SMOOTH SLIDING

Consulting company providing engineering services on issues related to sliding bearings

Engine Oils

Dr. Dmitri Kopeliovich
Smooth Sliding (Owner)
King Engine Bearings (VP R&D)

1. Engine Mechanisms Lubricated by Engine Oils

Engine oil (motor oil) provides lubrication of moving and sliding parts of the internal combustion engine.

The following base stocks are used for manufacturing engine oils: mineral oil, highly refined mineral oil, ultra refined mineral oil, synthetic oil (polyalphaolefins).

- Piston motion in cylinder.
- Crankshaft rotation in engine bearings;
- Piston pin rotation in the bush of small end of the connecting rod;
- Camshaft rotation in camshaft bearings;
- Cams sliding over the valve rods.

2. Functions of Engine Oil

- **Provision of stable oil film between sliding surfaces.**

Direct contact between a rotating crankshaft and the engine bearings occurs only for short periods of engine start and shutdown. In normally operating engine there is a continuous oil film between the two surfaces. This friction regime is called hydrodynamic.

Oil film provides low coefficient of friction, distributes load applied to the bearing over its surface, cools down the sliding parts, takes foreign particles away from the friction region.

- **Provision of reliable engine operation in a wide temperature range.**

Viscosity of an oil strongly depends on its temperature.
When an engine starts at low temperature the oil is viscous (thick). If the viscosity is too high the oil will not be able to flow to the sliding parts, and the non-lubricated engine will not operate.

On the other hand, oil viscosity in a heated engine is low. The oil flows easily, however oil film thickness of the hot oil is low, and it may become less than roughness of the sliding surfaces. In this case hydrodynamic regime is broken and direct metal-to-metal contact between the surfaces occurs. Metal-to-metal contact causes excessive wear, overheating and even Fatigue of the sliding materials.

- **Rust/corrosion protection of the engine parts.**

Combustion gases containing water vapors and other chemically active gases partially penetrate to the crankcase and may cause corrosion. In addition to this some constituents of the combustion gases dissolve in the oil and increase its acidity. Such oil may become aggressive to the metal parts contacting with it.
Corrosion inhibitors are added to engine oils in order to provide protection of metallic (both ferrous and non-ferrous) parts.

- **Cleaning the engine parts from sludge.**

Combustion gases past through the piston rings to the crankcase contain some amount of not burnt carbon, which may deposit on the rings, valves and cylinders, forming a sludge. The sludge clogs oil passages and clearances decreasing lubrication of the engine parts.
In order to remove the sludge from the surface detergents are added to the engine oils.
Dispersants, which are also added to the engine oils, help to maintain the removed sludge and other contaminants (non-metallic and metallic) in form of fine suspension permitting engine functioning between the oil changes.

- **Sealing piston ring - cylinder gap.**

Imperfection on the surfaces of the piston rings and cylinders walls result in penetration of combustion gases into the crankcase, which decreases the engine efficiency and causes contamination of the oil.
Engine oil fills these microscopic passages and seal the combustion gases.

- **Prevention of foaming.**

Engine oil circulating in an engine may entrap air and form foams (foam is a mixture of a liquid with gas bubbles). Foamed oils are less effective in their important functions (oil film formation, heat removal, cleaning). In order to diminish foam formation special additives (anti-foaming agents) are added to engine oils.

- **Cooling the engine parts.**

Combustion heat and friction energy must be removed from the engine to prevent its overheating. Most of heat energy is taken by the engine oil.
Clean oil passages, proper viscosity and low contamination provide sufficient flow rate of the engine oil and effective cooling.

3. SAE Viscosity Grading System

The Society of Automotive Engineers (SAE) established a viscosity grading system for engine oils.
According to the SAE viscosity grading system all engine oils are divided into two classes: monograde and multigrade:

- **Monograde engine oils**

Monograde engine oils are designated by one number (20, 30, 40, 50, 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 engine oils designated with a number only without the letter "W" (SAE 20, SAE 30, etc.) was specified at the temperature 212°F (100°C). These engine oils are suitable for use at high ambient temperatures.
Viscosity of engine oils designated with a number followed by the letter "W" (SAE 20W, SAE 30W, etc.) was specified at the temperature 0°F (-18°C). The letter "W" means *winter*. These grades are used at low ambient temperatures.

- **Multigrade engine oils**

Viscosity of engine oils may be stabilized by polymeric additives (viscosity index improvers). Viscosity of such engine 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 5W30, SAE 15W30, SAE 20W50, 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 15W30 oil has a low temperature viscosity similar to that of SAE 15W, but it has a high temperature viscosity similar to that of SAE 30.
Multigrade oils are used in a wide temperature range. The most popular multigrade engine oil in North America is SAE 10W30.