INTERNATIONAL STANDARD

ISO 6297

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Petroleum products — Aviation and distillate fuels — Determination of electrical conductivity

Produits pétroliers — Carburants aviation et distillats — Détermination de la conductivité électrique

Reference number
ISO 6297:1997(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 6297 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

This second edition cancels and replaces the first edition (ISO 6297:1983), which has been technically revised.

Annex A of this International Standard is for information only.

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Petroleum products — Aviation and distillate fuels — Determination of electrical conductivity

WARNING — The use of this International Standard may involve hazardous materials, operations and equipment. This International Standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard specifies a method for the determination of the electrical rest conductivity of aviation and distillate fuels with or without a static dissipator additive. The method measures conductivity when the fuel is uncharged, i.e. electrically at rest (known as rest conductivity).

Two methods are available for fuel conductivity measurement, either using a portable meter for the direct measurement in tanks or laboratory and field measurement of samples, or using an in-line meter for continuous measurement of fuel conductivities (equivalent to rest conductivity) in a flowing stream. When using either type of instrument care should be taken in allowing the relaxation of residual electrical charges before measurement and in preventing contamination.

The procedure can be used to measure conductivities from 1 pS/m to 2 000 pS/m using the equipment used to establish the reported precision. The range can be extended to greater than 2 000 pS/m with the correct selection of electrode size and current measuring apparatus.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3171:1988, *Petroleum liquids - Automatic pipeline sampling.*

ASTM D4057 : 1988, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*

3 Definitions

For the purposes of this International Standard the following definition applies.

3.1 rest conductivity: The reciprocal of the resistivity of uncharged fuel in the absence

of ionic depletion or polarization.

This is the electrical conductivity, expressed in picosiemens per metre (pS/m), at the initial instant of current measurement after a d.c. voltage is impressed between the electrodes.

NOTE 1 — The term conductivity unit (CU) is equal to 1 pS/m. A siemens is the SI definition of reciprocal ohm sometimes called mho (Ω^{-1}).

4 Principle

A voltage is applied across two electrodes immersed in the fuel and the resulting current expressed as a conductivity value. With portable meters, the current measurement is made almost instantaneously upon application of the voltage to avoid errors arising from ion depletion. Ion depletion or polarization is eliminated in dynamic monitoring systems by continuous replacement of the sample in the measuring cell.

5 Reagents

5.1 Propan-2-ol, reagent grade.

5.2 Toluene, reagent grade.

6 Apparatus

6.1 Portable conductivity cell and current-measuring apparatus, capable of giving a conductivity reading almost instantaneously with the application of a voltage.

6.2 In-line conductivity measuring cell, incorporating a facility to remove electrostatic charges before the representative fuel stream is passed through an in-line measuring cell.

NOTE 2 — A controlled continuous flow through the fuel cell prevents ion depletion thereby providing the equivalent of rest conductivity as a continuous measurement. This in-line instrument is designed for permanent installation in the fuel distribution system. It includes a pump to ensure constant flow through the fuel cell and also a sensor to monitor temperature.

Any sample tapping point shall be installed at least 30 m downstream of any additive injection system, unless a mixing device is used which has been shown to give adequate mixing of the additive concerned prior to sampling.

6.3 Temperature sensor, having a range suitable for measuring the temperature of fuel samples in the field to ± 1 °C. This is only required when using the portable conductivity cell.

6.4 Measuring vessel, capable of holding sufficient fuel sample to cover the electrodes of the conductivity measuring cell to the depth required for that particular piece of apparatus.

7 Sampling

To avoid errors in the measurement of fuel conductivity, either carry out the measurements *in situ*, or take samples using the procedures specified in ASTM D4057 or ISO 3171. The following additional precautions are also required:

a) the sample size shall be as large as practicable and not less than 1 litre;

b) containers shall be fully epoxy-lined cans or of polytetrafluoroethylene (PTFE) only (see note 3);

c) prior to sampling, all containers and their closures shall be rinsed at least three times with the fuel being sampled;

d) samples shall be tested as soon as possible after sampling.

NOTE 3 — Test method results are known to be sensitive to trace contamination during the sampling operation and from sample containers. New containers are recommended, but when only used containers are available they shall be thoroughly rinsed with cleaning solvent, propan-2-ol (5.1), followed by toluene (5.2), and dried with a stream of air.

8 Procedure

8.1 Calibration

Carry out calibration procedures in accordance with the equipment manufacturer's instructions immediately prior to use of the apparatus.

8.2 *In situ* field measurements in tanks, tank cars, trucks, etc.

NOTES

4 — For field measurements portable conductivity meters are considered suitable. In order to satisfy local safety regulations they should be certified as intrinsically safe for use in hazardous locations. Each meter has, or can be equipped with, an extension cable to lower the cell into the tank.

5 — High impedance hand-held meters are susceptible to electrical transients caused by the extension cable flexing during measurements. Failure to hold the apparatus steady may result in significantly reduced precision.

8.2.1 Check the calibration and earth (ground) the meter to the tank. Lower the conductivity cell into the tank to the desired level, taking care to avoid partial immersion or contact with tank water bottoms, if present. Move the conductivity cell in an up-and-down motion to remove air and previous fuel residues.

CAUTION - To prevent static discharge between a charged fuel and a conductive probe inserted into a tank, the appropriate safety precautions of earthing (grounding) and waiting for charge dissipation should be observed. It is recommended that a 30 min interval be allowed after pumping into a storage tank before an operator mounts a tank to insert a sampling device. This will ensure that the fuel is electrically at rest.

NOTE 6 — If the cell is in contact with water and the instrument is switched on, an immediate off-scale reading will be obtained. If the cell has been in contact with water, it should be thoroughly rinsed with cleaning solvent, and dried with a stream of air. In hot, humid conditions, condensation on the cell can occur, which can also cause high zero, calibration and sample readings. This can be avoided by storing the cell at a temperature 2 °C to 5 °C in excess of the maximum ambient temperature.

8.2.2 After flushing the cell, hold it steady and, after activating the instrument, record the highest reading after initial stabilization.

NOTE 7 — Stabilization should occur within 3 s.

On instruments with more than one scale range, select the scale which gives the greatest sensitivity for the conductivity value being determined. Record the fuel conductivity and temperature.

8.3 Laboratory and field measurements on sampled fuels

8.3.1 Prepare containers in accordance with 7 c).

8.3.2 Rinse the conductivity cell and measuring vessel with the fuel under test to remove previous fuel residues. Transfer the fuel to the measuring vessel, check the meter calibration, immerse the conductivity cell to the depth given in the manufacturer's instructions and measure the conductivity of the sample in accordance with 8.2. Ensure that the bottom of the conductivity cell does not touch the sample container, whatever the material of construction. Record the fuel conductivity and temperature.

8.4 Continuous in-line conductivity measurements

8.4.1 Ensure the conductivity cell is thoroughly purged of air.

8.4.2 Check the calibration and select the appropriate scale range for the fuel stream whose conductivity is being measured. Record the fuel conductivity and temperature.

9 Expression of results

Express the results either in picosiemens per metre (pS/m) to the nearest unit shown on the instrument used, or as less than 1 pS/m if the instrument reads zero; also the temperature of measurement to the nearest 1 °C.

NOTE 8 — It is recognized that the electrical conductivity of a fuel varies with temperature and the relationship differs for various types of aviation and distillate fuels. If it is necessary to correct the conductivity readings to a particular temperature, each laboratory should establish this relationship for the fuels and temperature range of interest.

10 Precision

NOTE 9 — The precision values given in table 1 were determined in accordance with ISO 4259, *Petroleum products — Determination and application of precision data in relation to methods of test*, on data obtained during the exercises referenced in annex A. The reproducibility values are subject to the limitations described in note 10.

10.1 Repeatability

The difference between successive test results obtained by the same operator with the same apparatus under constant operating conditions on identical test material, in the normal and correct operation of the test method, would exceed the values shown in table 1 in only one case in twenty.

10.2 Reproducibility

The difference between two single and independent measurements of conductivity obtained by different operators working at the same location (see note 10) on identical test material at the same fuel temperature, in the normal and correct operation of the test method, would exceed the values given in table 1 in only one case in twenty.

Table 1 - Precision values

Conductivity	Repeatability pS/m	Reproducibility pS/m
1	1	1
15	1	3
20	1	4
30	2	6
50	3	10
70	4	13
100	5	17
200	10	32
300	14	45
500	21	69
700	29	92
1 000	39	125
1 500	55	177

NOTES

10 — The reproducibility values given in table 1 were not obtained under the conditions of the standard definition of reproducibility. (The values were derived from results obtained at the same location on the same day, by different operators/instruments testing identical samples). Results obtained from samples at different times and locations, i.e. under standard reproducibility conditions, may not give comparable reproducibility values since the samples may change randomly due to sampling and environmental factors.

11 — The precision limits in table 1 are applicable at 20 °C for portable hand-held meters only. Significantly inferior precision (× 2) may apply at low temperatures, e.g. – 20 °C.

12 — The data used to determine the precision of this test method within the range 1 pS/m to 1 500 pS/m was obtained without extension cables on hand-held meters and did not include any gasolines or solvents.

13 — The repeatability of the in-line continuous conductivity meter has been established to be within the range given for the portable instruments but the reproducibility has not been determined.

11 Test report

The test report shall contain at least the following information:

a) a reference to this International Standard;

b) the type and complete identification of the product tested;

c) the result of the test (see clause 9);

d) any deviation, by agreement or otherwise, from the standard procedures specified;

e) the date of the test.