International Standard

ISO 7544

Rolling bearings — Test and assessment methods for cleanliness

Roulements — Méthodes d'essai et d'évaluation de la propreté

First edition
2024-09

Reference number
ISO 7544:2024(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 4, *Rolling bearings*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

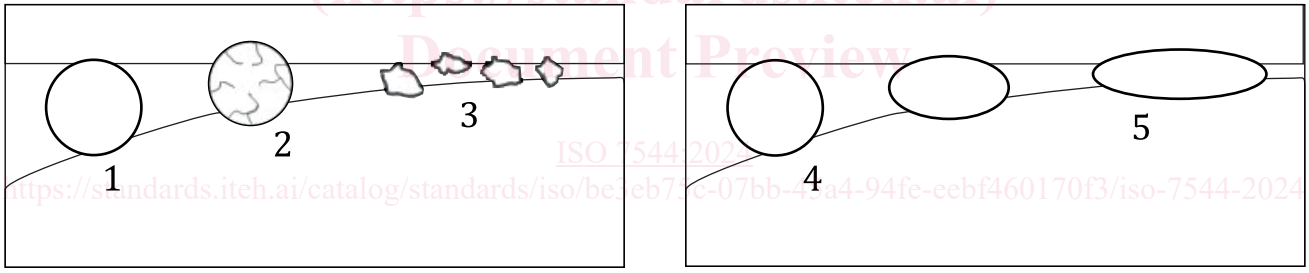
Introduction

This document is based on ISO 16232. However, the inspection and evaluation methods in ISO 16232 cannot be directly transferred to the rolling bearings industry, because of the different uses of rolling bearings in a wide variety of applications. This document has been prepared to describe a common and general approach for the inspection of cleanliness of rolling bearings.

The cleanliness requirements on rolling bearings increase steadily. The cleanliness of rolling bearings has a direct influence on achieving reliable performance, especially in association with vibration and noise, as well as the life of rolling bearings according to ISO 281. Therefore, the cleanliness of rolling bearings is necessary to a certain level. Various test and assessment methods of rolling bearing cleanliness lead to differences in inspection and assessment results. To avoid incomparable inspection results, the extraction procedure, the test fluid and the parameter settings for the test equipment are described in this document.

Figure 1 shows that the type of contaminant particle is crucial in determining the particle size and counting. After several times of over rolling, brittle particles break into small pieces as shown in Figure 1 a); in comparison to the measured thickness, their effective size is reduced significantly. Ductile particles can be deformed as shown in Figure 1 b).

Particulate contaminants (debris), entrapped into the contact between the rolling elements and the raceways, are the main cause for surface-initiated damages, which produce many rolling bearings failures. Subject to the elastic properties of the rolling element and raceway materials, entrapped particles, under the heavily loaded contacts, deform mainly in the inlet zone and remain nearly the same as they pass through the Hertzian contact zone, leaving the indentations on the mating surfaces. It seems clear that brittle particles, like corundum (Al_2O_3) and silicon carbide (SiC), tend to fracture and break into smaller pieces during the entrainment into the contact. Ductile particles, like copper, plastics and textile fibres are heavily deformed during the entrainment and extruded subsequently from the contact, as shown in Figure 1; see Reference [9] for further information.



a) Brittle particles **b) Ductile particles**

Key

1 initial deformation
2 debris fracture
3 fragments entering contact
4 debris starting to deform
5 elastic deformation closure around flattened particle giving dents on mating surfaces

Figure 1 — Deformation mechanisms of brittle and ductile particles

This document does not give the cleanliness limits for rolling bearings. The cleanliness required for a specific application is dependent on many factors. Cleanliness limits can be agreed between the supplier and customer.

Rolling bearings — Test and assessment methods for cleanliness

1 Scope

This document specifies procedures and equipment for cleanliness inspections of rolling bearings. It describes, in particular, test methods and assessment techniques.

This document is applicable to the test and assessment of various types of open bearings and capped bearings before grease filling, as well as the test and assessment of rolling bearing parts.

This document is not applicable for linear motion rolling bearings.

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 5593:2023, *Rolling bearings — Vocabulary*

ISO 16232:2018, *Road vehicles — Cleanliness of components and systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5593, ISO 16232 and the following apply.

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

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

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

3.1
component
rolling bearing, *rolling bearing part* (3.3) or subunit of a rolling bearing

3.2
extraction curve measurement
procedure for verifying the efficiency and suitability of extraction parameters by repeating the extraction a maximum of six times in an identical manner with the same test object

3.3
rolling bearing part
individual part comprising a rolling bearing but excluding all accessories

Note 1 to entry: The main rolling bearing parts are outer ring, inner ring, rolling elements and cage (if necessary, further parts of the rolling bearing like shield, seal etc.).

[SOURCE: ISO 5593:2023, 3.2.1.1, modified — Note 1 to entry has been added.]

3.4
surface
exterior area and interior area of the *component* (3.1)

3.5
controlled surface
surface (3.4) of the rolling bearings or rolling bearing parts that is subject to a cleanliness requirement

4 Symbols and abbreviated terms

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

A	unit of reference "1 000 cm^2 controlled surface" when specifying the CCC
CCC	component cleanliness code
CCC_a	component cleanliness code for all particles
CCC_m	component cleanliness code for shiny (metallic) particles without fibres
CCC_o	component cleanliness code for other particles without fibres
CCC_{wof}	component cleanliness code for all particles without fibres
D	nominal outside diameter, in millimetres (mm)
m	residue mass (net mass of particle load), in milligrams (mg)
m_1	initial mass (tare mass of analysis filter), in milligrams (mg)
m_2	final mass (gross mass, i.e. total mass of occupied analysis filter), in milligrams (mg)
P_U	power of ultrasonic device, in watts (W)
V_B	filling quantity of test vessel, in litres (l)
V_U	filling quantity of bath, in litres (l)
x	particle size, e.g. 150 µm ≤ x < 200 µm, in micrometres (µm)
φ_U	power density of the ultrasonic bath, in watts per litre (W/l)

5 Main steps of cleanliness inspection

The cleanliness inspection is made with the following steps (see Figure 2):

a) selection - taking the test lot for analysis;

b) extraction - removing the particles from the test component;

c) filtration - of the particles;

d) analysis - of the particles;

e) documentation - of the inspection parameters and results.

The cleanliness inspections shall be performed using the materials and equipment described in this document and in a suitable environment by skilled staff; for more information, see ISO 16232. The test environment shall be in accordance with ISO 16232:2018, 11.2.4.

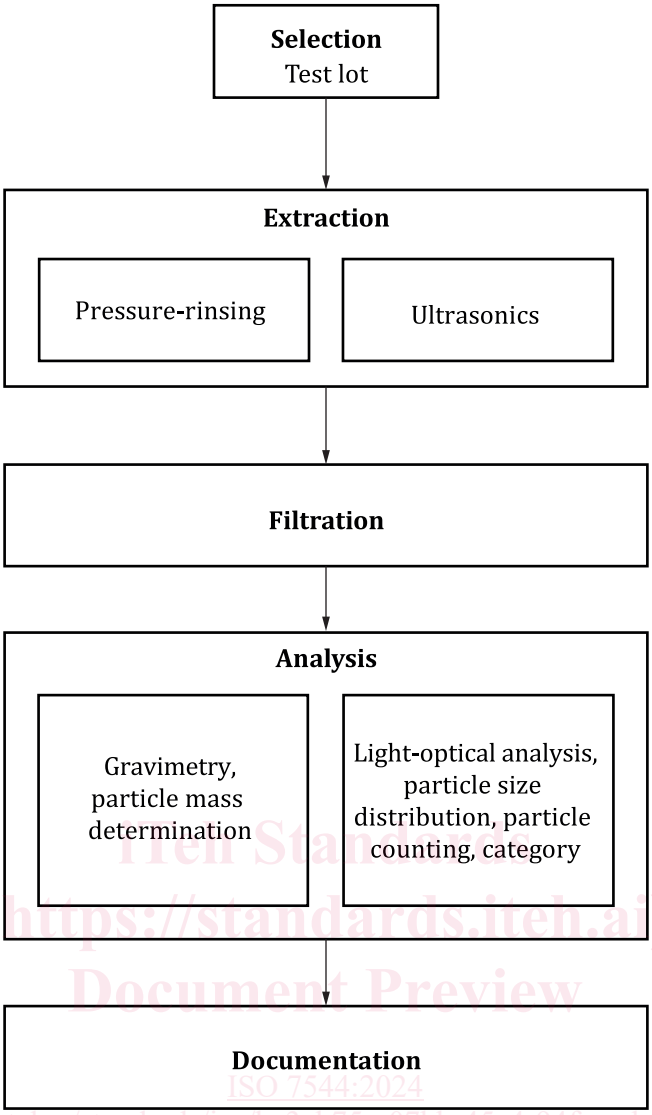


Figure 2 — Main steps of cleanliness inspection

To compare inspection results reliably, the same test fluid, extraction procedure and analysis parameter shall be applied.

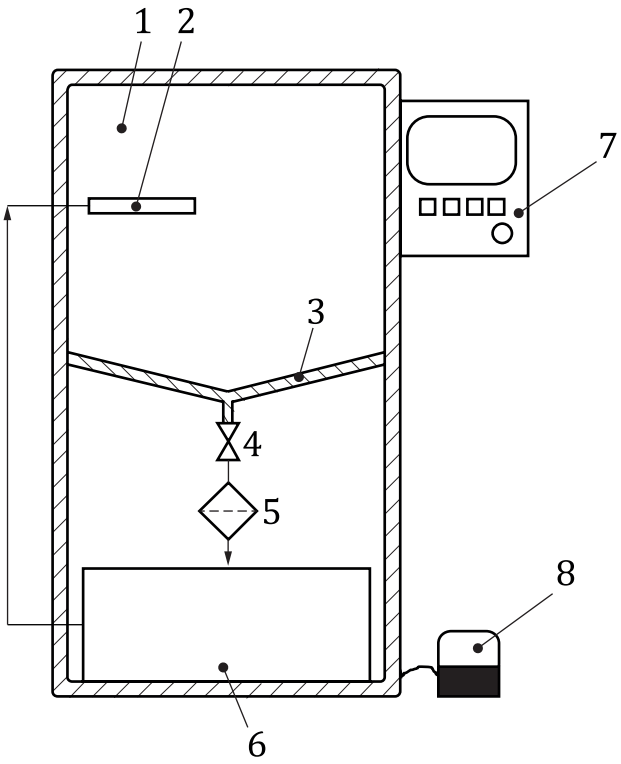
For further information about the analysis of the particles and the documentation, see Annex A and Annex D.

6 Equipment and accessories

6.1 Equipment for extraction

6.1.1 Equipment for pressure-rinsing method

A schematic diagram of a pressure-rinsing cabinet is shown in Figure 3. Other equipment such as open cabinets, pressure vessels with a spraying gun, or laboratory wash bottles can also be used.



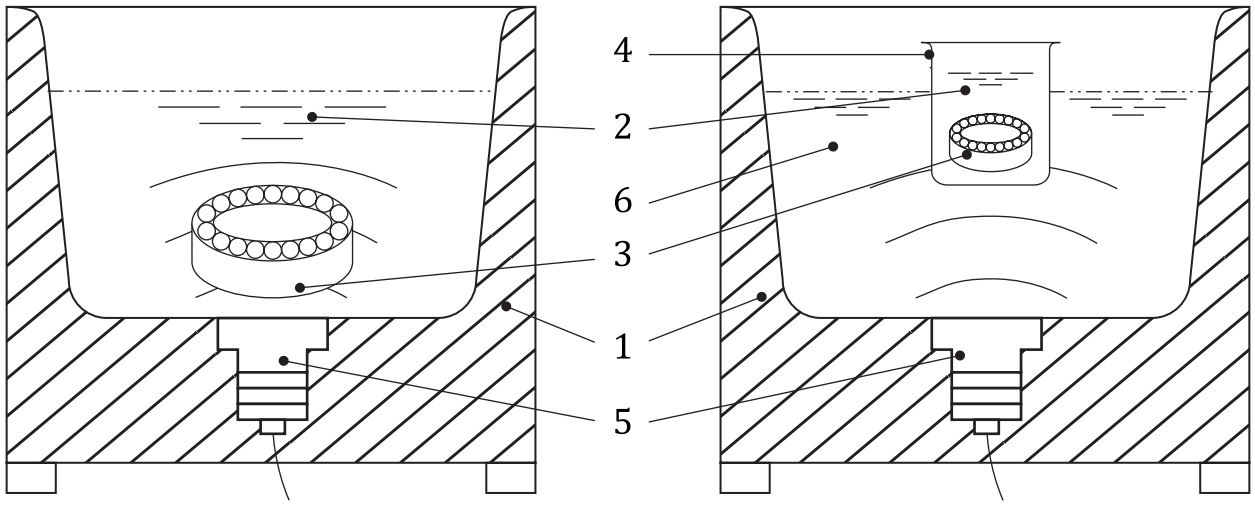
Key

1 extraction chamber (clean air area)
2 manual pressure-rinsing nozzles
3 collection trough
4 stop cock
5 analysis filter
6 media supply with
— test fluid
— purification filter
— pump or pressure supply
7 controls for rinsing programs with emergency stop
8 foot switch

Figure 3 — Example of a pressure-rinsing cabinet

6.1.2 Equipment for ultrasonic method

A schematic diagram of an ultrasonic bath is shown in Figure 4. Other equipment like extraction cabinets that uses the ultrasonic extraction method can also be used.



a) Test object in ultrasonic bath **b) Test object in test vessel**

Key

1 tank
2 test fluid
3 test object
4 vessel
5 ultrasound transducer
6 water (e.g. tap water)

NOTE 1 With increasing frequency of the ultrasonic, the related wavelength decreases.

NOTE 2 The distance between sound source and rolling bearings at a frequency of 40 kHz is more than 38 mm. At a frequency of 35 kHz, the distance is more than 43 mm.

Figure 4 — Schematic diagram of ultrasonic bath

The test object is direct in the bath [see Figure 4 a)]. The power density of the ultrasonic bath, φ_U, is calculated according to Formula (1).

$$\varphi_U = \frac{P_U}{V_U} \tag{1}$$

The test object is in test vessel [see Figure 4 b)]. The power density of the ultrasonic bath, φ_U, is calculated according to Formula (2).

$$\varphi_U = \frac{P_U}{V_U + V_B} \tag{2}$$

6.2 Equipment for filtration

In general, the equipment for filtration comprises the following parts:

— analysis filter;

— equipment for filtration.

The schematic diagram of the direct filtration is shown in Figure 5.