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Rolling bearings — Test and assessment methods for cleanliness

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee MCE/7, Rolling bearings.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Foreword

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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.

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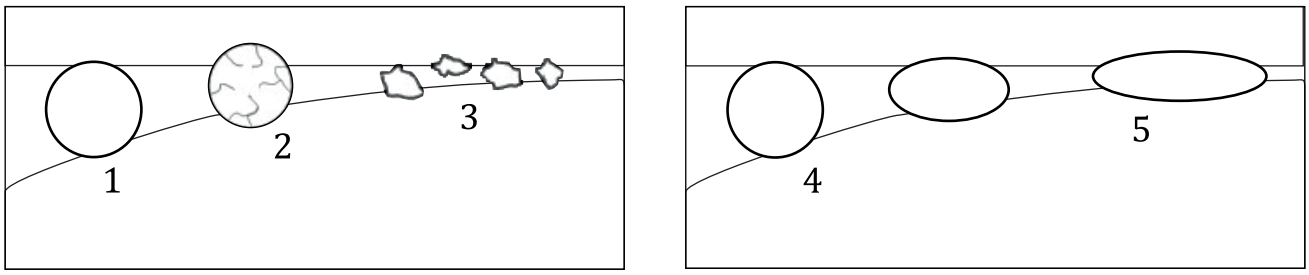
Introduction

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.

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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.]

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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.

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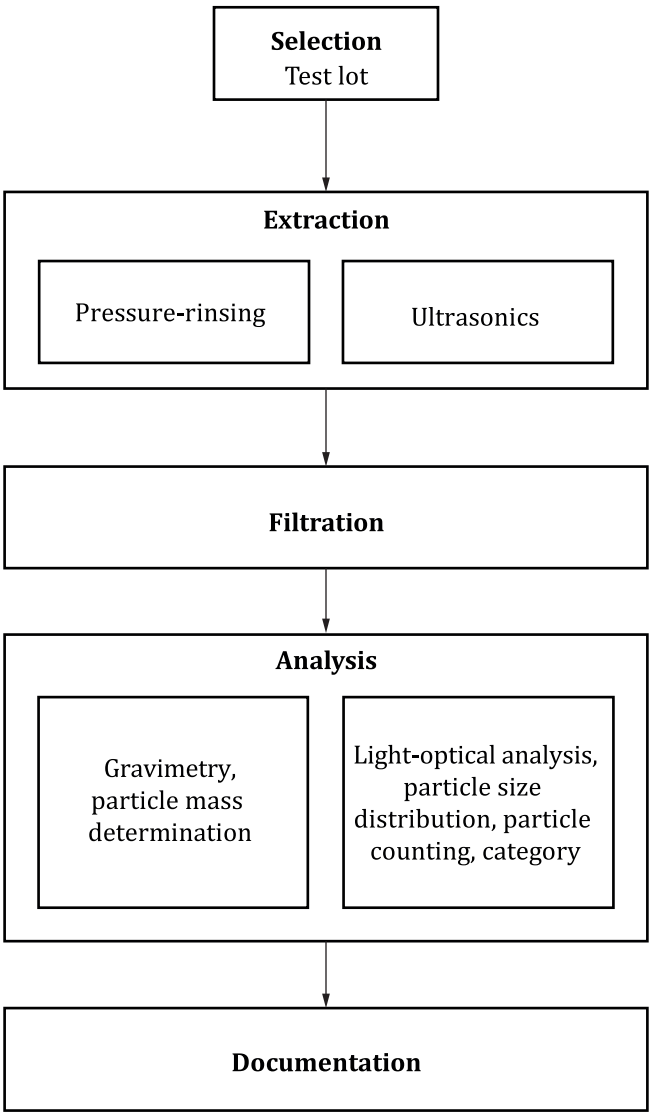

Figure 2 — Main steps of cleanliness inspection

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.

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