GUIDELINE

ASHRAE Guideline 40-2017R

Public Review Draft

Revision of Guideline 40-2017, Refrigeration Oil Description

First Public Review (May 2026)
(Complete Draft for Full Review)

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FOREWORD

(This foreword is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

Refrigeration oil covers a wide variety of commercially available or experimental lubricants that often differ widely in both composition and performance characteristics. Guideline 40 provides a uniform means of identifying particular refrigeration oils without resorting to commercial names or designations by utilizing common laboratory tests that are well recognized by those concerned with the use of the oil. The use of this guideline in the literature will permit investigators concerned with oil performance to duplicate experimental programs and allow readers to relate oil characteristics to the subject presented.

First published in 1981, Standard 99 was developed under the sponsorship of ASHRAE Technical Committee 3.4. It represents a joint effort of knowledgeable refrigerating industry consultants, equipment builders and oil suppliers to define the most meaningful laboratory tests that will adequately characterize a particular refrigeration oil. The 1981 standard was reaffirmed with minor editorial changes in 1987. In 2006, the standard was revised to include synthetic lubricants. In 2015, Standard 99 was converted to Guideline 40.

1. PURPOSE

The purpose of this guideline is to describe lubricants used in refrigeration and air-conditioning systems based on molecular structure, physical properties, and chemical properties. Because the properties of generically similar lubricants can vary significantly depending on source of formulation, terms such as "refrigeration lubricant" have little meaning in defining such materials. This guideline defines those properties critical to the precise identification of refrigeration lubricants, along with recognized test procedures for the determination of these properties.

2. SCOPE

2.1 Application. This guideline applies to lubricants used or proposed as compressor lubricants in refrigeration and air-conditioning systems.

2.2 Test Methods. This guideline provides recognized test methods to:

a. describe a specific class of refrigeration lubricant without the use of commercial designations,
b. describe the molecular structure for various classes of refrigeration lubricants, and
c. describe the critical properties needed to describe a refrigeration lubricant using recognized test procedures.

2.3 Limits. This guideline is not intended to define refrigeration oil quality through the establishment of test specifications or requirements. In addition, performance tests intended to measure quality have been excluded from this guideline.

3. DEFINITIONS

alkylbenzene: a synthetic hydrocarbon composed on a benzene ring attached to one or more saturated hydrocarbon chains.

alphaolefins: normally a paraffinic oil with an olefin bond at the alpha location (normally, off the first carbon in the chain).

aniline point: the minimum temperature at which a lubricant is soluble in aniline, a solvent for hydrocarbons. It is used to estimate the aromatic/olefin content in a lubricant.

antioxidants: typical additives that scavenge oxygen-containing species to prevent further breakdown of the lubricant or refrigerant.

antiwear/extreme pressure additive: typical additives that improve the lubrication when circumstances of boundary lubrication (lubricant film break through) are present.

aromatic content: the fraction of aromatic hydrocarbon contained in a lubricant.

aromatic hydrocarbon: a hydrocarbon compound containing one or more cyclic or ring structures characterized by alternating double bonds.

ASTM test: a test conducted according to an ASTM International standard test procedure.

cloud point: the temperature at which haziness is first observed upon cooling of a lubricant under prescribed conditions. This temperature designation also applies for refrigerant/lubricant mixtures with or without impurities.

color: the appearance of a lubricant when viewed by transmitted light.

complex ester: an ester lubricant prepared from a polyol and both mono- and dicarboxylic acids, either together or sequentially.

diester: an ester lubricant prepared from a dicarboxylic acid and monohydric alcohols.

flash point: the minimum temperature to which a lubricant must be heated under prescribed conditions in order to give off sufficient vapor to form a flammable mixture with air in the presence of an ignition source.

floc point: the highest temperature at which a mixture of lubricant and refrigerant forms a distinct precipitate.

foaming: the formation of a frothy mass of gas bubbles in or on the surface of a lubricant.

hydrotreated oil: a mineral-oil lubricant that has been treated with hydrogen to remove aromatic and olefinic components.

kinematic viscosity: a measure of a lubricant's resistance to flow.

mineral oil: a generic term representing different makeup of various types: naphthenic, paraffinic and aromatic (alkyl benzenes in contrast are synthetic aromatics). Sometimes referred to as Group II or Group III, these designations indicate that refining steps have been taken to improve the viscosity index and oxidation resistance by removing olefins, as well as, removing sulfur from crude base oil.

miscibility: a measure of the limit of mutual solubility of liquid refrigerant and lubricant fluid.

naphthenic oil: a mineral-oil lubricant fraction consisting predominately of cyclic or ring hydrocarbon structures.

olefin: a hydrocarbon molecule containing at least one carbon-to-carbon double bond.

paraffinic oil: a mineral-oil lubricant fraction in which straight and/or branched-chain hydrocarbon structures predominate.

polyalkylene glycol (PAG): a synthetic ethylene oxide and/or propylene oxide polymer normally initiated with an alcohol and sometimes capped.

polyalphaolefin (PAO): a synthetic, saturated acyclic hydrocarbon lubricant prepared from alphaolefins.

polyolester (POE): a synthetic ester lubricant prepared from a polyol and monocarboxylic acids. For refrigeration applications, polyolesters are prepared from neopentyl polyols that do not contain beta hydrogens.

polyvinyl ether (PVE): a synthetic lubricant prepared from vinyl ether monomers. The main chain of the molecule consists of carbon-to-carbon bonds, with ether-based side chains.

pour point: the lowest temperature at which a lubricant will flow under prescribed conditions.

refrigeration lubricant: a stable fluid that is compatible with system components, will form a friction-reducing film between rubbing surfaces and seal critical clearances, and has low-temperature transport properties suitable for the application in which it is used.

semi-synthetic lubricant: a mixture of synthetic and mineral-based lubricants.

solubility: a measure of the affinity for refrigerants to dissolve in refrigeration lubricants.

specific gravity: the ratio of the mass of a volume of liquid at 15.6°C (60°F) to the mass of an equal volume of water at the same temperature.

synthetic lubricant: a lubricant compound manufactured from distinct chemical compounds.

total acid number (TAN): a measure of the acidity of a lubricant.

total organic acid (TOA): total concentration of organic acids present in the lubricant.

viscosity index (VI): a measure of the change of a lubricant's viscosity with changes in temperature. A high VI value denotes a smaller viscosity change per degree of temperature change, while a low VI value denotes a larger viscosity change per degree of temperature. The lubricant or refrigerant/lubricant VI requirements are relative to the application of use.

white oil: a highly refined petroleum-based lubricant fraction that is essentially free of aromatic hydrocarbons, olefins, and heteroatoms (sulfur, nitrogen, or oxygen).

yellow metal passivator: an additive component intended to reduce corrosion of copper and copper-containing metals.

4. TEST PROCEUDRES AND SIGNIFICANCE OF TESTS

4.1 Aniline Point

4.1.1 Use Test Procedure ASTM D611 [1].

4.1.2 Per ASTM D611, a mixture of equal volumes of oil and aniline is cooled at a fixed rate until a phase separation occurs. The temperature of phase separation is the aniline point.

4.1.3 The aniline point can be used to determine the aromatic content of mineral oils. It has practical significance for mineral-based hydrocarbon lubricants in estimating rubber swell and halocarbon solubility, as the low aniline point naphthenic lubricants in general give increased rubber swell and have greater solubility in halocarbon refrigerants than do the higher aniline point paraffinic lubricants. The test is not applicable to synthetic base stocks.

4.2 Aromatic Content

4.2.1 Use Test Procedure ASTM D2549 [2].

4.2.2 A sample of the lubricant is charged on a silica gel column. Selected solvents are used to elute and separate the sample into aromatic and nonaromatic fractions.

4.2.3 The aromatic content characterizes a lubricant based on the amount of aromatic and nonaromatic fractions present. Such a characterization is not possible with many synthetic lubricants.

4.3 Cloud Point

4.3.1 Use Test Procedure ASTM D2500 [3]. Per ASTM D2500, the highest temperature at which haziness is first observed is recorded as the cloud point.

4.3.2 The cloud point of a lubricant can be a measure of contaminant content or solubility of the contaminant in the lubricant, such as process chemicals, waxes, and water.

4.4 Color

4.4.1 Use Test Procedure ASTM D1500 [4]. Per ASTM D1500, a sample of lubricant is compared to a numbered series of color standards ranging from very light pale to very dark red. The color standard that best matches the sample is the lubricant's color number.

4.4.2 Use Test Procedure ASTM D1209 [5]. Per ASTM D1209, a sample of lubricant is compared to a prepared solution of varying concentrations of platinum-cobalt. The color standard that best matches the sample is the lubricant's color number (APHA or Hazen).

4.4.3 The color of lubricant may be an indication of the base oil type, contaminants, and chemical degradation. Additionally, for mineral oils, higher anile point has a stronger color. Color is not on its own a indication of lubricant quality.

4.5 Flash Point

4.5.1 Use Test Procedure ASTM D92 [6]. Per ASTM D92, the temperature of a lubricant sample is raised at a constant rate. At specified intervals, an ignition source is applied to vapors above the liquid. This is repeated until there is a discernible ignition flash. The lowest temperature at which an ignition flash takes place is the

flash point.

4.5.2 The flash point is an indication of lubricant volatility; the lower the flash point, the greater the volatility.

4.6 Floc Point

4.6.1 Use Test Procedure in ANSI/ASHRAE Standard 86 [7]. Per Standard 86, a 9:1 mixture of R-12 and lubricant is cooled at a specific rate until the first distinct precipitate is observed. The highest temperature at which precipitate is observed is the floc point.

4.6.2 Use ANSI/ASHRAE Standard 172 [8] to determine insoluble precipitation temperatures with synthetic lubricants and HFC refrigerants other than R-12.

4.6.3 The floc point gives an indication of the wax or insoluble precipitation characteristics of a lubricant. Base oil type and degree of processing are factors affecting floc point. Low-floc point lubricants are generally required for refrigeration service.

4.7 Foam Test

4.7.1 Use Test Procedure ASTM D892 [9]. Per ASTM D892, a lubricant sample that is kept at a constant temperature is blown with air at a constant rate for 5 minutes and then allowed to settle for 10 minutes. Foam volumes are measured at the end of both periods. The foam test measures the milliliters of foam volume.

4.7.2 Foam can be a serious problem in systems operating at high speeds, with high-volume pumping and with splash lubrication. Inadequate lubrication due to foam can lead to mechanical failures. Conversely, foam is believed to be of benefit in the abatement of compressor noise, especially in small-appliance-type equipment. The test is useful in the selection of lubricants meeting desirable operating conditions. This test should be performed using the refrigerant gas of interest instead of air, and the rate of pressure changes inside the system will influence foaming.

4.8 Kinematic Viscosity

4.8.1 Use Test Procedure ASTM D445 [10]. Per ASTM D445, a known quantity of lubricant is allowed to flow through a calibrated capillary at a defined temperature. The kinematic viscosity is recorded as kinematic viscosity at a specified temperature.

4.8.2 At a given temperature, the longer the flow time, the more viscous the lubricant. Viscosity is of prime importance in selecting a lubricant for compressor applications because excessive viscosity leads to increased power consumption, while too low a viscosity can lead to gas leakage past critical clearances and increased component wear due to a lack of lubricant film.

4.8.3 The solubility of the refrigerant in the oil impacts the viscosity of the working refrigerant/lubricant mixture and should be incorporated into the engineering design. Refer to the *ASHRAE Handbook—Refrigeration*, Chapter 12, "Lubricants in Refrigerant Systems" [11].

4.9 Pour Point

4.9.1 Use Test Procedure ASTM D97 [12] or ASTM D5950 [13]. Per ASTM D97 or D5950, the lubricant is cooled at a specified rate and observed for evidence of flow at periodic intervals. The pour point is the highest temperature where flow is no longer detected.

4.9.2 Pressure and diluents as well as container size and shape will affect minimum flow temperatures.

4.10 Specific Gravity

4.10.1 Use Test Procedure ASTM D1298 [14]. Per ASTM D1298, the specific gravity of lubricants is measured using a calibrated hydrometer. The specific gravity is recorded as specific gravity at a specified temperature. Specific gravity provides a means to convert the volume of a lubricant to weight or its weight to volume. Specific gravity also allows conversion from kinematic viscosity to dynamic viscosity.

4.11 Total Acid Number (TAN)

4.11.1 Use Test Procedure ASTM D974 [15] or D664 [16]. Per ASTM D974 or ASTM D664, the acidity of lubricants is the amount of base required to neutralize acidity in the lubricant. The colorimetric method (D974) is considered to be the industry reference. TAN does not differentiate between weakly acidic organic species or strongly reactive inorganic acids.

4.11.2 The presence of acid can lead to chemical reactions such as corrosion of metals or breakdown of nonmetallic materials elsewhere in the system. Acids can be formed either from the breakdown of lubricants, refrigerants, or other system components.

4.12 Total Organic Acid

4.12.1 The concentrations of organic acids are measured via ion chromatography (IC) in parts per million.

4.12.2 Refer to Section 4.11.2. Organic acids are typically indicative of lubricant breakdown.

4.13 Viscosity Index (VI)

4.13.1 Use Test Procedure ASTM D2270 [17]. Per ASTM D2270, the viscosity index of lubricating oils is calculated from measured kinematic viscosity values at 40°C (104°F) and 100°C (212°F) as a reference to a historical calibration oil. The viscosity index of a lubricant is a number that characterizes the change of viscosity with temperature. Lubricants with a higher VI show a smaller viscosity change with temperature.

4.14 Moisture

4.14.1 Use ASTM D1533 [18] and E1064 [19].

4.14.2 The amount of moisture can lead to increased corrosion, catalyzed reactions, lubricant degradation and hydrolysis, icing and plugging of the expansion device, and other negative system effects.

4.15 Refrigerant-Lubricant Interactions. The following lubricant test procedures are more significant when tested in combination with refrigerant.

4.15.1 Dielectric Strength

4.15.1.1 Use Test Procedure ASTM D877 [20]. Per ASTM D877, the dielectric breakdown voltage is a measure of the ability of an insulating liquid to withstand electrical stress. It is typically measured in kV.

4.15.1.2 Dielectric strength is of particular importance when the refrigerant-lubricant breakdown is used in systems with a hermetic or semi-hermetic compressors as the lubricant must withstand the electrical stress created by the electrical system.

4.15.2 Miscibility and Solubility

4.15.2.1 Use Test Procedure ANSI/ASHRAE Standard 218 [21] to determine the miscibility of refrigerant and lubricant mixtures.

4.15.2.2 Miscibility defines the limits at which refrigerant-lubricant mixtures form a single liquid phase. Miscibility is considered during system design to determine suitable methods for returning lubricant to the compressor. Refrigerant solubility in the lubricant greatly reduces the lubricant's viscosity, thus promoting lubricant circulation.

4.15.3 Volume Resistivity

4.15.3.1 Use Test Procedure ASTM D1169 [22]. However, to reflect that lubricants are used with refrigerants at pressures higher than atmospheric pressure, the experiment should be carried out within a pressurized vessel.

4.15.3.2 The volume resistivity is of particular importance when the refrigerant-lubricant combination is used in systems with hermetic or semi-hermetic compressors as the lubricant-refrigerant mixture contributes to the overall electrical isolation.

5. REFERENCES

1. ASTM. 2023. ANSI/ASTM D611-23, *The Standard Test Methods for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents*. West Conshohocken, PA: ASTM International.
2. ASTM. 2023. ANSI/ASTM D2549-23, *Standard Test Method for Separation of Representative Aromatics and Nonaromatics Fractions of High-Boiling Oils by Elution Chromatography*. West Conshohocken, PA: ASTM International.
3. ASTM. 2023. ASTM D2500-23, *Standard Test Method for Cloud Point of Petroleum Products and Liquid Fuels*. West Conshohocken, PA: ASTM International.
4. ASTM. 2024. ASTM D1500-24, *Standard Test Method for ASTM Color of Petroleum Products (ASTM Color*

Scale). West Conshohocken, PA: ASTM International.

5. ASTM. 2025. ASTM D1209-25, *Standard Test Method for ASTM Color of Clear Liquids (Platinum-Cobalt Scale)*. West Conshohocken, PA: ASTM International.
6. ASTM. 2024. ANSI/ASTM D92-24, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*. West Conshohocken, PA: ASTM International.
7. ASHRAE. 2013. ANSI/ASHRAE Standard 86, *Methods of Testing the Floc Point of Refrigeration Grade Oils*. Peachtree Corners, GA: ASHRAE.
8. ASHRAE. 2024. ANSI/ASHRAE Standard 172, *Method of Test for Insoluble Materials in Lubricants and Refrigerant Systems*. Peachtree Corners, GA: ASHRAE.
9. ASTM. 2025. ANSI/ASTM D892-25, *Standard Test Method for Foaming Characteristics of Lubricating Oils*. West Conshohocken, PA: ASTM International.
10. ASTM. 2024. ASTM D445-24, *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)*. West Conshohocken, PA: ASTM International.
11. ASTM. 2022. ANSI/ASTM D97-17b, *Standard Test Method for Pour Point of Petroleum Products*. West Conshohocken, PA: ASTM International.
12. ASHRAE. 2026. *ASHRAE Handbook—Refrigeration*, Chapter 12, "Lubricants in Refrigeration Systems". Peachtree Corners, GA: ASHRAE.
13. ASTM. 2020. ASTM D5950-14, *Standard Test Method for Pour Point of petroleum products (Automatic Tilt Method)*. West Conshohocken, PA: ASTM International.
14. ASTM. 2024. ASTM D1298-24, *Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method*. West Conshohocken, PA: ASTM International.
15. ASTM. 2022. ASTM D974-22, *Standard Test Method for Acid and Base Number by Color-Indicator Titration*. West Conshohocken, PA: ASTM International.
16. ASTM. 2024. ASTM D664-24, *Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration*. West Conshohocken, PA: ASTM International.
17. ASTM. 2024. ASTM D2270-24, *Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40˚C and 100˚C*. West Conshohocken, PA: ASTM International.
18. ASTM. 2020. ASTM D1533-20, *Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration*. West Conshohocken, PA: ASTM International.
19. ASTM. 2024. ASTM E1064-24, *Standard Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration*. West Conshohocken, PA: ASTM International.
20. ASTM. 2024. ASTM D877/D877M-19e1, *Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes*. West Conshohocken, PA: ASTM International.
21. ASHRAE. 2026. ANSI/ASHRAE Standard 218, *Method of Test for Lubricant and Refrigerant Miscibility Determination*. Peachtree Corners, GA: ASHRAE.
22. ASTM. 2019. ASTM D1169-19a, *Standard Test Method for Specific Resistance (Resistivity) of Electrical Insulating Liquids.* West Conshohocken, PA: ASTM International.