Designation: D 923 – 07

Standard Practices for Sampling Electrical Insulating Liquids[1]

This standard is issued under the fixed designation D 923; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 These practices cover sampling of new electrical insulating liquids including oils, askarels, silicones, synthetic liquids, and natural ester insulating liquids as well as those insulating liquids in service or subsequent to service in cables, transformers, circuit breakers, and other electrical apparatus. These practices apply to liquids having a viscosity of less than 6.476×10^{-4} m^2/s (540 cSt) at 40°C (104°F).

1.2 Representative samples of electrical insulating liquids are taken for test specimens so that the quality pertinent to their use may be determined. The quality in different portions of a given container, or the average quality of the whole bulk may be ascertained if desired.

1.3 The values stated in SI units are regarded as the standard where applicable. Inch pound units are used where there is no SI equivalent.

1.4 These practices also include special techniques and devices for sampling for dissolved gases-in-oil (DGA) (D 3612), water (D 1533) and particles (D 6786).

1.5 For ease of use, this document has been indexed as follows:

1.6 Handle askarels containing polychlorinated biphenyls (PCBs) according to federal and local regulations existing for that country. For example, the federal regulations concerning PCBs in the United States can be found in 40 CFR Part 761.

1.7 Properly contain, package and dispose of any liquid or material resulting from the use of these practices in a manner that is in accordance with local and state regulations specific to the country in which the samples are taken.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific warning statements are given in 1.6, 1.7, Section 5, 10.1, 13.2, 15.2.3, Section 16, and 18.2. These practices involve close contact with the electrical insulating liquids being sampled as well as liquids and other materials used to clean the sampling tools and devices. When required, or as a matter of diligence to personal safety, use personal protective equipment (PPE).

[1] These practices are under the jurisdiction of ASTM Committee D27 on Electrical Insulating Liquids and Gases and is the direct responsibility of Subcommittee D27.07 on Physical Test.

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2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 1533 Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration

D 1933 Specification for Nitrogen Gas as an Electrical Insulating Material

D 3612 Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D 6786 Test Method for Particle Count in Mineral Insulating Oil Using Automatic Optical Particle Counters

3. Terminology

3.1 *Definition:*

3.1.1 *sampling*—the obtaining of that amount of a material which is adequate for making the required tests and which is representative of that portion of the material from which it is taken.

3.1.1.1 *Discussion*—In most cases the detection of contaminants that are not ordinarily dispersed uniformly through the liquid being sampled, such as water or solid particles, necessitates taking samples at specific locations where the contaminants are likely to be found. For a liquid having a relative density (specific gravity) less than one, water and some other impurities are most likely to be found on or near the bottom. In the case of a liquid having a specific gravity greater than one, some of these impurities are most likely to be found on or near the surface.

4. Significance and Use

4.1 Accurate sampling, whether of the complete contents or only parts thereof, is extremely important from the standpoint of evaluating the quality of the liquid insulant sampled. Obviously, examination of a test specimen that, because of careless sampling procedure or contamination in sampling equipment, is not directly representative, leads to erroneous conclusions concerning quality and in addition results in a loss of time, effort, and expense in securing, transporting, and testing the sample.

4.2 A study of gases and moisture contained in insulating oils from transformers and other electrical power apparatus can frequently give an early indication of abnormal behavior of the apparatus, and may indicate appropriate action be taken on the equipment before it suffers greater damage. Specific gas and moisture content can be determined from oil sampled for this purpose.

5. Mandatory Conditions and General Information

5.1 *Mandatory Conditions when Sampling Electrical Apparatus*:

5.1.1 Energized electrical apparatus being sampled must have a positive pressure at the sampling outlet, so as not to introduce an air bubble into the apparatus during the sampling process. Refer to 7.2.

5.1.2 Do not draw samples from any energized electrical equipment with a small volume of oil, especially those that require the addition of oil to maintain the electric strength of the insulation system. If the proper level or existing level can not be accurately determined do not proceed.

5.1.3 Maintain the insulating fluid within the electrical apparatus being sampled at a level that will not reduce the electric strength of the insulation system.

5.1.4 Do not sample electrical apparatus if only a drain plug is provided, as it would be difficult to control the flow.

5.1.5 Do not draw samples from energized instrument transformers such as CTs and PTs.

5.2 *General Information*:

5.2.1 Take and handle samples or test specimens in such a manner as to avoid the loss or gain of properties for which they are being tested. Some tests are greatly affected by minute traces of impurities, and it is imperative that utmost precautions be taken to prevent contamination when obtaining samples. Due to the hygroscopic tendency of insulating liquids, it is important to minimize exposure to the atmosphere of the sample being taken.

5.2.2 Take a sufficient quantity of liquid as a sample to cover the requirements of the respective tests to be made. Make reference to the procedures governing these tests to ascertain the quantity of liquid for each test specimen and the number of test specimens required.

5.2.3 When samples are to be taken the temperature of the liquid should be equal to or greater than the temperature of the surrounding air in order to minimize the possibility of condensed moisture from the air being absorbed by the liquid during the sampling process, particularly in a humid atmosphere.

5.2.4 When taking samples of liquid from large storage tanks, transformers, oil-circuit breakers, gravity-fed reservoirs on oil-filled cable feeders, and other electrical equipment, the electrical equipment drain valve is usually adequate. However, when high relative humidity conditions exist and it is desired to obtain samples through a closed system, the manifold in Fig. 10 is recommended.

5.3 *General Information when Sampling Electrical Apparatus*:

5.3.1 All non-hermetically sealed equipment, filled with insulating liquid having a relative density (specific gravity) less than 1, should be provided with the sampling outlet located at the bottom of the tank so that bottom samples of the oil may be obtained.

5.3.2 All non-hermetically sealed equipment, filled with insulating liquid having a relative density (specific gravity) greater than 1, should be provided with the sampling outlet located at the top of the tank at the 25°C (77°F) liquid level so that a top sample of the liquid may be obtained.

5.3.3 When make-up liquid is added to any piece of electrical equipment or the liquid is filtered, allow sufficient

[2] 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.

time to lapse to allow for complete mixing before sampling in order that a representative sample is obtained.

5.3.4 If samples or test specimens must be taken when the liquid temperature is below 0°C (32°F), high water content may not be detected because of the formation of ice. Ice is a concern in both energized and de-energized electrical apparatus where insulating oil-filled compartments operate at temperatures below freezing, such as some tap changer compartments and circuit breaker tanks.

5.3.5 When retrieving samples from electrical apparatus, record the apparatus temperature (°C) along with the identification information as required by Section 19. Knowledge of the apparatus temperature (°C) at the time of sampling aids in the interpretation of results from certain tests (Refer to Appendix X1).

5.4 *General Information when Sampling Liquid-Filled Tanks, Drums, Tank Trucks, Tank Cars and other Similar Containers*:

5.4.1 When sampling large outdoor tanks, tank trucks, tank cars, and de-energized electrical equipment the temperature of the liquid to be sampled may be colder than the surrounding air. On such an occasion, determine and report the temperature of the liquid and air as well as the relative humidity with the results of tests. It is undesirable to collect samples that are exposed to the atmosphere when the relative humidity exceeds 50 % or under conditions of rain or snow.

5.4.2 Allow containers of new liquid to remain undisturbed for at least 8 h before samples or test specimens are taken. In some instances, such as in the case of tank cars, it is not practical to wait this prescribed length of time, and samples for routine tests may be taken after the liquid has remained undisturbed for as long a period as practicable. For referee tests, allow the full 8-h waiting period to elapse before taking samples or test specimens. Repeat samples or test specimens from tank cars may be taken without waiting an additional 8 h.

5.4.3 Unless otherwise specified, take samples of insulating liquids having a relative density (specific gravity) of less than 1 from the bottom of the liquid container. For drums, cans, small tanks, etc., design the sampling device so that the sample is obtained a distance of 3 mm from the bottom of the container, while for large tanks, tank trucks and tank cars, the distance is within 13 mm of the bottom.

5.4.4 Unless otherwise specified, take samples of insulating liquids having a relative density (specific gravity) of greater than 1 from the surface layer of the liquid.

6. Description of Sampling Devices and Containers

6.1 Devices suitable for withdrawing samples of liquid from containers, electrical equipment, cable feeders, and cable joints are described below, shown in Figs. 1–10 and the Annex, and discussed in Appendix X1.

6.2 *Electrical Equipment Sampling Drain Valve or Port*—Used for taking top or bottom samples from energized or de-energized electrical apparatus. This device is especially suitable when collecting samples in a glass jar, metal can, or other suitable containers as described in this section.

6.3 *Glass Bottle*—Used for securing and storing the sample. Amber or clear (see Notes 1 and 2) and may be either glass-stoppered or fitted with screw caps having a pulp-board liner faced with tin or aluminum foil, or with a suitable oil-resistant plastic such as polyethylene, polytetrafluoroethylene (PTFE) or fluoro-elastomers. Do not use any incompatible natural or synthetic rubber materials. Must meet the requirements of Section 16. (See Appendix X2.)

NOTE 1—While amber-colored glass bottles are used for storing samples as protection against light, clear glass bottles afford better visual inspection of the samples or test specimens for impurities such as water and foreign particles. Take samples that are to be subjected to referee tests in new amber-colored containers that have been cleaned as described in Section 16.

6.4 *Other Bottle or Can Containers (Note 2)*—Used for securing and storing the sample. May be constructed from a suitable oil-resistant plastic such as high-density polyethylene (HDPE) (do not use for long term storage when water content is to be determined), or metal cans such as those made from aluminum, stainless steel, other appropriate metal, or PTFE lined. Metals cans are to be constructed as fully extruded, pressed seams or welded seams. Solder seams may leave a residue that will contaminate the sample. Screw caps and closures must meet the requirements of 6.3. (See Appendix X2.)

NOTE 2—It is recommended to retrieve samples for DGA and water analysis using only syringes or stainless steel cylinders. If bottles and cans are used, gases that are to be measured in the DGA analysis can easily escape from these types of containers. Alternatively, environmental gases can become entrained into the sample. Both situations can alter the results significantly.

6.5 *Glass Syringe*—The device shown in Fig. 1 must be of a suitable size terminated with a Luer lock fitting to which is attached a three-way stopcock. It is used for taking samples usually from a valve located on an insulating liquid-filled electrical apparatus. Syringes having precision ground barrels and pistons are preferred. This sampling device is the preferred mechanism for taking samples for dissolved gases-in-oil and water content. Refer to Figs. 1–4 for step by step instruction on how the device is to be used. (See Appendix X2.)

6.5.1 Stopcocks used on syringes must be compatible with the insulating liquid being sampled. Polycarbonate and polystyrene for example stopcocks are not appropriate.

6.6 *Stainless Steel Sampling Cylinders*—The device shown in Fig. 5 is equipped with valves on each end may be used for sampling from a valve located on an insulating liquid-filled electrical apparatus. This is an alternative sampling device for taking samples for dissolved gases-in-oil, water content, and areas of excessive environmental contamination.

6.6.1 The materials of construction of the valves used on stainless steel cylinders must be compatible with the liquid being sampled. Valve packing materials such as Nitrile rubber, fluoro-elastomers and PTFE have been found suitable.

6.7 *Dip Type or Drum Thief*—The device shown in Fig. 6 is used for taking bottom samples from drums, storage tanks, and small de-energized electrical equipment, that are to be subjected to routine tests. It is fabricated of metal, glass or a compatible plastic and available from most laboratory supply houses. It is not recommended for use under the following conditions:

6.7.1 When the samples are to be subjected to referee tests,