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Hydraulic fluid power — Hose and hose assemblies — Method of collecting a fluid sample for analyzing the cleanliness of a hose or hose assembly

Transmissions hydrauliques — Flexibles et flexibles de raccordement — Méthode de collecte d'échantillon de fluide pour l'évaluation de la propreté de flexibles ou flexibles de raccordement

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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 131, *Fluid power systems*, Subcommittee SC 4, *Connectors and similar products and components.*

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a pressurized liquid within a circuit where piping allows the fluid to flow between components. Part of the piping may consist of hose assemblies, usually manufactured by assembling a length of hose, cut out from a hose coil, with specific connectors at its ends.

One of the functions of the hydraulic liquid in a system is to separate and lubricate the moving parts of components. The presence of solid particles produces wear, resulting in loss of efficiency, reduced component life and subsequent unreliability. Thus, hydraulic liquid cleanliness is very important for the system's uninterrupted operation and long life.

The amount of solid contamination present in a hydraulic system at start-up has a great influence on reliability during initial operation and subsequent component life. Components should be cleaned to an appropriate level after manufacturing and prior to use.

Hose assemblies are potential sources of contamination because of the bulk hose manufacturing processes, which can be intrinsically dirty, and because of other contaminants coming from assembly operations (hose cutting, dirty connectors, etc.) and/or storage.

It may be required to assess the actual built-in solid contamination of hose assemblies before installation (e.g. ISO 4413: 2010, 5.4.6.4, in general requirements for piping).

Hydraulic fluid power — Hose and hose assemblies — Method of collecting a fluid sample for analyzing the cleanliness of a hose or hose assembly

1 Scope

This document specifies two methods for collecting a fluid sample to be used to analyse the cleanliness of hydraulic fluid power hoses or hose assemblies within a certain inside diameter and length range (this range includes the majority of hose assemblies of real fluid power applications).

The two methods described in this document are intended for collecting only solid particulate contamination; they may not be appropriate for collecting contamination in liquid or grease form.

This document is a specific application of ISO 18413:2015, specifically Annexes A and B.

The scope of this document does not include providing efficient and effective cleaning methods for hose assemblies. These methods are recommended for statistical validation of other hose cleaning methods, which are more suitable for systematic processing of large production batches.

Contamination analysis is excluded from the scope of this document.

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 3722, *Hydraulic fluid power — Fluid sample containers — Qualifying and controlling cleaning methods*

ISO 4405, *Hydraulic fluid power — Fluid contamination — Determination of particulate contamination by the gravimetric method*

ISO 4406, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

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

ISO 4788, *Laboratory glassware — Graduated measuring cylinders*

ISO 5598, *Fluid power systems and components — Vocabulary*

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

ISO 18413, *Hydraulic fluid power — Cleanliness of components — Inspection document and principles related to contaminant extraction and analysis, and data reporting*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and ISO 18413 and 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
SCL
hose cleanliness level
hose assembly cleanliness level
cleanliness level of a hydraulic fluid power hose or hose assembly with regards to solid particulate contamination

Note 1 to entry: This may consist of a set of numbers of contaminant particles per 100 ml in each particle size class of interest or any other cleanliness level code agreed upon.

3.2
contaminant
loose or detachable solid material present in a hose or hose assembly or on a wetted surface of a hose or hose assembly

3.3
controlled surface
A_C
wetted surface of a part or component that is subject to a cleanliness requirement

Note 1 to entry: For the purposes of this document, A_C represents the nominal surface area of the test item that is exposed to system liquid.

3.4
controlled volume
V_C
volume of a part or component that is subject to a cleanliness requirement

Note 1 to entry: For the purposes of this document, V_C represents the nominal internal volume of the test item that the system liquid will occupy during normal end use.

3.5
external surfaces
those surfaces that will not be in contact with the system liquid during normal operation of the hose assembly

3.6
nominal inside diameter
d_{int}
nominal inside diameter of the hose

Note 1 to entry: This is to be considered a dimensional quantity for calculation purposes in accordance with Annex B.

3.7
nominal length of the test item
L
nominal length of the hose or hose assembly whose cleanliness shall be analysed

Note 1 to entry: This is to be considered a dimensional quantity for calculation purposes in accordance with Annex B.

4 Test equipment

4.1 Sample containers, cleaned, qualified, and controlled as appropriate for purpose. ISO 3722 provides an acceptable method of qualification and control.

4.2 Graduated cylinders or beakers, as required, conforming to ISO 4788 and cleaned, qualified, and controlled as appropriate for purpose. ISO 3722 provides an acceptable method of qualification and control.

4.3 Caps or plugs, as required to seal test items; these shall be leak-free and properly rinsed or flushed and shall not increase the measured contamination of the test item.

4.4 Test liquid, with the following characteristics:

a) It shall be compatible with all materials used in the test item, as well as with the working liquid of the final system. It should also be compatible with the test equipment, including seals and filters.

b) It shall have a viscosity of ≤5 mm^2/s at the test temperature.

c) It shall have a contamination level sufficiently low to minimize its contribution to the total measured test item's contamination. If different specifications are not agreed upon between the involved parties, the test liquid contamination level is sufficiently low when the contaminant present in a test liquid volume equal to V_C is less than 10 % of the SCL, in each size class. When the SCL. is not specified, test liquid contamination shall not exceed in any size range the limit number of particles per 100 ml given in Table 1 (limits are cumulative: all particles over the given size are recorded).

Table 1 — Default limits of cumulative numbers of particles of specific sizes

	Particle size [µm (c)]				
	> 6	> 14	> 21	> 38	> 70
Maximum number of particles per 100 ml	9 730	1 730	306	53	8

WARNING — Test liquid might be a solvent (for example, petroleum ether) with a low flash point. In this case, exercise care as there could be a risk of explosion. Appropriate precautions should be taken to avoid inhalation of fumes from these solvents. Always use suitable protective equipment and applicable health and safety recommendations.

4.5 Test liquid dispensing system, a simple, low-pressure hydraulic system for detaching contaminants from the test item with the quick rinse method, by means of a fast and short-lasting flow, and collecting them in defined volumes for subsequent measurement.

5 Contaminant collection methods

5.1 General

5.1.1 Contaminant collection consists of various techniques for removing contaminants from the wetted surface of the test item (hose length or hose assembly), suspending contaminants in a suitable test liquid, and lastly collecting the test liquid for subsequent analysis (analysis results should allow the assessment of the cleanliness of the test item). This document recommends and describes two contaminant collection methods:

a) **Agitation ("slosh" test)** — Contaminant contained on the internal surface or suspended in the internal volume of a test item is removed by partially filling the test item with the test liquid, sealing the openings, and agitating the test item to suspend the contaminant in the test liquid. Immediately after agitation, all test liquid is drained and collected for analysis.

b) **Quick rinse** — Contaminant contained on the internal surface or suspended in the internal volume of the test item is removed by a pressurized stream of sufficiently clean test liquid. All test liquid flowing out of the test item is collected for analysis. This method is not practical for test items of large V_C (i.e. of a large size).

NOTE In the quick rinse method, several small volumes of test fluid flow quickly through the assembly only once (single-pass).

Both methods do not require either expensive apparatus or highly specialized operators. They may be regarded as methods for cleaning hose assemblies, however they are time-consuming and they are not recommended cleaning methods for production.

5.1.2 The particular method shall be applied to a certain test item depending on its length (L) and its hose nominal internal diameter, d_{int},(see Annex A).

NOTE The overlapping band is along the V_C = 100 ml line.

5.1.3 Record the cleanliness level of the test liquid, and ensure that it does not exceed the limits determined in 4.4.

5.1.4 Each container of collected test liquid (partial fluid sample) shall be individually labelled; its label shall include at least the following data:

a) individual identification of the test item, i.e. hose length or hose assembly length;

b) date and time of collection (the order of collection of the various liquid volumes shall be clear to the reader);

c) "ISO/TS 18409-A" for liquid volumes collected with the agitation method or "ISO/TS 18409-Q" for liquid volumes collected with the quick rinse method.

5.1.5 Contaminant collection shall take place indoors, outside of areas where flows of unfiltered air are prevalent (e.g. far from ventilation fans in industrial shops), and reasonably far from dust-producing processes. Operators shall not wear visibly dusty and dirty clothes. Ambient temperature shall be between 15 °C and 45 °C, and the test liquid shall be at ambient temperature.

5.2 Procedure for collecting a sample using the agitation ("slosh") method

5.2.1 Check for caps or plugs at the ends of the test item. Hose assemblies without caps or plugs at their ends shall not be tested. If the hose assembly comes directly from production, fit caps or plugs at its ends to simulate the complete production process.

5.2.2 Calculate the controlled volume (V_C) of the test item in accordance with Annex B).

5.2.3 Clean the external surfaces of the test item and properly rinse its two capped or plugged ends; take care not to introduce contaminant into controlled volume. Remove one of the caps or plugs to ensure that only one end is sealed.

5.2.4 Maintain the test item in a position that allows it to be filled. Fill it with the amount of test liquid shown in Table 2 in accordance with C.1 under a protective clean hood or equivalent means to reduce the

amount of ambient air dust falling into the test item. The volume of test liquid shall be measured with a graduated cylinder.

Table 2 — Test liquid amounts

	V_C (ml)		
	< 400	400 to 2 000	> 2 000
Percentage fill	75 %	50 %	25 %

5.2.5 Seal the second end of the test item.

5.2.6 Subject the sealed test item to the following procedure (see C.2):

a) Soaking phase — Lay and keep straight the test item on a horizontal plane and every 15 s ± 5 s quickly rotate it 180 ° ± 10 ° (nominal half turn) around its longitudinal axis three times.

b) Agitation phase — Swing the sealed hose assembly 45 ° in each direction for 10 cycles. At the end of each cycle, rotate the hose 180 ° along the longitudinal axis. A cycle consists of manipulating the hose so that the test liquid travels from one end of the hose to the other and then back to the starting end.

5.2.7 Keep the test item straight and rotate it a few degrees above the horizontal plane: to let air in, loosen or remove the higher cap or plug and then proceed to rotate it at least up to 60 ° above the horizontal position. Remove the lower cap or plug and collect the test liquid in a sample container under a protective clean hood or equivalent means, to reduce the amount of ambient air dust falling into the collected test liquid (see C.3). Allow enough time to completely drain the test item. When removing the caps or plugs, care should be taken to prevent exfoliation of plating and the generation of metal flakes.

5.2.8 When the collection is over, seal the test item with its caps or plugs and keep it in controlled storage (for possible further investigations) until the analysis results of the collected volumes are available.

5.2.9 Analyse the collected test liquid using one of the following ISO procedures: ISO 4405, ISO 4406, ISO 4407 and ISO 11500.

5.3 Procedure for collecting a sample using the quick rinse method

5.3.1 Check for caps or plugs at the ends of the test item. Hose assemblies without caps or plugs at their ends shall not be tested. If the hose assembly comes directly from production, fit caps or plugs at its ends to simulate the complete production process.

5.3.2 Calculate the controlled volume (V_C) of the test item (see Annex B).

5.3.3 A test liquid dispensing system (see Annex D) is needed to run this procedure.

5.3.4 Fill the reservoir of the dispensing system with pre-filtered test liquid (see 4.4). The volume of test liquid shall be the greater of 250 ml or at least four times the controlled volume (V_C) of the test item.

5.3.5 Pressurize the reservoir of the dispensing system at 0,5 MPa (5 bar) ± 10 %.

5.3.6 Quickly open the valve and let all the test liquid flow through the test item. Allow at least 5 min for complete drain, with the test item in a vertical position.