International Standard 6297

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Petroleum products — Aviation and distillate fuels containing a static dissipator additive — Determination of electrical conductivity

Produits pétroliers — Carburants aviation et distillats contenant un additif destiné à éliminer l'électricité statique — Détermination de la conductivité électrique

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 6297 was developed by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, and was circulated to the member bodies in February 1982.

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It has been approved by the member bodies of the following countries :

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Petroleum products — Aviation and distillate fuels containing a static dissipator additive — Determination of electrical conductivity

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0 Introduction

0.1 The ability of a fuel to dissipate charge that has been generated during pumping and filtering operations is controlled by its electrical conductivity, which depends upon its content of ion species. If the conductivity is sufficiently high, charges dissipate fast enough to prevent their accumulation and dangerously high potentials in a receiving tank are avoided.

0.2 Two methods are available for field tests of fuel conductivity, namely a portable meter method for the direct measurement in tanks or the field or laboratory measurement of fuel samples, and an in-line meter method for the continuous measurement of fuel conductivities in a fuel distribution system.

In using either type of instrument, care must be taken in allowing the relaxation of residual electrical charges before measurement and in preventing fuel contamination. For specification purposes, conductivity measurements should be made with the portable meters.

1 Scope and field of application

This International Standard specifies two methods namely

Method A : a portable meter method

Method B : an in-line meter method

for the determination of the electrical conductivity of aviation fuels containing a static dissipator additive. The methods normally give a measurement of the conductivity when the fuel is uncharged, that is, electrically at rest (known as the rest conductivity).

2 Reference

ISO 6353/2, *Reagents for chemical analysis — Part 2 : Specification — First series.*

3 Principle

A voltage is applied across two electrodes 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 due to ion depletion. Ion depletion or polarization is eliminated in dynamic monitoring systems by continuous replacement of the sample in the measuring cell. The procedure, with the correct selection of electrode size and current measurement apparatus, can be used to measure conductivities from 1 pS/m (picosiemens per metre) up. The commercially available equipment referred to in this method is designed to cover a conductivity range up to 2 000 pS/m with good precision, although some meters can only be read up to 500 or 1 000 pS/m (see 8.2).

Method A : Portable meter method

4 Apparatus

4.1 Conductivity cell and current-measuring apparatus, capable of giving a conductivity reading almost instantaneously with the application of the voltage.[1)]

4.2 Thermometer, having a suitable range for measuring fuel temperature in the field. The thermometer shall be calibrated to ± 0,5 °C. A thermometer holder shall be available so that the temperature can be directly determined for fuel in bulk storage, rail tank cars, and trucks.

4.3 Measuring vessel, cylindrical and capable of holding sufficient fuel to cover the electrodes of the conductivity cell. For the equipment referred to in footnote 1, a minimum volume of 1 l is required.

5 Reagents and material

Cleaning solvent.

Use isopropyl alcohol if water is suspected, followed by analytical grade toluene (see ISO 6353/2, reagent R 39).

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6 Sampling

Fuel conductivity measurements shall be made *in situ* to avoid changes during sample shipment. If it is necessary to take samples for subsequent analysis, the precautions as specified in a), b) and c) shall be taken :

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

b) all sample containers shall be thoroughly cleaned with cleaning solvent and dried with a stream of air. Prior to taking the samples, all containers, including caps, shall be rinsed at least three times with the fuel under test;

c) conductivity measurement shall be made as soon as possible after sampling and preferably within 24 h.

7 Procedure

7.1 Calibration

The specific instrument calibration procedures are an essential part of the following generalized procedures. The appropriate calibration steps for the instrument used shall be followed prior to commencing the subsequent procedures.

7.2 *In situ* field measurement on tanks, tank cars, tank trucks, etc.

There are several commercially available meters suitable for *in situ* measurement. The following instructions apply to these meters.

7.2.1 Check the meter calibration. Ground the meter to the tank and 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 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 grounding and waiting for charge dissipation must 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 also ensure that the fuel is electrically at rest.

NOTE — 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 cause abnormally high zero, calibration and sample readings. This can be avoided by storing the cell at a temperature 2 to 5 °C in excess of the maximum ambient temperature where this is practicable.

7.2.2 After flushing the cell, hold it steady and after activating the instrument, record the highest reading after stabilization. On instruments with more than one scale range, select the scale that gives the greatest sensitivity for the conductivity value being determined. Ensure that the appropriate scale multiplying factor (or scale range) is used. Record the fuel temperature.

7.3 Laboratory and field measurements on sampled fuel

Rinse the conductivity cell thoroughly with the fuel under test to remove fuel residues remaining on the cell from previous tests. Transfer the fuel to the measuring vessel and record the conductivity of the fuel using the procedure applicable to the particular apparatus. In general, it is desirable to rinse the cell concurrently with the rinsing of the measuring vessel. Then transfer the sample to be tested to the clean, rinsed measuring vessel. Check the meter calibration. Fully immerse the conductivity cell into the test fuel and measure the conductivity following the procedure specified in 7.2.2 and the appropriate meter instruction manual. Record the fuel temperature.

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1) Suitable meters are obtainable commercially. Details of suppliers may be obtained from the Secretariat of ISO/TC 28 or the ISO Central Secretariat.

NOTE — In order to avoid erroneous readings, it is important to ensure that the bottom of the conductivity cell does not touch the sample container. This is applicable to all containers, whatever the material of construction.

8 Expression of results

8.1 Express the results as the electrical conductivity of the fuel in picosiemens per metre (pS/m).

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

8.2 Precision

The precision of the method, as obtained by statistical examination of inter laboratory test results, is as follows :

8.2.1 Repeatability

The difference between successive measured conductivity values obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the values in the table only in 1 case in 20.

8.2.2 Reproducibility

The difference between two single and independent measurements of conductivity obtained by different operators working in different locations on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the values in the table only in 1 case in 20.

Table — Precision data in picosiemens per metre

Level	Repeatability	Reproducibility
50	4	12
100	6	18
150	8	23
200	9	27
250	10	30
300	11	34

NOTE — The precision limits in the table are applicable at room temperature; significantly higher limits (approximately × 2) are applicable at temperatures near −15 °C.

9 Test report

The test report shall contain at least the following information :

a) the type and identification of the product tested;

b) the fuel temperature at which measurement was made;

c) a reference to this International Standard or to a corresponding national standard (portable meter method);

d) the result of the test (see 8.1);

e) any deviation, by agreement or otherwise, from the procedure specified;

f) the date of the test.

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Method B : Continuous in-line conductivity monitor method

10 Principle

Continuous measurements can be made where suitable precautions have been taken to remove static charges before the representative fuel stream is passed through the in-line measuring cell. A controlled, continuous flow through the cell prevents ion depletion, thereby providing the equivalent of rest conductivity as a continuous measurement.

11 Apparatus

11.1 In-line conductivity measurement cell.[1]

11.2 Thermometer, having a suitable range for measuring fuel temperature in the pipeline.

11.3 Flow controller.

11.4 High- and **low-level alarm circuits** (optional).

12 Installation

In general, the equipment is designed for permanent installation in the fuel distribution system. Follow the manufacturer's recommendations concerning installation and flow control, particularly with respect to the provisions of adequate relaxation time. Install the sample tapping point 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. The thermometer (11.2) shall be installed downstream of the cell (11.1).

13 Calibration

The specific calibration procedure detailed by the equipment manufacturer is an essential part of the general procedure and shall be completed prior to initiating automatic monitoring and control of continuous fuel streams. If fitted, the high- and low-level alarm circuits can be calibrated as recommended by the manufacturer.

14 Procedure

Flush the cell thoroughly by initiating a controlled flow of the fuel to be measured. Purging of the air from the cell and adequate flushing are normally achieved in a few minutes. The controlled flow shall conform to the manufacturer's recommendation. Too fast or too slow a flow will result in inaccuracies in the conductivity measurement.

Select the instrument scale of the approximate range anticipated for the fuel stream and initiate continuous measurements of fuel conductivity. Make measurements at the test cell temperature (indicated by the installed thermometer), which shall approximate the temperature of the fuel in the system.

15 Expression of results

15.1 Express the results as the electrical conductivity of the fuel in picosiemens per metre (pS/m).

15.2 Precision

The precision of this method as obtained by statistical examination of inter-laboratory test results, is as follows :

15.2.1 Repeatability

The repeatability of the continuous meter has been established to be within the range given for the portable instruments (see 8.2.1).

15.2.2 Reproducibility

The reproducibility has not been established.

16 Test report

The test report shall contain at least the following information :

a) the type and identification of the product tested;

b) the fuel temperature at which measurement was made;

c) a reference to this International Standard or to a corresponding national standard (continuous in-line conductivity monitor method);

d) the results of the test (see 15.1);

e) any deviation, by agreement or otherwise, from the procedure specified;

f) the date of the test.

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1) A suitable meter is available commercially. Details of suppliers may be obtained from the Secretariat of ISO/TC 28 or the ISO Central Secretariat.