TECHNICAL REPORT

ISO/TR 22681

First edition
2019-09

Hydraulic fluid power — Impact and use of ISO 11171:2016 µm(b) and µm(c) particle size designations on particle count and filter test data

Reference number
ISO/TR 22681:2019(E)

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 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 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 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

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

A minor revision to ISO 11171:2010 was approved during 2016. The revision was necessitated by a particle size shift resulting from the replacement of the particle counter calibration material, National Institute of Standards and Technology (NIST) SRM 2806a, with SRM 2806b. Prior to this revision, particle count data based upon ISO 11171 was reported in units of µm(c). Following the introduction of SRM 2806b, users of particle count data in the absence of this revision could not discern whether particle sizes being reported were based upon SRM 2806a or SRM 2806b. Hypothetically, a particle size reported as 20 µm(c) could actually be as large as 20 µm or as small as 18 µm depending upon whether SRM 2806a or SRM 2806b were used. This approximately 10 % shift in particle size can become significant in terms of the actual numbers of particles counted.

To minimize confusion and provide for clear communication, ISO 11171:2010, 6.8 and 7.1 were revised to provide a means for reporting particle size that clearly identifies the basis for reported particle size and provides the industry with tools to relate past SRM 2806a and new SRM 2806b data without extensive revisions to existing standards, specifications, and other literature. It provides a historically consistent, traceable definition of µm(c), while allowing an option to report sizes in terms of a defined µm(b) as needed. This document summarizes the underlying reasons for the minor revision and its practical impact on the industry.

Hydraulic fluid power — Impact and use of ISO 11171:2016 µm(b) and µm(c) particle size designations on particle count and filter test data

1 Scope

This document explains the use of the two acceptable methods of reporting particle size, µm(c) and µm(b), that are defined in ISO 11171:2016. It also explains the reasons for the existence of two alternative size reporting methods and its implications with respect to particle count and filter Beta Ratio data.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Origins of the particle size shift

ISO 11171 provides direct traceability to the standard international (SI) definition of a metre through NIST SRM 2806. ISO 11171 has been widely used to calibrate automatic particle counters (APCs) for hydraulic, lube oil, diesel fuel, and other non-aqueous liquid applications since 1999. NIST SRM 2806 is the primary calibration material used in this document.

During 2010, the original supply of SRM 2806, also sold as SRM 2806a, was exhausted. For ease of communication, the term “SRM 2806a” is used henceforth in this document to refer to both designations, SRM 2806 and SRM 2806a, of the original calibration material.

During 2014, its replacement, SRM 2806b, was released. The SRM 2806b production and certification process was overseen by an international group of experts from ISO/TC 131/SC 6. The specifications for SRM 2806b were better defined than those for SRM 2806a and it was produced by a different supplier. Advances in sample preparation and metrology were used to produce and certify SRM 2806b. A critical difference between SRM 2806a and SRM 2806b is that particle sizing was done manually from SEM micrographs with SRM 2806a, while automated image analysis was used with SRM 2806b.

This allowed an order of magnitude of more particles to be analysed and in a manner not subject to human bias. The end result was a certified calibration material, SRM 2806b, with better precision in the size distribution and a reduction in uncertainty compared to its predecessor, SRM 2806a.

An international round robin of ISO 11171 found that particle size, as defined using SRM 2806b compared to SRM 2806a, had shifted. The relationship between SRM 2806a and SRM 2806b sizes was determined from data submitted by 15 participating labs and is given by the following formula:

$$d_c = 0{,}898\ d_b$$

where

d_c is the particle size in μm(c) obtained using an APC calibrated with SRM 2806 and SRM 2806a;

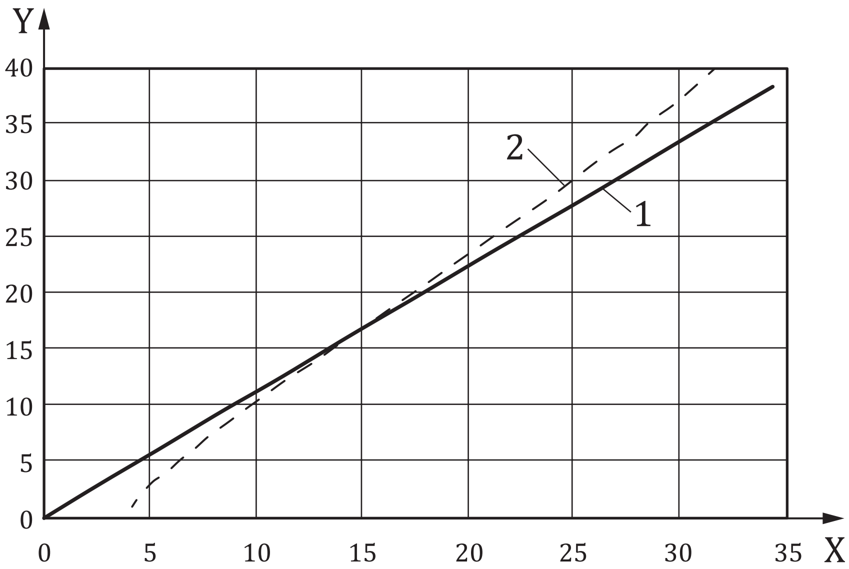
d_b is the particle size in μm(b) obtained using an APC calibrated with SRM 2806b.

As a result of the minor revision to ISO 11171, particle size reported in μm(c) is traceable to SRM 2806a using the conversion equation, or by direct measurement using an APC calibrated with SRM 2806a or SRM 2806a-traceable secondary samples in the case of data generated prior to 2016. Particle sizes traceable to SRM 2806b are reported in units of μm(b). Users of particle count data have the option to report particle size in units of either μm(c) or μm(b), or both, as appropriate. This particle size shift is within the published uncertainty of SRM 2806a, but it is great enough to affect particle count and filter test data. The magnitude of the particle size shift is illustrated graphically in Figure 1.

In Figure 1, particle size in μm(c) as determined using ISO 11171 and SRM 2806a is plotted on the X-axis. The corresponding particle size as determined using other means, i.e. using SRM 2806b or AC Fine Test Dust, is plotted on the Y-axis. The **bold** line shows the relationship between μm(c) and μm(b). The relationship passes through the origin with a slope of 1,114.

For reference, the thin line shows the relationship between μm(c) and μm sizes determined using the obsolete ISO 4402[1)] calibration method and AC Fine Test Dust. This relationship does not pass through the origin and the slope is steeper. Figure 1 demonstrates that the particle size shift with SRM 2806b is significant, yet less than what was observed when the industry transitioned from ISO 4402 to ISO 11171.

1) Withdrawn standard.



Key

Y particle size µm

X particle size, µm (c)

1 µm(b) ISO 11171

2 AC fine test dust, ISO 4402

Figure 1 — Relationship between particle sizes defined using SRM 2806a and those obtained using SRM 2806b, and using AC Fine Test Dust

5 Implications of the particle size shift

Prior to the revision in ISO 11171, there was no convenient method for users of particle count data to determine whether or not their data was affected by the particle size shift. Users could not tell whether particle count results were based upon SRM 2806a or SRM 2806b calibrations. As a result of the revision, in most cases particle count and size data reported in units of µm(c) can be used in the same manner that was done prior to the release of SRM 2806b. In those cases where µm(b) is used or compared to µm(c) data, the direction and magnitude of the correction are clearly defined and identified. The implications of the particle size shift can be discussed in terms of its impact upon particle size, particle count, ISO Code, and filter Beta Ratio results.

The impact upon particle size is illustrated in Figure 1, as previously discussed. For the particle size range from 0 to 38 µm(b), the corresponding µm(c) sizes are 10,2 % smaller. The µm(c) sizes are obtained by multiplying µm(b) sizes by 0,898. At sizes larger than 38 µm(b), latex is used for calibration and the particle size does not require correction.

The magnitude of the impact of the size shift on observed particle count data depends upon the particle size distribution of the sample in question as shown in Figure 2.

Figure 2 shows particle count data for two different dusts, ISO MTD (thin lines) and ISO UFTD (**bold lines**). ISO MTD is used in ISO 16889 filter testing. ISO UFTD is a finer dust with a steeper particle size distribution such as might be found downstream of a high performance filter. For illustrative purposes, the gravimetric dust concentration was chosen arbitrarily. The results for each dust are plotted in two different ways. The dashed lines show the results reported in µm(c) while the solid lines show results reported in µm(b). For any given particle size, µm(b) particle counts tend to be greater than the corresponding µm(c) results. The magnitude of the increase becomes greater as the slope of the particle size distribution becomes steeper (more negative) as per ISO UFTD example.

