INTERNATIONAL STANDARD

ISO 21018-3

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Hydraulic fluid power — Monitoring the level of particulate contamination of the fluid —

Part 3: Use of the filter blockage technique

Transmissions hydrauliques — Surveillance du niveau de pollution particulaire des fluides —
Partie 3: Technique de colmatage de filtre

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 21018-3 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

ISO 21018 consists of the following parts, under the general title *Hydraulic fluid power — Monitoring the level of particulate contamination of the fluid*:

— *Part 1: General principles*

— *Part 3: Use of the filter blockage technique*

A Part 2, dealing with the calibration and verification procedure for field contamination monitoring, and a Part 4, dealing with the use of the light extinction technique, are under development.

Introduction

In hydraulic fluid power systems, power is transmitted through a liquid under pressure within a closed circuit. The liquid is both a lubricant and power-transmitting medium. The presence of solid contaminant particles in the liquid interferes with the ability of the hydraulic liquid to lubricate and causes wear. The extent of contamination in the liquid has a direct bearing on the performance and reliability of the system and should be controlled to an appropriate level.

Quantitative determination of particulate contamination requires precision both in obtaining a representative sample of the liquid and the measurement of the contamination. The awareness of the benefits of cleanliness monitoring has led to the development of instruments that operate on-line (i.e. directly connected to a system) in an attempt to reduce measurement errors that are inherent with bottle samples. Automatic particle counters (APC) and monitors have been developed and are extensively used. Unfortunately, the hydraulic liquids in many systems might not be suitable for this method of measurement as the optical interfaces created by two-phase liquids (emulsions), immiscible liquids (water in oil and vice versa) and air in all liquids, interfere with the operation of the APC and give incorrect data.

Instruments using the filter blockage principle were developed specifically to provide an alternative on-line instrument in applications where light extinction or scattering techniques are not suitable. The principle used is that the rate of filter blockage is related to the number of captured particles whose size is larger than the pore size of the filters. The filter blockage technique does not directly measure the size of individual particles and so the principle of direct traceability does not apply.

Instruments using this technique are becoming widely used in industry and an International Standard is required in order to standardize operating procedures. This part of this ISO 21018 defines procedures for the use of filter blockage instruments in evaluating the cleanliness level of a hydraulic liquid. It also includes procedures for calibrating and verifying that the instruments are operating correctly to ensure consistent results and also closer correlation with on-line or in-line instruments using the light extinction principle.

Hydraulic fluid power — Monitoring the level of particulate contamination of the fluid —

Part 3:
Use of the filter blockage technique

1 Scope

This part of ISO 21018 specifies a method for the semi-quantitative determination of the particulate contamination level using the filter blockage technique (also known as the mesh-obscuration method or the pore-blockage technique) either on-line or off-line in containers. It also defines procedures for calibrating the instruments and verifying their correct operation both in the laboratory and in service.

In general, the techniques described in this part of ISO 21018 are suitable for monitoring

a) the general cleanliness level in hydraulic systems,

b) the progress in flushing operations,

c) support equipment and test rigs.

The use of this method is applicable to all single- or multi-phase liquid systems.

2 Normative references

The following referenced documents are indispensable for the application 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 4021, *Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system*

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

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

ISO 11943:1999, *Hydraulic fluid power — On-line automatic particle-counting systems for liquids — Methods of calibration and validation*

ISO 12103-1:1997, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*

ISO 21018-1, *Hydraulic fluid power — Monitoring the level of particulate contamination of the fluid — Part 1: General principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and ISO 21018-1 and the following apply.

3.1
blockage
restriction to flow through a filter caused by the capture of particles

3.2
extraneous contamination
contamination that is not an integral part of the sample being analysed and is from another source

NOTE It unrepresentatively increases the level of contamination.

4 Health and safety

4.1 General

Operate the instrument in accordance with the manufacturer's instructions and follow local health and safety procedures at all times.

4.2 Electrical power

Take care when connecting the instrument to an electrical power source and follow the manufacturer's instructions. Ensure that the correct safety fuse is fitted.

4.3 Mechanical fluid power

Instruments shall be connected to pressurized lines in accordance with the instrument manufacturer's instruction and in such a manner that the connection is secure and leak-free. Any connectors used shall be suitable for the pressure at the point of sampling.

Internal pressure shall be dissipated before removing any fittings or closures.

NOTE See 7.2 for guidance regarding sampling from pressurized lines.

4.4 Process liquids

4.4.1 Volatile liquids

Flammable liquids shall be used

a) in accordance with the relevant material safety data sheet (MSDS),

b) at a temperature below the stated flash point,

c) away from potential sources of ignition.

4.4.2 Solvents

Solvents shall be used in well-ventilated areas and the generation of aerosol mists shall be avoided.

4.4.3 Electrical earthing/grounding

Equipment used for filtering or dispensing solvents or any volatile flammable liquid shall be electrically earthed/grounded so as to avoid the risk of static discharge near the jet.

4.4.4 Environmental

All liquids and substances shall be disposed of in accordance with local environmental procedures.

Spillage shall be cleaned-up as detailed in the relevant MSDS.

4.4.5 Chemical compatibility

Ensure that all chemicals and fluids used in the various processes are chemically compatible with each other and with any equipment used.

5 Principle of filter blockage technique

The filter blockage technique shall be based on either of the following principles:

a) constant differential pressure across the filter: The change in flow through a filter is measured as it gradually becomes blocked by particles in a known volume of liquid. A change in flow relates to the quantity of particles that are removed from the liquid by the filter; or,

b) constant flow through the filter: The differential pressure across the filter is measured as it gradually becomes blocked by particles in a known volume of liquid. The change in differential pressure relates to the quantity of particles removed from the liquid by the filter.

Particles that are retained on the surface of the filter are removed by back-flushing prior to performing the next analysis.

NOTE 1 Individual particles are not detected and any reported numerical data is only an assessment of the number of particles from the detection process.

NOTE 2 If the liquid being analysed contains contaminants other than particulate (e.g. gels or non-soluble additives), these can be removed by the instrument filters and affect the output data.

6 Equipment

6.1 General

If the analysis is performed using sample bottles or containers (see 7.5), sampling apparatus (6.2.1) may be required. Such equipment avoids adding contamination when the inlet hose is inserted into the sample bottle.

For the process of calibration and verification of correct operation, use the equipment detailed in 6.2.

6.2 Equipment for on-line and off-line calibration and verification

6.2.1 Bottle sampling apparatus, for transferring the calibration/verification sample to the instrument.

If a pressure chamber is used to force the liquid through the device at constant pressure, a suitable source of filtered and regulated air is required.

6.2.2 Calibration/verification dust, test dust, designated ISO 12103-A3, used for calibration and/or verification shall meet the requirements ISO 12103-1:1997, Clause 3, and have a size distribution measured using an automatic particle counter (APC) calibrated in accordance with ISO 11171 or ISO 11943.

6.2.3 Flushing liquid, separate liquid for flushing the instrument prior to verification.

This liquid shall have a required cleanliness level (RCL) of less than 10 particles sized $\geqslant$ 6 µm(c)/ml.

NOTE µm(c) refers to the sizes of an APC calibrated in accordance with ISO 11171 or ISO 11943.

6.2.4 Oven, non-circulating, capable of providing a controlled temperature between 100 °C and 150 °C for drying the test dust.

6.2.5 Reference instrument, for example, a filter blockage unit or an APC, with a calibration status verified using an APC calibrated in accordance with ISO 11171 or ISO 11943.

6.2.6 Sample agitating device, suitable for re-dispersing the test dust within the contents of the sample bottle, such as an ultrasonic bath rated at 3 000 W/m^2 to 10 000 W/m^2 of base area, or a three-axis shaker.

The agitating device shall not alter the basic size distribution of the test dust.

6.2.7 Sample bottles, cleaned and validated in accordance with ISO 3722.

Use the following RCLs:

a) less than 100 particles $\geqslant$ 6 µm(c)/ml of sample bottle volume for sample bottles used for mixing the test dust;

b) less than 5 particles $\geqslant$ 6 µm(c)/ml of sample bottle volume for sample bottles used for both verifying system cleanliness and preparing the calibration verification samples.

6.2.8 Solvent, compatible with the instrument and equipment used and miscible with the test liquid.

Any solvent used shall be filtered to 0,8 µm or better to achieve an RCL of less than 2 particles $\geqslant$ 6 µm/per ml.

6.2.9 Solvent dispenser, pressurized, fitted with a 0,8 µm in-line membrane filter at the outlet.

6.2.10 Test rig, validated in accordance with ISO 11943.

6.2.11 Test liquid, conforming to the requirements used for on-line calibration (ISO 11943:1999, 7.2.7).

The test liquid is used for both cleaning and validating the test instrument and shall be kept in suitable sample bottles.

6.2.12 Vacuum source, to de-aerate the test liquid samples after shaking, and may be incorporated in the bottle sampling apparatus.

An ultrasonic bath can be used as an alternative method (see 6.2.6).

NOTE De-aeration might not be required if the instrument utilizes a constant pressure source.

6.2.13 Verification samples, samples bottles containing a suspension of ISO 12103-A3 in oil (see ISO 12103-1:1997, Clause 3) that is compatible with the instrument concerned and at a concentration specified by the instrument manufacturer.

The particle size distribution shall be determined using an APC calibrated in accordance with ISO 11171 or ISO 11943.

6.2.14 Weighing balance, with a resolution of 0,1 mg or better.

7 Operating procedures

7.1 General

Select the mode of operation from the following:

a) from a pressurized line (see 7.2);

b) by suction from a system reservoir (see 7.3);

c) by suction from a bulk container (see 7.4);

d) from a sample bottle (see 7.5).

NOTE Operating on-line from a pressurized source is preferred as it eliminates contamination from the environment.

Select the sampling position and sampling valves in accordance with ISO 4021.

If periodic or continuous trend monitoring is being carried out on a machine or process, take repeat samples from the same place, in the same manner and under similar operating conditions.

7.2 Operating from a pressurized line

7.2.1 General

WARNING — Ensure that all equipment and procedures used are safe and compatible with the maximum system pressure.

Select the sampling valve so that it complies with ISO 4021.

Position the sampling valve in a flow line that carries a significant flow and at a point of turbulence, such as after an elbow.

A pressure tapping point should not be considered a suitable sampling valve unless it complies with the requirements of ISO 4021. Such a tapping point can require sustained flushing prior to sampling.

7.2.2 Procedure

7.2.2.1 Stabilize the system at its normal operating conditions. Ensure that the minimum system pressure is sufficient for correct operation of the instrument.

7.2.2.2 Establish whether there is any liquid residual from a previous analysis in the instrument and whether it is miscible with the current test liquid. If it is not or there is any doubt, use the procedure detailed in A.3 to flush the previous liquid out of the unit. If it is miscible, proceed to 7.2.2.3.

7.2.2.3 Clean the outside of the sampling valve and then connect the instrument to the sampling valve.

7.2.2.4 Operate the instrument in accordance with the manufacturer's instructions. If the instrument does not have an automatic self-flushing sequence, run the instrument to ensure that the sampling line and instrument are adequately flushed (seek advice from the manufacturer where necessary). If the instrument was previously used to analyse a different but miscible liquid, flush with at least ten complete volumes (instrument and connecting pipes) of system liquid and direct to waste.

7.2.2.5 Analyse the sample in accordance with the manufacturer’s instructions. Perform at least two analyses and compare the results. If the difference between successive analyses is greater than one contamination code, this indicates that the flushing was inadequate or that the system was not stabilized. Repeat the analysis as appropriate.

7.2.2.6 After analysis, close the sample valve and ensure that any residual pressure has been exhausted from the sampling line before disconnecting the instrument.

7.2.2.7 Record the data.