SLOVENSKI STANDARD
oSIST prEN ISO 20623:2017

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Naftni in sorodni proizvodi - Določanje nosilnih in protiobrabnih lastnosti maziv - Metoda s štirimi kroglicami (Four ball method) (evropski pogoji) (ISO/DIS 20623:2017)

Petroleum and related products - Determination of the extreme-pressure and anti-wear properties of fluids - Four ball method (European conditions) (ISO/DIS 20623:2017)

Mineralölerzeugnisse und verwandte Produkte - Bestimmung der EP-Eigenschaften und Verschleißkennwerte von Schmierstoffen - Verfahren mit dem Vierkugel-Apparat (Europäische Bedingungen) (ISO/DIS 20623:2017)

Pétrole et produits connexes - Détermination des propriétés extrême pression et anti-usure des fluides - Essai quatre billes (conditions européennes) (ISO/DIS 20623:2017)

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Petroleum and related products — Determination of the extreme-pressure and anti-wear properties of lubricants — Four-ball method (European conditions)

Pétrole et produits connexes — Détermination des propriétés extrême pression et anti-usure des lubrifiants — Essai quatre billes (conditions européennes)

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*.

This second edition cancels and replaces the first edition (ISO 2623:2003), and is now extended to all types of liquid lubricants and greases, whereas it were only fire-resistant hydraulic fluids before. Procedures have been technically revised but the essentials remain the same. The test balls are better specified (see Annex A) and calculations for the wear test included. The calibration procedure of the friction recorder springs has been deleted and reference is now made to the manufacturer's instructions

Introduction

The four-ball machine is widespread and commonly used to assess the anti-wear properties of all types of liquid lubricants and consistent lubricants like greases.

An electrical motor, the rotational speed of which depends on the frequency of the current, actuates the four-ball machine. So, depending on the country where the machines are used, the results obtained cannot be compared.

ASTM has standardized a lot of procedures with these methods, based on the use of the 4-ball machine:

— ASTM D 2266: Standard Test Method for Wear Preventive Characteristics of Lubricating Grease (Four-Ball Method)

— ASTM D 4172: Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)

— ASTM D 2596: Standard Test Method for Measurement of Extreme-Pressure Properties of Lubricating Grease (Four-Ball Method)

— ASTM D 2783: Standard Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Four-Ball Method)

For these methods, the rotational speed is 1200 rpm for ASTM D 2266 and ASTM D 4172, and 1770 rpm for the ASTM D 2596 and ASTM D 2783. The 1200 rpm rotational speed is specific to the equipment. 1770 rpm is the rotational speed for an electrical motor fed with a current at a 60 Hz frequency.

The Institute of Petroleum has standardized IP 239, that covers more or less the 4 ASTM methods, but with a single rotational speed.

DIN has standardized DIN 51350, divided into 5 parts:

— DIN 51350-1: Testing of lubricants – Testing in the 4-ball tester – Part 1: General working principles

— DIN 51350-2: Testing of lubricants – Testing in the 4-ball tester – Part 2: Determination of the welding load of liquid lubricants

— DIN 51350-3: Testing of lubricants – Testing in the 4-ball tester – Part 3: Determination of the wearing characteristics of liquid lubricants

— DIN 51350-4: Testing of lubricants – Testing in the 4-ball tester – Part 4: Determination of the welding load of consistent lubricants

— DIN 51350-5: Testing of lubricants – Testing in the 4-ball tester – Part 5: Determination of the wearing characteristics of consistent lubricants

For the IP 239 and DIN 51350, rotational speed is 1450 rpm for an electrical motor fed with a current at a 50 Hz frequency.

Contrarily to ASTM and IP, DIN only considers the weld load and the wear. ASTM and IP are considering, in addition, the initial seizure load (ISL) and the mean hertz load (MHL).

The following table summarizes the test conditions for the above standards:

Standard	Lubricant	Type of test	Load (N)	Duration	Rotational speed rpm	Temperature °C
ASTM D 2266	Grease	Wear	392	60 min	1200	75 °C
ASTM D 4172	Oil	Wear	147 (A) 392 (B)	60 min	1200	75 °C 75 °C
ASTM D 2596	Grease	Extreme-pressure	59 to 7848	10 s	1770	18 to 35 °C
ASTM D 2783	Oil	Extreme-pressure	59 to 7848	10 s	1770	19 to 35 °C
IP 239	Grease - oil	Extreme-pressure + wear	60 to 7940	Wear: 60 min EP: 10 or 60 s	1450	Not specified
DIN 51350-2	Oil	Weld load	2000 to 12000	60 s	1450	18 to 40
DIN 51350-3	Consistent lubricant	Wear	150 (A) 300 (B)	60 min	1450	18 to 40
DIN 51350-4	Oil	Weld load	2000 to 12000	60 s	1450	18 to 40
DIN 51350-5	Consistent lubricant	Wear	150 (C) 300 (D) 1000 (E)	60 min	1450	18 to 40

The purpose of the present document is to propose a single standard to evaluate the extreme-pressure and the anti-wear properties of all types of lubricants, with the four-ball machine, based on a single rotational speed of 1450 rpm (European conditions and countries with a current frequency of 50 Hz).

In addition, one has to consider that equipment manufacturers are proposing new types of machines, fitted with variable speed electrical motors, with digital control, preset speeds, electric, hydraulic or pneumatic loading systems with high accuracy, precise friction force measuring devices, automatic digital timers controlling the duration of the test. All these new features have to be taken into account to define the equipment used for the test and the operating procedures.

The lubricants properties involved are as follows:

1) Initial seizure load (ISL);

2) Weld load (WL);

3) Wear load curve;

4) Mean Hertz load (MHL);

5) Anti-wear characteristics short duration (10 or 60 s) and long duration (60 min).

Petroleum and related products — Determination of the extreme-pressure and anti-wear properties of lubricants — Four-ball method (European conditions)

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

1 Scope

This document specifies procedures for the measurement of the extreme-pressure (EP) and antiwear properties of liquid lubricants (categories C, D, F, G, H, M, P of ISO 6743-99), lubricating greases (ISO 6743-9, category X) and other consistent lubricants. The testing conditions are those that apply in Europe and other areas that have similar electrical supply characteristics (200 V to 250 V, 50 Hz). The test conditions are not intended to simulate particular service conditions, but to provide information over a range of standard conditions for the purpose of research, development, quality control and fluid ranking. The output is used in lubricant specifications.

NOTE Application of this test using electrical supply characteristics other than those noted in the Scope is possible when it is ensured that a corresponding power supply, transformer or regulator is used such that voltages and frequencies are converted inside the apparatus to ensure compliance with the conditions of the Scope during actual testing.

High temperatures can potentially evolve during testing; therefore, it is necessary to take special precautions to avoid boiling when water-containing products are being tested. If a suitable temperature control is not possible, water-containing fluids shall not be tested using this test method.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3290-1, *Rolling bearings — Balls — Part 1: Steel balls*

ISO 3170, *Petroleum liquids — Manual sampling*

ISO 4259, *Petroleum products — Determination and application of precision data in relation to methods of test*

ISO 6743-9, *Lubricants, industrial oils and related products (class L) — Classification — Part 9: Family X (Greases)*

ISO 6743-99, *Lubricants, industrial oils and related products (class L) — Classification — Part 99: General*

ASTM D4047, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
wear
removal of metal from the test pieces

Note 1 to entry: Under conditions of low load and low friction, wear causes only small circular scars on the three stationary balls and a ring on the rotating ball. The diameters of these scars are slightly larger than the diameter of the indentation due to the static load (Hertz diameter).

3.2
seizure
localized fusion of metal between the rubbing surfaces of the test pieces

Note 1 to entry: Seizure is indicated by an increase in friction and wear, and results in roughened scars and a ring on the balls.

3.3
weld
fusion of metal between the rubbing surfaces sufficient for metal to merge and the balls to weld together in the form of a pyramid

3.4
mean Hertz load
MHL
single-number representation of the overall wear-load diagram that covers loads from well below seizure to welding

Note 1 to entry: The MHL is expressed in Newton.

3.5
wear-load curve
logarithmic plot of the load against the mean wear-scar diameter

3.6
flash temperature parameter
FTP
single number representation of the critical flash temperature above which a given fluid will fail under given conditions

Note 1 to entry: Under the conditions of this International Standard, the FTP is given by

$$FTP = \frac{L_a}{d^{1,4}} \quad (1)$$

where

L_a is the applied load, expressed in N;

d is the wear-scar diameter at load L_a, expressed in millimeters.

3.7
initial seizure load
ISL
lowest load at which seizure occurs

4 Principle

A single ball is rotated in contact with three fixed balls, the fluid under test being used to lubricate the balls. A lever enables loads to be applied and resulting measurements of wear, friction and weld are obtained.