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Road vehicles — Cleanliness of components and systems

Véhicules routiers — Propreté des composants et des systèmes

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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 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 34, *Propulsion, powertrain, and powertrain fluids*.

This edition of ISO 16232 cancels and replaces the entire ISO 16232:2007 series (all parts) which have been technically revised and consolidated into a single document.

The main changes are described in Annex L.

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

In order to achieve reliable performance of components and systems, control over the amount of particles introduced during the build phase is necessary, and measurement of particulate contaminants is the basis of control.

Based on a world-wide broadening and ongoing development of technical cleanliness issues this document is intended to:

— further improve the comparability of cleanliness inspection results;

— include new (extraction and analysis) techniques; and

— provide information on how to define cleanliness specifications and explain how to react when cleanliness limit values are exceeded.

This document has been prepared to fulfil the requirements of the automotive industry, since the function and performance of modern automotive components and systems are sensitive to the presence of a single or a few critically sized particles. Consequently, this document deals with the analysis of the total volume of extraction liquid and of all contaminants collected using an approved extraction method.

To be able to compare inspection results the same extraction procedure, the same test fluid and also same parameter settings for the analysis instruments are intended to be used.

This document is based on existing International Standards such as those developed by ISO/TC 131/SC 6. They have been extended, modified and new ones have been developed to produce a comprehensive suite of International Standards to measure and report the cleanliness levels of components and systems fitted to road vehicles.

Road vehicles — Cleanliness of components and systems

1 Scope

WARNING — The use of this document can 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 any other restrictions prior to its use.

This document specifies requirements for applying and documenting methods for determining particulate contamination on functionally-relevant components and systems (cleanliness inspection) of road vehicles.

A cleanliness inspection comprises the basis of an assessment of technical cleanliness, which is performed, for example, under the following circumstances:

— initial inspection and evaluation;

— inspection of incoming and outgoing components; and

— quality control or monitoring of manufacturing processes relevant to cleanliness (e.g. cleaning, surface treatment and assembly processes).

This document is intended to improve the informative quality and comparability of test results. It also defines the standardized expression of cleanliness specifications and cleanliness test results in the quality chain of the automotive industry.

This document does not apply to the following:

— detection of filmy contamination (grease, oils, etc.);

— application of non-quantifiable particulate detection methods on test components (e.g. visual assessment, wipe test with clean cloth, etc.); and

— characterization of operating fluids (fuel, oils, coolants, brake fluid, etc.).

This document does not define any cleanliness limit values for specific components or systems. The degree of cleanliness required for a specific component or system is dependent on a number of highly-individual factors. Cleanliness specifications are intended to be undertaken only by specialists who not only know the component concerned but also the system it is built into, the later conditions of use, technically-feasible practices and possible consequences for manufacturing processes and the supply chain. Guidance for deriving limit values can be found in Annex H.

2 Normative references

There are no normative references in this document.

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 https://www.iso.org/obp

3.1
active component
component which may set the fluid in motion or be activated by the fluid during operation

EXAMPLE Pump, cylinder, distributor, injector, valve regulator.

3.2
aerosol formation
atomization of a liquid to create small droplets, e.g. in pressure-rinsing due to the shape of nozzles or impaction of the pressure-rinsing jet on a surface

3.3
agglomerate
two or more particles which are in intimate contact and cannot be separated by gentle stirring and the small shear forces thus generated

3.4
agitation
extraction method implemented for internal surfaces

Note 1 to entry: Its cleaning effect is based on the turbulent change in direction of the test liquid inside the component.

3.5
air cleanliness class
specification of air quality based on the concentration of particles in a defined volume of air

3.6
analysis balance
balance with a high (10^{-4} g) to very high (10^{-6} g) resolution capable of weighing minute quantities of particulate residue

3.7
analysis filter
filter membrane
thin membrane, either meshed or foamed, possessing defined deposition properties that cause particles of a specific size to be retained during filtration

3.8
analysis parameters
settings on an *analysis system* (3.9) that are used in the analysis step

3.9
analysis system
device to measure and/or characterize particles

3.10
automatic particle counter
APC
counting system that works on the light extinction principle

3.11
back-scattered electron detector
BSE detector
device that supplies scanning electron microscope (SEM) images with a high material contrast, used for the detection of particles on a membrane filter

3.12
blank level
blank value
amount of contaminant introduced from sources other than the test component, such as reagents, glassware, preparation of test units, and the environment

3.13
blank level criterion
maximum value that may not be exceeded when determining the blank level, i.e. max. 10 % of the required or expected cleanliness value

3.14
blank level test
analysis carried out in the same operating conditions as on the test component but without the test component

Note 1 to entry: The blank test enables quantification of the contamination introduced from sources other than the test component, such as reagents, glassware, preparation of test units, and the environment.

3.15
cavity
cavity in the test component, which cannot be wetted by the test liquid due to the presence of gas

3.16
clean
state of *cleanliness* (3.18) of a component or fluid that meets the specified cleanliness level

3.17
cleaning
process to make a liquid, object or extraction setup as clean as required

3.18
cleanliness
condition of a product, surface, device, liquid, etc., characterized by the absence of particulate contamination

3.19
cleanliness inspection
extraction and analysis of component contamination including documentation

3.20
cleanliness level
C_L
amount and/or nature of contaminant present on the controlled surfaces and/or in controlled volumes of a component

Note 1 to entry: The term may apply to the presumed, specified or measured extent of contamination.

3.21
cleanliness specification
documentation of permissible particle features and quantities for a component

3.22
cleanliness state
component cleanliness
cleanliness value (3.23) or values of a component that may change over time due to external influences

3.23
cleanliness value
single value specifying the cleanliness of a component, e.g. residue mass, longest particle or particle count

3.24
cleanroom
room within which the number concentration of airborne particles is controlled and classified, and which is designed, constructed and operated in a manner to control the introduction, generation and retention of particles inside the room

Note 1 to entry: The class of airborne particle concentration is specified.

Note 2 to entry: Levels of other cleanliness attributes such as chemical, viable or nanoscale concentrations in the air, and also surface cleanliness in terms of particle, nanoscale, chemical and viable concentrations might also be specified and controlled.

Note 3 to entry: Other relevant physical parameters might also be controlled as required, e.g. temperature, humidity, pressure, vibration and electrostatic.

[SOURCE: ISO 14644-1:2015, 3.1.1]

3.25
coincidence
particles grouped together, which can therefore not be analysed as single particles, e.g. by an optical particle counter or microscope

3.26
collection equipment
any device (e.g. conical flask, beaker, tray, funnel, collection surface of the extraction cabinet) with a size and a shape suited to the collection of all the extraction liquid draining from the test component

3.27
component
part, sub-assembly, or part assembly used in a road vehicle

Note 1 to entry: This definition differs from that given for the same term in ISO 5598.

3.28
component cleanliness code
CCC
alpha-numeric expression of the *cleanliness level* (3.20) of a *component* (3.27) measured or specified by the particle size distribution of the contaminants

3.29
component contamination
amount or nature of contaminants extracted from the wetted or controlled surfaces of a *component* (3.27), as measured by an applicable analysis method

3.30
conditioning
preparation step in which the *analysis filter* (3.7) is pressure-rinsed, dried and dehumidified before its tare mass is weighed

3.31
contaminant
undesirable solid substance that is in suspension in a fluid or in a component or on a *controlled surface* (3.33) of a component

Note 1 to entry: For the purposes of this document, contaminants are particles as defined in 3.77**.** This definition differs from ISO 5598 in its exclusion of liquids and gases.

3.32
contamination
all contaminants in a fluid, system or on a component

3.33
controlled surface
surface of a component that is subject to a cleanliness requirement

3.34
controlled volume
volume of a component that is subject to a cleanliness requirement

Note 1 to entry: The controlled volume may differ from the wetted volume.

3.35
critical particle
particle which geometric dimensions or chemical-physical nature could cause *component* (3.27) damage

Note 1 to entry: A sub-category of critical particles is formed by so-called "killer" particles, which cause an immediate component failure.

3.36
decline
decrease observed in the contamination level of a component, on repeated extraction

3.37
declining criterion
threshold for assessing the suitability of extraction conditions

3.38
declining test
procedure used to verify the efficacy and suitability of extraction parameters in which the extraction step is repeated six times on the same test component in an identical manner

3.39
declining value
D_n
quotient of the cleanliness value under consideration and the sum of all preceding cleanliness values (including that under consideration)

Note 1 to entry: It is expressed in percent.

3.40
dissolving liquid
test liquid used for extraction or another liquid with stronger solvent action to speed up dissolving step during the extraction process, compatible with the test component and inspection equipment

3.41
double inspection
procedure in which two identical extraction steps are performed in order to confirm the efficacy and suitability of qualified extraction parameters

Note 1 to entry: In this case, the declining criterion is set at 30 % instead of the 10 % that applies for declining tests.

3.42
effective filter surface area
area of the analysis filter membrane through which extraction liquid flows during the filtration step

3.43
element analysis
EDX analyses
energy dispersive X-ray spectroscopy capable of analysing elements based on their characteristic X-ray spectra

3.44
extraction
sampling
operation required to transfer as much contaminant as possible that is present within a controlled volume or on a controlled surface into a test fluid and its collection for subsequent analysis

3.45
extraction curve
declining curve
progress curve of the cleanliness level of an extraction fluid applied to the test component as a function of the number of extractions

Note 1 to entry: This is related to the extraction time or to the volume of test fluid passed through or over the test component.

3.46
extraction liquid
analysis liquid
extraction fluid
extraction air
test medium loaded with contaminants extracted from the test component

3.47
extraction method
technique to detach the particle load from the test component

3.48
extraction parameters
totality of all physical parameters influencing the extraction which can be set on or calculated from the extraction setup

3.49
extraction procedure
complete sequence of all extraction steps performed

3.50
extraction setup
extraction device
equipment used to perform the extraction

3.51
extraction step
sampling step
single work step forming part of the *extraction procedure* (3.49) that is performed either in a *declining test* (3.38) or when extracting several controlled surfaces

3.52
extraction volume
total volume of test fluid used to extract the contaminants from a component

3.53
fibre
long, thin structure which is defined by a ratio between stretched length and maximum inner circle diameter greater than 20, the width measured via maximum inner circle diameter being lower than or equal to 50 µm

Note 1 to entry: It is generally used to characterize a textile fibre (flexible, pliable, and made from organic materials) and differentiate it from compact particles.

3.54
filter background
colour of the analysis filter

3.55
filter housing
casing consisting of an upper and lower section with an inlet and outlet as well as a supporting grid; used to clamp and tension the *analysis filter* (3.7)

3.56
filter occupancy
ratio between surface area of the *analysis filter* (3.7) covered with particles to entire analysed filter area

3.57
filter pore size
<mesh filter> nominal mesh width

3.58
filter pore size
<foamed analysis filter> equivalent mesh width measured by means of the bubble point test

3.59
filtration
process in which particles are deposited on the analysis filter

3.60
final rinsing
application of fluid to remove any particulate residues from the surfaces of the extraction setup and deposit them on the analysis filter

Note 1 to entry: With "final rinsing", liquid flows over a component without any pressure being used. The step is implemented after extraction to remove any particles that may be adhering slightly to the component or surfaces of the extraction equipment due to re-sedimentation and to forward them to the analysis step. The liquid is applied to the surface using a spray.

3.61
final rinsing liquid
(test-) liquid used after the extraction step to remove any particulate residues from the surfaces of the extraction setup and deposit them on the analysis filter

3.62
fixative
liquid used to fix particles on the *analysis filter* (3.7) to prevent their loss though electrostatic charging

3.63
fan nozzle
flat jet nozzle
nozzle that generates a linear jet on impaction on a smooth surface

Note 1 to entry: Parameters include jet width and equivalent bore diameter.

3.64
functional test bench
closed circuit of test liquid onto which the test component is installed in order to be subjected to stresses or to provide similar functions to those to which it will be subjected to under final use operating conditions

3.65
gravimetry
analysis method used to determine the mass of all residues present on the analysis filter by measuring differences in mass

