

GEAR OILS

Gear oil is a fluid lubricant used in gears (gearboxes) for reduction of friction and wear of the gear tooth surfaces, removal of the heat generated by the operating gear and corrosion protection of the gear parts.

Gear (gearbox) is a mechanical assembly transmitting energy of rotational motion and changing its parameters (torque, speed, direction) by means of toothed wheels and cylinders.

The principal gear types are as follows:

- ☐ Spur gear;
- ☐ Helical gear;
- ☐ Herringbone gear;
- ☐ Bevel gear;
- ☐ Worm gear;
- ☐ Hypoid gear;
- ☐ Annular gear.

The following properties of gear oils are important for their operation:

- ☐ Proper viscosity;
- ☐ Ability to withstand extreme pressures (EP);
- ☐ Thermal and oxidation stability;
- ☐ Corrosion and rust protection;
- ☐ Compatibility with seal materials.

Gear oils should provide reliable, efficient (low friction), low maintenance operation of gears at different speeds, temperatures, oil contaminations.

- ☐ **Types of gear oils**
- ☐ **Viscosity of gear oils**
- ☐ **SAE Designation of gear oils by viscosity**
- ☐ **Designation of gear oils by performance**
- ☐ **Properties of some gear oils**

Types of gear oils

Combinations of additives impart special functions to gear oils:

- ☐ Rust and oxidation preventive gear oils

Rust and oxidation preventive (R&O) oils are mainly mineral base. They contain rust and oxidation inhibitors. The viscosity of R&O oils according to the ISO grading system is between 32 to 320.

- ☐ Compounded gear oils

Compounded oils are mineral base. They contain rust and oxidation inhibitors, demulsifiers and up to 10% of fatty oils for better lubricity. Compounded oils are used mainly in worm gears. The viscosity of compounded oils according to the ISO grading system is between 460 to 1000.

☐ Extreme Pressure (EP) gear oils

EP oils may be either mineral or synthetic base. They contain EP additives, rust and oxidation inhibitors, anti-foaming agents and demulsifiers. The viscosity of EP oils according to the ISO grading system is between 68 to 1500.

☐ Synthetic gear oils

Synthetic gear oils may be based on polyalphaolefins (PAO), esters oils or polyglycols. They may contain EP additives, rust and oxidation inhibitors, anti-foaming agents and demulsifiers. The viscosity of synthetic oils according to the ISO grading system is between 32 to 6800.

Synthetic gear oils are used for gears operating under extreme conditions: very low or very high temperatures, high pressures.

Viscosity of gear oils

Viscosity of gear oils (lubricants) is a compromise between the gear parameters requiring low viscosity and those requiring high viscosity.

Low viscosity is favorable for: high speed, low loaded gears with a good tooth surface finish. Low viscosity provides thin oil film, low friction (high mechanical efficiency), good cooling (heat removal) conditions.

High viscosity is favorable for: low speed, highly loaded gears with a rough tooth surface. High viscosity provides thick oil film, high wear resistance and low galling even at high pressure (EP).

Viscosity of a gear oil depends on the temperature, therefore an oil selected for a particular gear should provide its reliable operation within the expected temperature range.

The low temperature limit of a gear oil is 9°F (5°C) higher than its **pour point** (the lowest temperature, at which the oil may flow).

Mineral oils possess relatively high pour point - about 20°F (-7°C). Pour point of synthetic oils may reach -50°F (-46°C).

The highest operation temperature in spur gears is about 130°F (54°C). In the worm gears the temperature may reach 200°F (93°C).

SAE Designation of gear oils by viscosity

The Society of Automotive Engineers (SAE) established a viscosity grading system for gear and Engine oils.

According to the SAE viscosity grading system all oils are divided into two classes: monograde and multigrade:

☐ **Monograde gear oils**

Monograde gear oils are designated by one number (70, 90, 140, 250, etc.). The number indicates a level of the oil viscosity at a particular temperature. The higher the grade number, the higher the oil viscosity.

Viscosity of gear oils designated with a number only without the letter "W" (SAE 80, SAE 90, SAE 140

etc.) was specified at the temperature 212°F (100°C). These gear oils are suitable for use at high ambient temperatures.

Viscosity of gear oils designated with a number followed by the letter “W” (SAE 70W, SAE 75W, SAE 80W etc.) was specified at the temperature 0°F (-18°C). The letter “W” means *winter*. These grades are used at low ambient temperatures.

☐ **Multigrade gear oils**

Viscosity of gear oils may be stabilized by polymeric additives (viscosity index improvers). Viscosity of such gear oils is specified at both high and low temperature. These oils are called multigrades and they are designated by two numbers and the letter “W” (SAE 75W-90, SAE 80W-90, SAE 85W-140 etc.). The first number of the designation specify the oil viscosity at cold temperature, the second number specifies the oil viscosity at high temperature.

For example: SAE 85W-140 oil has a low temperature viscosity similar to that of SAE 85W, but it has a high temperature viscosity similar to that of SAE 140.

Multigrade gear oils are used in a wide temperature range.

Designation of gear oils by performance

American Petroleum Institute (API) established a performance grading system for gear oils (mostly automotive gear oils). According to the system gear oils are designated by the letters GL (Gear Lubricant) followed by a number 1,2,3,4 or 5:

☐ GL-1

GL-1 gear oil has rust and oxidation protection effect but it does not contain extra pressure (EP) additives. the oil is used in low load applications only.

☐ GL-2

GL-2 gear oil contain more additives than GL-1, but without EP effect. It is used in medium loaded worm gears.

☐ GL-3

GL-3 gear oil possesses light EP effect. It is used in non-hypoid gears.

☐ GL-4

GL-4 gear oil possesses moderate EP effect. It is most widely used oil.

☐ GL-5

GL-5 gear oil possesses high EP effect. It is used in hypoid and other highly loaded gears.

ISO Designation of industrial gear oils

International Standardization Organization (ISO) established a viscosity grading (VG) system for industrial gear oils. According to the system industrial gear oils are designated by the letters ISO followed by a number equal to the oil viscosity measured in centistokes at 40°C (104°F):

ISO VG 32, ISO VG 46, ISO VG 68, ISO VG 100, ISO VG 150, ISO VG 220 etc.

Properties of some gear oils

(Materials Data)

- ▣ Synthetic gear oil SAE 75W-90
- ▣ Gear oil SAE 80W-90
- ▣ Gear oil SAE 85W-140
- ▣ Industrial gear oil ISO 68
- ▣ Industrial gear oil ISO 100
- ▣ Industrial gear oil ISO 150
- ▣ Industrial gear oil ISO 220

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