**How to Read an Oil Can**
*by Ray Thibault*

Just like nutrition facts printed on the label of every item in a grocery store, the symbols on a can of motor oil tell consumers the service rating and certification for that product.

In the United States, the American Petroleum Institute (API) administers the licensing and certification of engine oils through a system that meets the warranty, maintenance and lubrication requirements of original equipment manufacturers. OEMs, oil marketers, additive companies and testing laboratories work together to establish engine oil performance requirements, test methods and limits for the various classifications and testing processes.

The system includes a formal licensing agreement executed by lubricant suppliers with API. Through this program, API has standardized the labeling of engine oils by adopting the donut logo (Figure 1). The logo was designed to be placed in a prominent position on a variety of lubricant quart/liter containers. API has also developed a starburst certification mark to select engine oils that meet the gasoline performance standards established by the International Lubricant Standardization and Approval Committee (ILSAC). This logo is displayed on the front of licensed motor oil product packages.

To protect the consumer, API requires that all lubricant suppliers using the API Service Symbol obtain a license to use the symbol and sign an affidavit stating that test data is available to support performance claims.

Figure 1. API Service Symbol (Donut)

Many changes with motor oil have occurred recently. The ILSAC GF-3 rating is in place but there remain concerns regarding the rocker arm sludge and piston varnishing tests to be resolved over the next few months. The SL category will be licensed by July 1, 2001, a year later than expected.

Ford and Honda recommend a viscosity of 5W-20 oil on 2001-model cars. The rest of the manufacturers recommend 5W-30. Work has already begun on GF-4 oils for a mid-2003 implementation. New and tighter emissions requirements will affect the new oils. There is concern over the level of phosphorous in the antiwear package (ZDDP) in the oils affecting the catalytic converters. This has to be balanced with the wear protection of the oils provided by the additive.

**Motor Oil Properties**
Motor oils, unlike industrial oils, operate in a severe environment and must be developed with unique properties. The primary functions of motor oil are:

* Lubricate engine moving parts to reduce friction and prevent wear.
* Clear engine of contaminants.
* Seal piston and liner for optimum engine efficiency.
* Resist high temperature degradation.
* Promote low temperature lubrication.
* Lubricate over a wide temperature range.

On the average, typical motor oils contain 18 percent additives in 82 percent basestock. New oils are faced with tougher requirements, a trend sure to continue. In response, basestock quality must continue to improve. Most new oils require Group 2 basestocks. In addition, additive technology will be challenged to meet tough standards.

**Viscosity**
The most important property of any oil is its viscosity, which is defined as its resistance to flow due to internal friction. The two major viscosity measurements used in engine oils are kinematic and absolute. Kinematic viscosity (KV) is oil’s resistance to flow and shear by the forces of gravity and is typically expressed in centistokes (cSt) or mm/sec2. Absolute viscosity is defined as oil’s resistance to flow and shear and is expressed as centipoise (cP). It is not influenced by the oil’s specific gravity. The relationship between kinematic and absolute viscosity is expressed as:

Figure 3. Measuring Kinematic Viscosity

**Kinematic Viscosity Measurement**

* Low shear rate
* Precise with 0.35 percent repeatability
* Viscosity normally determined at 40°C and 100°C (104°F and 212°F)
* Measuring time for a known volume to flow through capillary tube (efflux time) (Figure 3)
* Viscosity is determined by units expressed as centistokes (cSt) or mm/sec2

**Absolute Viscosity**
Absolute viscosity typically uses rotary viscometers to measure the torque on rotating spindle to measure a fluid’s shear resistance. The Cold Cranking Simulator (CCS), Mini-Rotary Viscometer (MRV), Brookfield Viscometer and Tapered Bearing Simulator are all rotary viscometers. Changing rotor (spindle) dimensions, the gap between the rotor and stator wall and the speed of rotation can change rate of shear. The units of absolute viscosity are expressed as centipoises (cP).

**SAE J300 Viscosity Classification**
The Cold Cranking Simulator test has excellent correlation with engine cranking data at low temperature. All values are expressed as centipoises (cP). Oils cannot exceed the maximum value to qualify as a particular weight grade. For example, oil classified as 10W cannot exceed 3,500 cP of viscosity at -20°C.

The Mini-Rotary Viscometer test is run under a low shear environment. Slow sample cooling is the sample’s key feature. This correlates with the pumpability properties of oil.

To qualify for a particular viscosity weight classification, oil must not exceed 60,000 cP for a designated temperature.

Kinematic viscosity measurements are run at 100°C (212°F). Oil with a W designation must achieve a minimum viscosity in cSt. Oil with no W designation has to fall within a minimum and maximum range; 40-weight oil must have a minimum viscosity of 12.5 cSt at 100°C (212°F) and must be less than 16.3 cSt.

Oil must be able to withstand high temperature and high shear conditions. This is achieved with the High Temperature, High Shear Viscometer Test. To qualify as a particular SAE grade, an oil must achieve a minimum viscosity at high shear and high temperature conditions.

**Multigrade Oils**
How does motor oil have good low temperature flow properties and give the protection necessary at high engine operating temperatures? This is achieved by having a high Viscosity Index which is defined as an empirical number indicating the degree of change in viscosity within a given temperature range. A high VI indicates relatively small change in viscosity with temperature change, whereas a low VI reflects a larger viscosity change with temperature. Most mineral oils range in VI from 0 to 100. Synthetics (used in motor oil) and hydrocracked stocks usually have VI temperatures exceeding 100.

Achieving the high Viscosity Indexes required by modern motor oils has been accomplished by adding VI improvers to create multigrade oils such as 10W-30. The W signifies winter and is the oil’s low temperature characteristics, while the higher number gives the oil’s high temperature viscosity properties. A 10W-30 oil behaves as 10-weight oil at low temperatures but gives the protection of 30-weight oil at the high engine operating temperatures. Viscosity Modifiers or VI improvers are high molecular weight polymers that remain inert at low temperatures. As oil is heated, they expand to help the oil maintain its viscosity.

Low viscosity base oil fortified with viscosity modifiers can perform well at low temperatures. If the viscosity modifiers break down under high shear conditions, the oil offers impaired protection at high engine temperatures. The development of shear stable viscosity modifiers has improved significantly over the years.

Consider Figure 4 before oil can be classified as 5W-30. Figure 4

The oil must have properties of both low and high temperatures to satisfy modern gasoline engine requirements.

See Table 1 and Table 2. (below)

**Conclusion**

* Gasoline engine oils are classified under the API and must meet all requirements to receive the certification demonstrated on oil containers.
* Motor oils must perform under difficult environments in both low and high temperature conditions.
* New environmental regulations will require new types of engine oil formulations.
* Emission regulations and fuel economy will require oils to be lighter in weight and to contain different additives to minimize catalyst damage.
* Basestock improvements and new additive technology will be needed to meet future stringent environmental regulations.
* Lube basestock and additive suppliers have met the challenge and will continue to do so.