 F).

Viscosity

Viscosity is that physical property of a fluid which measures resistance to relative motion of its parts. It is a measure of the physical ability of the fluid to maintain lubrication under specified conditions of operating speed, temperature and pressure.

Oils which are thick, heavy and offer great resistance to flow — like molasses on a cold day — are said to possess a high viscosity. Oils which flow very easily — like water — are said to possess a low viscosity, or to be non-viscous. Viscosity is usually determined by counting the number of seconds of time required for a given quantity of oil to pass through a small orifice at an established temperature. The instrument used to measure viscosity is called a viscometer. It is scientifically built and controlled. The most common unit of measure is called a centistoke. The SAE viscosity numbers constitute a classification of crankcase lubricating oils in terms of viscosity only. Other factors of oil character or quality are not considered.

Manufacturers of engines frequently recommend crankcase oils in terms of SAE grades, which vary with the expected temperature of use. At air temperatures above 32 degrees F, the manufacturers may recommend an SAE grade of 10W-30, 10W-40, 20W-50 or 20W-40. Below 0 degrees F air temperature, the recommendation may be for SAE grades of 5W-20, 5W-30 or 5W-40.

Viscosity Index

All oils thin when hot and thicken when cold, but they all do not react to temperature changes in the same way. Two oils with the same SAE grade which possess the same viscosity at 100 degrees C may have radically different viscosities at higher temperatures and at lower temperatures. The oil showing the **least** change over a wide temperature change is most desirable. Less wear and easier engine starting at lower temperatures result. An oil with little change in viscosity over a wide range of temperatures is said to have a high viscosity index (V.I.). Oils affected greatly by temperature changes have a low viscosity index. The high viscosity index is most desirable when additives are not used to cause the high index.

Borderline Pumping Temperature and Pour Point

Borderline pumping temperature (BPT) is the lowest temperature at which oil in the oil pan will flow to the oil pump to provide adequate oil pressure to various lubrication points. When oil is used below its BPT, a flow restriction occurs. Lubrication points will not receive oil and component failure can result.

The pour point of an oil is the temperature below which an oil will not pour. Wax in the oil will become solid and traps the oil so it will not pour or flow. Only SAE grades with a W for winter grade are suitable for low temperature operation where BPT and pour point become a factor.

Wax and Paraffin

When crude oil was initially subjected to chemical analysis (Pennsylvania Crude Oil), it was found to have little chemical affinity. It was, therefore, referred to as being paraffinic. Wax was found to separate from this crude oil upon cooling. It also resisted chemical reaction and became known as paraffin wax. For this reason, it was assumed that all wax taken from crude oil was paraffinic and a crude oil from which wax could be taken became known as a paraffinic crude. It is now known that this is not true. Some oil companies today market what they call paraffin-base lubricating oil. Many buyers believe that these oils are Pennsylvania or taken from Pennsylvania oils. This is not true.

Additives

To help keep today's engines operating troublefree, it has become necessary to add a number of chemical agents to an oil. These agents have specific jobs to do in assisting the oil to function properly. Additives are used for the following purposes:

- *To enhance the detergency dispersancy characteristics of the oil*. A detergent is a cleaning agent. Detergents are not to clean dirty engines — they are to keep a clean engine clean. During fuel combustion, products such as soot, carbon, water, acids, lead salts and others are formed. These particles are smaller than can be seen with even a normal microscope. The additive keeps these particles dispersed so they cannot collect and form deposits on the engine parts. When the crankcase oil is drained, the contaminants are removed and the engine remains clean.
- *To improve oxidation resistance*. In time, acids and sludge will form because of oxidation. To reduce this possibility, **additive** agents are added to oil. They help keep the oil cleaner and prevent corrosion of engine parts.
- *To prevent rusting, corrosion and foaming*. During the combustion of fuel, combustion acids and water are formed. To prevent this formation, inhibitors are added.

Oil foams when churned with air. These agents break up the foam and prevent it from exceeding an acceptable level.

American Petroleum Institute Service Classifications

Performance levels of crankcase lubricants can be described in three basic systems:

***Military specifications*:** Military specifications are written for times of national emergency. A large supply of a low quality oil may be acceptable to the military.

The same oil may not be desirable for long-term continued service in an engine.

***Manufacturer's specifications*:** Manufacturers may decide that current testing or performance levels are not satisfactory for their engines. They then use a manufacturer's number to identify an oil that meets their requirements. Examples are Ford M2C253B, GM 6048-M and Mack EO-J.

***American Petroleum Institute service classifications (API)*:** In 1970, the API instituted a new classification system for engine oil. The new system was open-ended so new grades could be added. Two basic categories of oil were named. "S" oils would be sold at service stations and "C" oils would be commercial oils. The following table describes and explains some facts about these oil grades:

API Service Classification	Military Specifications	Manufacturer's Specification	Recommended Use
SA	None	None	Mineral Oil
SB	None	None	Non-Detergent Oil
SC	None	Ford M2C101-A	1964-67 Gas Engines
SD	None	Ford M2C101-B GM 6041-M	1968-70 Gas Engines
SE	None	Ford M2C253-B GM 6136-M	Some 1971 and 1972 to 1979 Gas Engines
SF	None	Ford M2C153-B, GM 6058-M Chrysler MS-6556	1980 and later Gas Engines
SG	None		1989 and later Gas Engines
SH	None		1993 and later Gas Engines
SJ	None		1996 and later Gas Engines
CA	MIL-L-2104A	None	Light Duty Diesel Engines
CB	US Army 2-104B	None	Moderate Duty Diesel Engines
CC	MIL-L-2104B	None	Moderate Duty Gas/Diesel Engines
CD	MIL-L-45199	None	Severe Duty Diesel Engines
CE		None	Severe Duty Diesel Engines
CF		None	1994 or later Off-Road Diesel Engines
CF-2		None	1994 or later Two-Stroke Diesel Engines
CF-4		None	1994 or later High Speed, Four-Stroke Diesel Engines
CG		None	1994 or later High Speed Four-Stroke Off-Road and Highway Applications

Some oils may carry a dual classification, such as SJ/CE or SF/CD. This means that the oil meets the requirements for both grades listed. SF oil can be used in engines that require SE, SD, SC, SB or SA oils, as it surpasses the performance requirements of all these other grades. SJ oil is required in all 1996 and newer model autos to meet manufacturers' specifications.

Selecting Oil for Two-Stroke Cycle Engines

Most two-stroke cycle gasoline engines require the oil to be pre-mixed with the gasoline. There is usually no oil reservoir, and the oil is taken into the engine with the gasoline. The requirements of two-stroke cycle oil are different from the requirements of four-stroke cycle oil.

Some of the additives that make four-stroke oil so effective are harmful to two-stroke cycle engines. Oil contamination is not a problem since the oil is completely used. It is important that the oil be highly soluble in gasoline and the combustion chamber deposits be kept to a minimum.

Oil for Two-Stroke Engines
Selection:

1. Select only manufacturer's recommended SAE rating. NOTE: Pumps on oil-injection systems are designed for the weight oil recommended by the manufacturer. Using the wrong SAE rating can affect lubrication.
2. Select only oil recommended for use in either air-cooled or water-cooled two-cycle engines. NOTE: The use of standard detergent oils can cause carbon buildup in cylinder head and around moving parts.

Use:

1. Use the oil-fuel mixture recommended by the engine manufacturer. NOTE: An oil rated for 50:1 mixture does not necessarily mean that your engine is. Check for recommended ratio by the manufacturer.
2. Use oils that meet or exceed the engine manufacturer's recommendations. NOTE: A good quality oil may seem expensive when compared to a more economical brand, but it is inexpensive when compared to an engine overhaul.

Classification Number	Intended Services
TSC-1 or TA	Mopeds and other small engines (less than 50 cc)
TSC-2 or TB	Motorscooters and other highly loaded small engines (50 cc - 200 cc)
TSC-3 or TC	Lawnmowers, chain saws, weed trimmers, power blowers
TSC-4 or TD	Outboard Engines

This information is not intended to replace the operator's manual recommendations. For more information on engine oils, request a copy of publication 1509, "Engine Service Classifications and Guide to Crankcase Oil Selection," from the following:

American Petroleum Institute
2101 L Street, Northwest
Washington, DC 20037

SP399B-1M-11/98(Rev) E12-2015-00-066-99
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