INTERNATIONAL STANDARD

ISO 4021

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Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system

Transmissions hydrauliques — Analyse de la pollution par particules — Prélèvement des échantillons de fluide dans les circuits en fonctionnement

Reference number
ISO 4021:1992(E)

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.

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.

International Standard ISO 4021 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Sub-Committee SC 8, *Product testing and contamination control.*

This second edition cancels and replaces the first edition (ISO 4021:1977), which has been technically revised.

Annex A of this International Standard is for information only.

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Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a fluid under pressure within an enclosed circuit. This fluid is both a lubricant and a power-transmitting medium.

Reliable system performance requires control of the fluid medium. Qualitative and quantitative determination of particulate contamination in the fluid medium requires precision in obtaining the sample and determining the nature and extent of contamination.

The most representative sample is obtained using a sampler installed in a main flowline where the fluid is flowing in a turbulent manner. If such a sampler is unavailable, then fluid samples may be extracted from the system reservoir.

This International Standard describes procedures for obtaining both dynamic and static samples from an operating system.

Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system

1 Scope

This International Standard specifies procedures for extracting fluid samples from a hydraulic fluid power system under operation.

The preferred method is to extract fluid samples from a main flowline of an operating hydraulic system in such a manner that the particulate contaminant in the sample is representative of the fluid flowing at the point of sampling.

An alternative method is to extract a sample from the reservoir of an operating hydraulic system, but this method should only be used if a suitable sampler is not fitted.

The samples taken are used for particulate contamination analysis.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3722:1976, *Hydraulic fluid power — Fluid sample containers — Qualifying and controlling cleaning methods.*

ISO 5598:1985, *Fluid power systems and components — Vocabulary.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 5598 and the following definitions apply.

3.1 clean sample bottle: Sample bottle which has been thoroughly cleaned and verified in accordance with ISO 3722.

3.2 fluid sampling, line: The extraction of a sample of fluid from a turbulent section of a flow stream.

3.3 fluid sampling, reservoir: The extraction of a sample of fluid from the reservoir of an operating system.

3.4 sampler: A device which allows the extraction of a quantity of representative fluid from the hydraulic system. (See figures 1 and 2.)

3.5 turbulent flow: Fluid flow in which particle movement, anywhere in the flow, varies rapidly in velocity and direction. Flow may be turbulent when the Reynolds number (Re) is greater than 2 300 and can be assumed to be turbulent when $Re \geqslant 4\ 000$. See annex A.

4 Principles of fluid extraction

4.1 Sampling from fluid lines

4.1.1 Extract samples from main fluid lines in a section where turbulent flow conditions exist, using a sampler having the following characteristics (see example in figure 1):

a) being compatible with the fluid and the system operating pressure;

b) permitting on/off valving of sample flow;

c) having the ability to reduce the pressure value from the system pressure to atmosphere at a minimum flow rate of 100 ml/min (preferably 500 ml/min) in the open position; the pressure-reducing device shall not alter the contamination level or distribution;

d) having a sampling tube with internal diameter in the range 1,2 mm to 5 mm;

e) having an extraction point which is located in a turbulent flow zone; if this cannot be assured, use a means of creating turbulence, such as a turbulent flow inducer;

f) being compatible with the sampling procedure and particle-counting apparatus to be used;

g) giving repeatable and reproducible samples;

h) being easy to use and leak-free;

i) being so constructed that areas where particulate contamination may settle out, when the valve is not in use, are minimized; being so designed to minimize the generation of contaminants by the valve itself; being of a type which cleans itself by flushing.

4.1.2 Ensure that the extraction point is clear of the boundary layer of the system pipework and the axis of the sampler is approximately perpendicular to the main flow stream, preferably entering the system pipework from the top. Arrange the point of exit of the sampled fluid such that the flow is directed vertically downwards.

4.1.3 Permanently attach the valve, or check valve portion of a quick-disconnect coupling, to the port through which the sample is to be taken.

4.1.4 Provide dust caps for the item in 4.1.3 to reduce the ingress of environmental contaminants.

4.1.5 Operate the hydraulic circuit for not less than 30 min to diffuse particulate contaminants as evenly as possible throughout the system.

NOTES

1 When a procedure to diffuse particulate contaminants has been established for a particular system, that procedure should be maintained for all similar systems.

2 If a sample representing normal operating conditions is desired, the hydraulic circuits should not be operated for prolonged periods in an artificially clean environment.

4.1.6 Ensure the sampler is in the wide-open position when sampling and that it will provide a flow rate of approximately 500 ml/min (minimum 100 ml/min). Depending on the system pressure and valve size, it may be necessary to attach a length of small-bore tubing at the shut-off valve outlet in order to reduce the flow rate. Do not use tubing having an inside diameter smaller than 1,25 mm.

4.1.7 Locate the sampling valve in an area where it is readily accessible and away from sources of environmental contamination.

WARNING — Fluid sampling from high-pressure lines can be dangerous and should be performed only by experienced personnel. If skin is penetrated by fluid whilst taking a sample, see a physician immediately; failure to do so may result in serious harm.

4.2 Sampling from reservoirs

4.2.1 If a sampler cannot be fitted directly to the system, then samples may be extracted from the system reservoir. However, extreme care should be taken to avoid adding further contamination at the sampling point. Samples extracted by this means are less representative of the system contamination than samples extracted by means of live dynamic sampling.

4.2.2 Extract the sample from a centralized area where the fluid is in motion and away from quiescent areas caused by corners and baffles.

4.2.3 Select a convenient opening in the reservoir, above the fluid level, through which the sampler can enter.

Determine the distance $h/2$ (as shown in figure 2) to establish the depth of the sampling point below the fluid surface.

Place a reference mark on the sampler to indicate the surface of the reservoir at point of entry.

4.2.4 Carefully select the method of extracting the sample and ensure that the ingress of contaminant, from the environment, is kept to a minimum.

4.2.5 A proven method is shown in figure 2. This consists of a bottle cap with special fittings for drawing fluid samples into the sample bottle using a vacuum source. Lengths of laboratory grade flexible tubing, compatible with the fluid being sampled, are also required.

4.2.6 Two clean sample bottles are required:

bottle A, used for flushing the tubing prior to taking the sample (may be re-used);

bottle B, used to contain the sample.

4.2.7 A supply of filtered solvent is also required.

4.2.8 Operate the hydraulic circuits to diffuse the particulate contaminants as evenly as possible throughout the reservoir.

NOTES

3 When a procedure to diffuse particulate contaminants has been established for a particular system, that procedure should be maintained for all similar systems.

4 If a sample representing normal operating conditions is desired, the hydraulic circuits should not be operated for prolonged periods in an artificially clean environment.

5 Sampling procedure

5.1 Sampling from fluid lines using samplers

5.1.1 Clean the external surfaces of the sampler. A supply of filtered solvent will assist in this.

5.1.2 Where a sampler incorporating a quick-disconnect coupling is used, attach the separable portions to the permanently attached portion after removing the dust cap.

5.1.3 Open the sampler and flush through the valve with a sufficient quantity (normally at least 500 ml of fluid but not less than five times the total volume of the sampler), collect in a separate container and discard. Do not close the valve after flushing.

5.1.4 Uncap the precleaned sample bottle, place the sample bottle under the emerging jet of fluid and fill the bottle to about 75 % of its total volume. Do not allow the sampler to come into contact with the sample bottle.

5.1.5 When sufficient volume has been collected, remove the sample bottle, replace the cap immediately and close the valve.

5.1.6 It is acceptable to use proprietary sample containers of the type which do not require the bottle cap to be removed. If these are employed, it is necessary to allow the sample valve to come into contact with the sample bottle inlet tube. Take great care to avoid exterior contamination of the sample by this action.

5.1.7 Where a sampler incorporating a quick-disconnect coupling is used, disconnect the separate portions of the sampler and remove any residual fluid films by flushing with a suitable solvent.

5.1.8 Replace the dust cap on the permanently mounted section of the valve.

5.2 Sampling from reservoirs

5.2.1 Select a suitable area of the reservoir from which the sample is to be extracted (see 4.2). Clean the area around the entry point before breaking into the reservoir.

5.2.2 Using an arrangement as shown in figure 2, draw about 200 ml of prefiltered solvent through the sampling line to bottle A using a vacuum source.

5.2.3 Remove bottle A from the special cap of the sampling apparatus and discard the solvent. Reattach bottle A to the special cap and insert the sampling tube into the desired area of the reservoir.

5.2.4 Draw approximately 500 ml of fluid (but not less than five times the total volume of the sampler) through the tubing and discard the fluid.

5.2.5 Remove the cap from the precleaned sample bottle B and attach the bottle to the special cap of the sampling apparatus. Draw off sufficient volume to fill the sample bottle to about 75 % of its total volume using the volume source.

5.2.6 Remove sample bottle B from the special cap and immediately seal with its original cap. Reconnect sample bottle A to the special cap and withdraw the sample tube from the reservoir.

5.2.7 Fit the closure to the reservoir.

6 Labelling

The sample bottle shall be provided with a label bearing the following information, as appropriate:

a) sample reference number;

b) date and time of sample;

c) system reference;

d) fluid type, fluid temperature and (if known) the flow rate;

e) sampling location and pressure used;

f) running time.

7 Identification statement (Reference to this International Standard)

Use the following statement in test reports, catalogues and sales literature when electing to comply with this International Standard:

"Method of extracting fluid samples conforms to ISO 4021:1992, *Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system.*"

Dimensions in millimetres

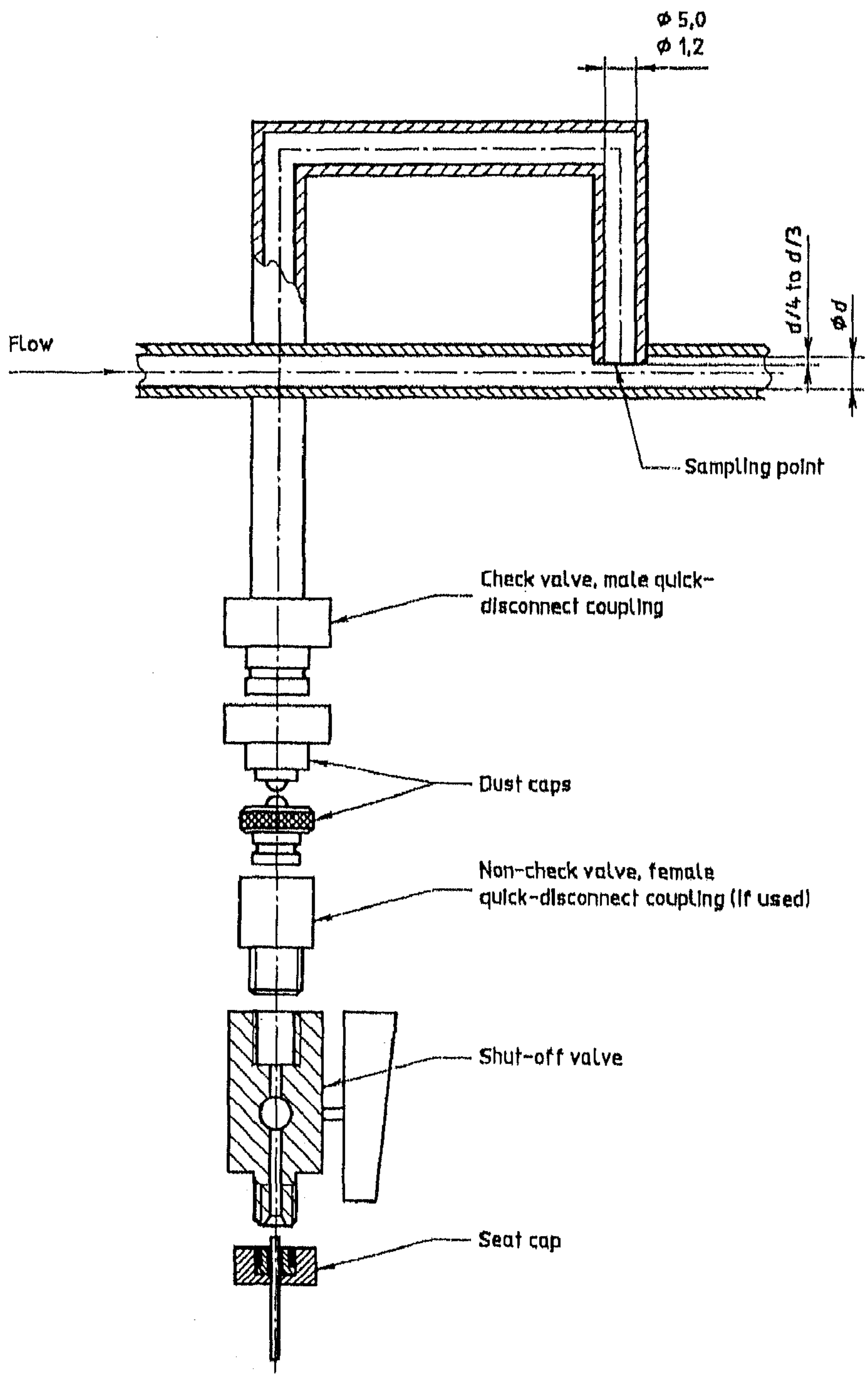

Figure 1 — Typical example of a field-type sampler

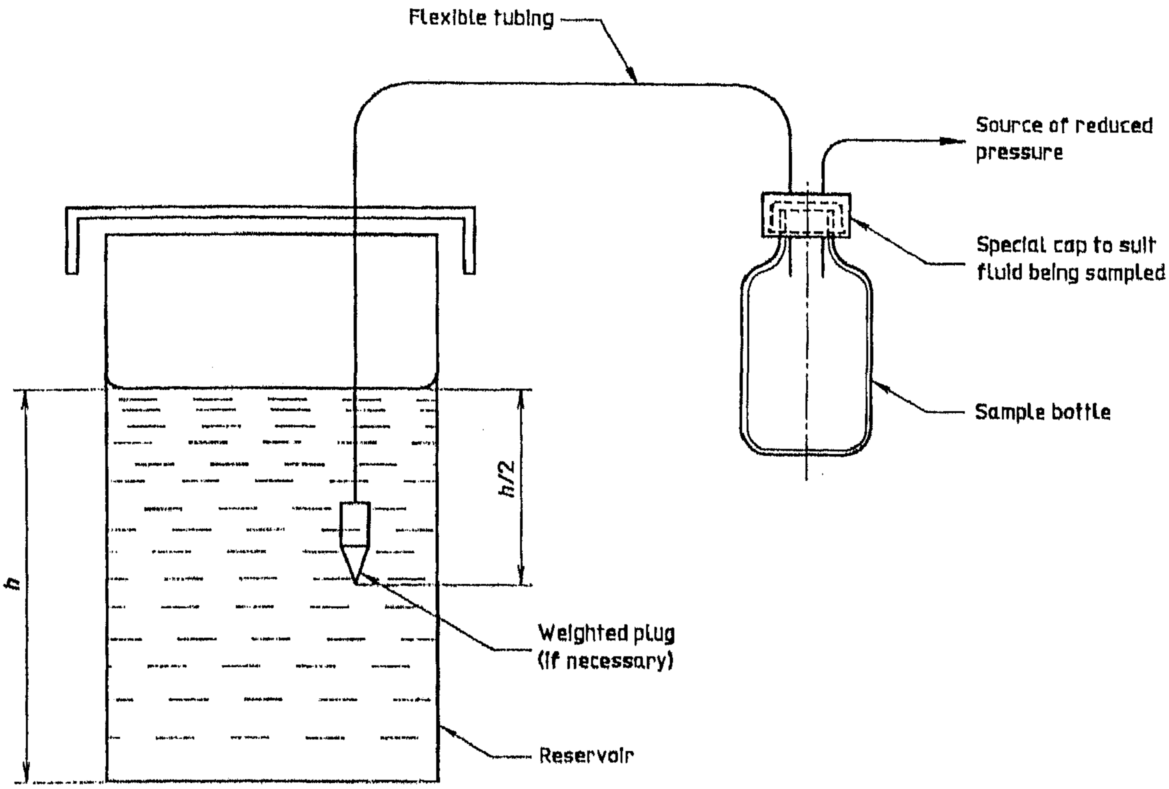

Figure 2 — Typical example of a reservoir sampler

Annex A
(informative)

Calculation of Reynolds number, Re

$$Re = \frac{\rho D V \times 10^3}{\mu} = \frac{D V \times 10^3}{\nu}$$

where

D is the pipe diameter, in millimetres;

V is the fluid velocity, in metres per second;

ρ is the density of fluid, in kilograms per cubic metre;

μ is the dynamic viscosity, in centipoises;

ν is the kinematic viscosity, in square millimetres per second.

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Descriptors: hydraulic fluid power, fluid circuits, hydraulic fluids, contamination, particle density (concentration), tests, sampling.

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