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Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles

Transmissions hydrauliques — Fluides — Méthode de codification du niveau de pollution particulaire solide

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Foreword

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This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

This third edition cancels and replaces the second edition (ISO 4406:1999), which has been technically revised.

The main changes compared to the previous edition are as follows:

— All year references for ISO 11171 have been removed to ensure that only the most recent version of ISO 11171 is used. This is needed to ensure consistency in the usage and definition of the µm(c) particle sizes used in this document.

— All year references for ISO 4407 and ISO 11500 have been removed to ensure that only the most recent version of these standards are used.

This corrected version of ISO 4406:2017 incorporates the following corrections.

Following the first (and only) sentence in 3.4.5, the following text has been added: "Graphical presentation of ISO Code results shall be as described in Annex A."

Following the first (and only) sentence in 3.5.4, the following text has been added: "Graphical presentation of ISO Code results shall be as described in Annex A."

Figure A.1 has been replaced by a new Figure A.1 which includes the missing exponent in Y.

Introduction

In hydraulic fluid power systems, power is transmitted, and controlled, through a liquid under pressure within an enclosed circuit. Solid particle contaminant is always present in the hydraulic fluid and the amount needs to be determined because the contaminant may cause serious problems.

Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles

1 Scope

This document specifies the code to be used in defining the quantity of solid particles in the fluid used in a given hydraulic fluid power system.

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 4407, *Hydraulic fluid power — Fluid contamination — Determination of particulate contamination by the counting method using an optical microscope*

ISO 11171, *Hydraulic fluid power — Calibration of automatic particle counters for liquids*

ISO 11500, *Hydraulic fluid power — Determination of the particulate contamination level of a liquid sample by automatic particle counting using the light-extinction principle*

3 Code definition

3.1 General

The purpose of this code is to simplify the reporting of particle count data by converting the numbers of particles into broad classes or codes, where an increase in one code is generally a doubling of the contamination level.

The original code, in accordance with the first edition of this document, stated the reporting at two sizes ≥ 5 µm and ≥ 15 µm. The sizes in this document account for the use of a different calibration standard for optical automatic particle counters (APCs). The reported sizes are ≥ 4 µm(c), ≥ 6 µm(c) and ≥ 14 µm(c), the last two of these being equivalent to the 5 µm and 15 µm particle sizes obtained using the ISO 4402:1991[1)] method of calibrating APCs. Throughout this document the use of µm(c) means that particle size measurements are carried out using an automatic particle counter that has been calibrated in accordance with ISO 11171.

Measurement of particles using an optical microscope as specified in ISO 4407 establishes the size of a particle as being equal to its longest dimension, whereas an automatic particle counter derives the size of an equivalent particle from its cross-sectional area, a value different in most cases from that determined using a microscope. The particle sizes to be reported for measurement by microscope ≥ 5 µm and ≥ 15 µm are unchanged from those specified in the first edition of this document.

CAUTION — Particle counts are affected by a variety of factors. These factors include procurement of sample, particle counting accuracy and the sample container (where used), and its cleanliness. Proper care should be taken during sample procurement to ensure that the sample obtained is representative of the fluid circulation in the system.

1) ISO 4402:1991 has been replaced by ISO 11171.

3.2 Basis of code

The code for contamination levels using automatic particle counters comprises three scale numbers that permit the differentiation of the dimension and the distribution of the particles as follows:

— the first scale number represents the number of particles equal to or larger than 4 µm(c) per millilitre of fluid;

— the second scale number represents the number of particles equal to or larger than 6 µm(c) per millilitre of fluid;

— the third scale number represents the number of particles equal to or larger than 14 µm(c) per millilitre of fluid.

The code for microscope counting comprises two scale numbers using 5 µm and 15 µm.

3.3 Allocation of scale numbers

3.3.1 The scale numbers are allocated according to the number of particles counted per millilitre of the fluid sample (see Table 1).

3.3.2 A step ratio of generally two, as given between the upper and lower limits for the number of particles per millilitre in Table 1, has been adopted to keep the number of scale numbers within a reasonable limit and to ensure that each step is meaningful.

Table 1 — Allocation of scale numbers

Number of particles per millilitre		Scale number
More than	Up to and including	
2 500 000		> 28
1 300 000	2 500 000	28
640 000	1 300 000	27
320 000	640 000	26
160 000	320 000	25
80 000	160 000	24
40 000	80 000	23
20 000	40 000	22
10 000	20 000	21
5 000	10 000	20
2 500	5 000	19
1 300	2 500	18
640	1 300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
2,5	5	9

NOTE: Reproducibility below scale number 8 is affected by the actual number of particles counted in the fluid sample. Raw counts should be more than 20 particles. If this is not possible, refer to 3.4.7.

Table 1 *(continued)*

Number of particles per millilitre		Scale number
More than	Up to and including	
1,3	2,5	8
0,64	1,3	7
0,32	0,64	6
0,16	0,32	5
0,08	0,16	4
0,04	0,08	3
0,02	0,04	2
0,01	0,02	1
0,00	0,01	0
NOTE: Reproducibility below scale number 8 is affected by the actual number of particles counted in the fluid sample. Raw counts should be more than 20 particles. If this is not possible, refer to 3.4.7.		

3.4 Determination of code using automatic particle counter analysis

3.4.1 Counting shall be undertaken in accordance with ISO 11500 or another recognized method, using an APC calibrated to ISO 11171.

3.4.2 A scale number shall be allocated to the number of particles equal to or larger than 4 µm(c).

3.4.3 A second scale number shall be allocated to the number of particles equal to or larger than 6 µm(c).

3.4.4 A third scale number shall be allocated to the number of particles equal to or larger than 14 µm(c).

3.4.5 The three numbers shall be written one after the other and separated by oblique strokes (slashes).

EXAMPLE A code of 22/18/13 signifies that there are more than 20 000 and up to and including 40 000 particles equal to or larger than 4 µm(c), more than 1 300 and up to and including 2 500 particles equal to or larger than 6 µm(c) and more than 40 and up to and including 80 particles equal to or larger than 14 µm(c) in 1 ml of a given fluid sample.

Graphical presentation of ISO Code results shall be as described in Annex A.

3.4.6 When applicable, include either "*" (too numerous to count) or "—" (no requirement to count) notation when reporting the scale number.

EXAMPLE 1 */19/14 means that this sample has too many particles equal to or larger than 4 µm(c) to count.

EXAMPLE 2 —/19/14 means that there was no requirement to count particles equal to or larger than 4 µm(c).

3.4.7 When the raw data in one of the size ranges results in a particle count of fewer than 20 particles, the scale number for that size range shall be labelled with the symbol ≥.

EXAMPLE A code of 14/12/≥7 signifies that there are more than 80 and up to and including 160 particles equal to or larger than 4 µm(c) per millilitre and more than 20 and up to and including 40 particles equal to or larger than 6 µm(c) per millilitre. The third part of the code, ≥7, indicates that there are more than 0,64 and up to and including 1,3 particles equal to or larger than 14 µm(c) per millilitre but less than 20 particles were counted which lowers statistical confidence. Because of this lower confidence, the 14 µm(c) part of the code can be higher than 7, indicating a particle count of more than 1,3 particles per millilitre.