Designation: D5372 − 20

Standard Guide for Evaluation of Hydrocarbon Heat Transfer Fluids[1]

This standard is issued under the fixed designation D5372; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*[2]

1.1 This guide provides information, without specific limits, for selecting standard test methods for testing heat transfer fluids for quality and aging. These test methods are considered particularly useful in characterizing hydrocarbon heat transfer fluids in closed systems.

1.2 The values stated in SI units are to be regarded as standard.

1.2.1 *Exception*—The values given in parentheses are for information only.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D86 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure
D91 Test Method for Precipitation Number of Lubricating Oils
D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester
D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
D95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
D97 Test Method for Pour Point of Petroleum Products
D189 Test Method for Conradson Carbon Residue of Petroleum Products
D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
D471 Test Method for Rubber Property—Effect of Liquids
D524 Test Method for Ramsbottom Carbon Residue of Petroleum Products
D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
D893 Test Method for Insolubles in Used Lubricating Oils
D1160 Test Method for Distillation of Petroleum Products at Reduced Pressure
D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
D1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)
D2270 Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 °C and 100 °C
D2887 Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography
D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
D4530 Test Method for Determination of Carbon Residue (Micro Method)
D6743 Test Method for Thermal Stability of Organic Heat Transfer Fluids
D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)
D7896 Test Method for Thermal Conductivity, Thermal Diffusivity, and Volumetric Heat Capacity of Engine Coolants and Related Fluids by Transient Hot Wire Liquid Thermal Conductivity Method
E203 Test Method for Water Using Volumetric Karl Fischer Titration
E659 Test Method for Autoignition Temperature of Chemicals
E1269 Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry
G4 Guide for Conducting Corrosion Tests in Field Applications

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

[1] This guide is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricantsand is the direct responsibility of Subcommittee D02.L0.06 on Non-Lubricating Process Fluids.

Current edition approved Sept. 1, 2020. Published October 2020. Originally approved in 1993. Last previous edition approved in 2017 as D5372 – 17. DOI: 10.1520/D5372-20.

[2] The background for this standard was developed by a questionnaire circulated by ASTM-ASLE technical division L-VI-2 and reported in *Lubrication Engineering*, Vol 32, No. 8, August 1976, pp. 411–416.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

3.1.1 *heat transfer fluid, n*—a petroleum oil or related hydrocarbon material which remains essentially a liquid while transferring heat to or from an apparatus or process. Small percentages of nonhydrocarbon components such as antioxidants and dispersants can be present.

4. Significance and Use

4.1 The significance of each test method will depend upon the system in use and the purpose of the test method as listed under Section 5. Use the most recent editions of ASTM test methods.

5. Recommended Test Procedures

5.1 *Pumpability of the Fluid:*

5.1.1 *Flash Point*, closed cup (Test Method D93)—This test method will detect low flash ends which are one cause of cavitation during pumping. In closed systems, especially when fluids are exposed to temperatures of 225 °C (approximately 400 °F) or higher, the formation of volatile hydrocarbons by breakdown of the oil may require venting through a pressure relief system to prevent dangerous pressure build-up.

5.1.2 *Pour Point* (Test Method D97)—The pour point can be used as an approximate guide to the minimum temperature for normal pumping and as a general indication of fluid type and low-temperature properties. Should a heat transfer system be likely to be subjected to low temperatures when not in use, the system should be trace heated to warm the fluid above minimum pumping temperature before start-up.

5.1.3 *Viscosity* (Test Method D445 or D7042)—Fluid viscosity is of importance in the determination of Reynolds and Prandtl numbers for heat transfer systems, to estimate fluid turbulence, heat transfer coefficient, and heat flow. Generally, a fluid that is above approximately 200 centistokes is difficult to pump. The pump and system design will determine the viscosity limit required for pumping. The construction of a viscosity/temperature curve using determined viscosities can be used to estimate minimum pumping temperature.

5.1.4 *Specific Gravity* (Test Method D1298 or D4052)—Hydraulic shock during pumping has been predicted via the use of a combination of density and compressibility data.

5.1.5 *Water Content* (Test Methods D95 or E203)—The water content of a fresh heat transfer fluid can be used to indicate how long the heat transfer system must be dried out during commissioning, while raising the bulk oil temperature through the 100 °C plus region, with venting, before the system can be safely used at higher temperatures. The expansion tank should be partially full (not empty) during the operations to ensure that moisture is safely vented in the lowest pressure part of the system. A nitrogen sweep through the expansion tank can assist with water removal. Positive nitrogen pressure on the heat exchange systems will minimize entry of air or moisture. Heat transfer systems operating at temperatures of 120° or greater must, for reasons of safety, be dry, because destructive high pressures are generated when water enters the high-temperature sections of the system. Heating the oil before it is placed in service also removes most of the dissolved air in the oil. If not removed, the air can cause pump cavitation. The air can also accumulate in stagnant parts of the system at high pressure and could cause an explosion.

5.2 *Safety in Use:*

5.2.1 *Autoignition Temperature* (Test Method E659)—The above test relates to the autoignition temperature of a bulk fluid. Hydrocarbon fluids absorbed on porous inert surfaces can ignite at temperatures more than 50 °C (approximately 100 °F) lower than indicated by Test Method E659. An open flame will ignite leaking hydrocarbon fluids exposed on a porous surface at any temperature.

5.2.2 *Flash Point* (Test Methods D92 or D93)—Some heat transfer fluids are volatile and present a fire hazard at slightly elevated temperatures, or even below 25 °C (77 °F).

5.3 *Effect on Equipment:*

5.3.1 *Effect on Rubber or Elastomeric Seals* (Test Method D471)—Most seals in heat exchange equipment are made of steel or other metal. If rubber seals are present, it is desirable to maintain rubber swelling in the range of 1 % to 5 % to prevent leakage because of poor seal contact. Seals may degrade in some fluids. As an oil deteriorates in service, additional tests may be required to ensure that seals remain compatible with the altered oil. The temperature ranges of the tests should correspond to temperatures to which seals will be exposed in service.

5.3.2 *Corrosion* (Guide G4)—The above tests concern selection of materials of construction with fluids usable for heat transfer systems. Guide G4 uses test metal specimens fixed within the stream of test fluid under use. The specimens and conditions for test must be specified for each system.

5.4 *Efficiency:*

5.4.1 *Thermal Conductivity* (Test Method D7896) and *Specific Heat* (Test Method E1269)—These thermal conductivity and specific heat tests are difficult to carry out, facilities for performing them are few, and the precision data is yet to be established. Values can be estimated for design use from the general chemical composition. Differences contribute to efficiency to a lesser degree than values such as viscosity, moisture contamination, and other measurable values in 5.1 and 5.5 of this guide. The values for thermal conductivity and specific heat may be available from the fluid supplier.[4]

5.5 *Service Life:*

5.5.1 *Thermal Stability, Laboratory Tests* (Test Method D6743)—Thermal stability is here defined as the resistance of a hydrocarbon liquid to permanent changes in properties that make it a less efficient heat transfer fluid. These changes may be related to alterations in the liquid's properties, such as viscosity, or to the tendency to foul heat exchanger surfaces with insulating deposits. Normally, testing should be done in the absence of air and moisture to stimulate "tight" systems. The test may be useful for assessing the remaining service life of a used fluid, or it may be used to compare the expected service life of competitive new heat transfer fluids.

5.5.2 The following test methods can be used to determine the change in values between new and used fluids, or between a fluid before and after subjection to a laboratory thermal

[4] Useful estimates may be obtained from sources such as the "Technical Data Book, Petroleum Refining," American Petroleum Institute, 1220 L St., N.W, Washington, DC 20005-4070.