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

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Foreword

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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.

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This International Standard describes procedures for obtaining both dynamic and static samples from an operating system.
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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 $Re \geq 4 000$. 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.