Lubricants for Two-Stroke -Cycle Gasoline Engines— SAE J1510 MAR85

SAE Information Report
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Report of the Fuels and Lubricants Technical Committee, approved March 1985.

1. Introduction—The information in this report has been compiled by Subcommittee 6, Small Engine Lubricants, of the SAE Fuels and Lubricants Technical Committee. The intent is to provide those concerned with the design and maintenance of two-stroke-cycle engines with a better understanding of the properties of two-stroke-cycle lubricants. Reference is also made to test procedures that may be used to measure the chemical and physical characteristics of these lubricants.

2. Universal Classification—At the present time, engine and lubricant manufacturers use a variety of proprietary engine tests to define lubricant performance. For example, for several years, the National Marine Manufacturing Association (NMMA), formerly the Boating Industry Associations (BIA), has been approving oils for water-cooled, high performance outboard motors. Products having this approval bear a BIA TC-W® logo.

The value of a universal classification for all two-stroke-cycle lubricants is broadly accepted. SAE, API, ASTM, and CEC are currently developing such a system encompassing several categories. It will aid in the correct labeling and application of these oils and will classify them according to their ability to perform in different engine types.

3. Engine Applications—Two-stroke-cycle engines are used in many applications where importance is attached to a high ratio of net power to engine weight. Water-cooled outboard motors with displacements to 3400 cc are not common. At the other end of the scale are air-cooled engines for power tools, with displacements of 30 cc or less. In between are engines of various displacements and specific outputs. Typically, they are used to power mopeds, lawn mowers, motorcycles, small tractors, chainsaws, portable generators or pumps, snowmobiles, etc.

4. Lubrication Systems—Two approaches to two-stroke-cycle engine lubrication are common:

(a) premixed, where the lubricant is added to the fuel, and

(b) injected, where the lubricant is metered directly to the fuel intake manifold or other points using a pump that is controlled by engine speed and throttle setting.

Use of the latter system is expanding. In addition to being more convenient, it optimizes lubricant delivery rates.

5. Fuel:Oil Ratios—The ratio of fuel to lubricant depends on the engine, the application, and the lubricant. A fuel:oil ratio of 50:1 is often specified by both engine manufacturers and lubricant marketers for oils, such as those used in large outboards. However, higher ratios, e.g., 100:1, are sometimes recommended. Ratios of 16:1 to 32:1 are often specified for oils designed for use in air-cooled engines.

Variable ratios are a feature of lube injection systems. In one lube-injected snowmobile, for example, the ratio varies from 100:1 at idle, to 24:1 at wide-open throttle (WOT).

6. Lubricant Role—Two-stroke-cycle gasoline engines all utilize "once-through" lubrication. In any application, the lubricant is expected to protect the engine from wear, scuffing, ring sticking, piston deposits, and rust. It must do this without causing excessive plug fouling, pre-ignition, detonation or exhaust-port blockage. If the engine is lube-injected, the lubricant should continue to flow from the reservoir to the injection pump at the lowest ambient temperatures expected in the most severe application for which the oil is intended.

7. Oil Composition—With the wide variety of two-stroke-cycle engines and uses, it is not surprising that one lubricant composition is not optimum for all applications. However, two-stroke lubricants, like other lubricant classes, do have features in common. The base oils are most often petroleum-derived but can be synthetic or part-synthetic. Frequently, a portion of the base oil is a high viscosity component such as Bright Stock. Most oils contain an additive package to improve engine cleanliness. Many are also diluted with a high boiling paraffinic naphtha to improve the rate of mixing with gasoline and the flow at low ambient temperatures. Some two-stroke oils also contain a pour depressant.

For some applications, e.g., large outboard motors, where WOT operation for extended periods is common practice, the cleanliness additives must be essentially ashless to avoid pre-ignition and detonation. However, many lubricants, especially those designed for air-cooled engines, contain ash-containing components to improve ring zone deposit control at high operating temperatures. Many modern high performance air-cooled engines perform well with oils containing a mixture of ashless and ash-containing components.

8. Physical and Chemical Properties

8.1 Viscosity—Most undiluted two-stroke petroleum oils have kinematic viscosities in the SAE 40 grade range, i.e., from 12.5 to less than 16.3 cSt at 100°C. It is generally accepted that this viscosity range provides adequate film strength under severe operating conditions. If the oil is diluted to improve mixing and flow, the kinematic viscosity is reduced to some lower level, depending on the solvent volume. Frequently, the product becomes an SAE 20 grade and the solvent represents 10 to 25% of the total blend.

At the present time, there are no generally accepted low temperature, low shear viscosity tests or targets for two-stroke lubricants. SAE will specify the Brookfield method, ASTM D2983, in the classification under development, to define four fluidity levels.

8.2 Miscibility—The BIA TC-W® classification, developed and maintained by the NMMA, specifies a minimum rate of mixing for a lubricant in fuel under specified laboratory conditions at −10°F (−23°C); procedure BIA-312-82.

Oils meeting this specification typically contain 15 to 20% solvent. Again, the new SAE classification will define four levels of miscibility. Comparisons will be made against four reference oils. Performance levels will be defined by the time required, at a range of temperatures, for miscibility to occur when the lubricant is mixed with gasoline.

8.3 Rust—The ability of the oil to prevent internal engine corrosion during shut-down is a critical property. The BIA TC-W® classification provides a laboratory test procedure (BIA 312–82) whereby the rust inhibiting properties of an oil can be established in the presence of a brine solution. This method (or a new engine rust test under development) will also be part of the new SAE, API, ASTM classification, and is currently required for BIA TC-W® certification.

8.4 Stability and Compatibility—It is imperative that oils intended for use in lube injected engines remain homogeneous over a broad range of ambient temperatures for extended periods of time. Otherwise filter plugging and engine damage due to oil starvation may occur. Therefore, oils should be inspected to ensure they are free of sediment, particulates, immiscible liquids, etc.

Oils must remain fluid when contaminated with water. Oils which are individually satisfactory may not be so when mixed with other oils.

8.5 Pour Point—Two-stroke-cycle lubricants are usually pour depressed to ensure adequate dispensability at low ambient temperatures. The level of pour depression, which varies depending on the intended applications, can be established using method ASTM D97.

8.6 Solvent Content—The solvent content of a two-stroke oil can be established by applying the ASTM D3607 Method, Removing Volatile Contaminants from Used Engine Oils by Stripping. However, because the levels of solvent dilution are considerably higher than the fuel content of used oils, the stripping time should be extended to 6h.

8.7 Ash Content—The amount of ash formed from burning a two-stroke oil may be obtained by ASTM Method D874, Sulphated Ash from Lubricating Oils and Additives. As mentioned in Section 7, some engines do not perform satisfactorily with ash-containing oils, while others may actually benefit from them.

8.8 Elemental Analysis—The elemental analysis of ash-containing oils can be established using techniques, such as emission spectrography, X-ray flourescense, etc. The level of metal detergents, which frequently are calcium or barium salts, can be determined.

The additive level of ashless two-cycle oils generally can be determined by an analysis for elemental nitrogen.

8.9 Flash Point—The flash point of solvent diluted two-stroke-cycle oils can be quite low, e.g., in the range of 40 to 65°C (104 to 149°F) by ASTM Method D93, Flash Point by Pensky-Martens Closed Tester. Such oils may be classified as "combustible liquid." This has obvious safety implications in terms of oil manufacturing, storage, packaging, or shipment.

8.10 Color—Most two-stroke-cycle lubricants are dyed to help establish that the oil has been mixed with the gasoline prior to use. The intensity of the color should, therefore, be high enough to ensure a light but readily visible color cast to the fuel after mixing.