131

INTERNATIONAL STANDARD

ISO 9632

First edition
1992-05-01

Hydraulic fluid power — Fixed displacement pumps — Flow degradation due to classified AC Fine Test Dust contaminant — Test method

Transmissions hydrauliques — Pompes à cylindrée fixe — Dégradation de l'écoulement due à la pollution par ACFTD

Reference number
ISO 9632 : 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 9632 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Sub-Committee SC 8, *Product testing and contamination control*.

Annex A of this International Standard is for information only.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Printed in Switzerland

Introduction

The life of a hydraulic fluid power pump is terminated when it can no longer deliver a specified flow rate at a given shaft speed, discharge pressure and fluid condition. The rate of wear in hydraulic pumps is related to the contamination level of the hydraulic fluid exposed to the internal surfaces of the pump. Wear forms critical clearance spaces (leakage paths) and is accompanied by a degradation in flow rate. The construction materials, together with the characteristic size and shape of critical clearance spaces, uniquely establishes the pump's sensitivity to contamination for given operating conditions.

Based on the above considerations, a contamination tolerance for the comparison of hydraulic pumps under the same operating conditions can be determined.

The test specified in this International Standard uses silica dust as a test medium to determine contaminant sensitivity (flow degradation due to contaminant wear) and is not intended to be representative of all types and rates of wear experienced in long-term field applications. It should be realized that many other parameters besides contaminant sensitivity must be considered when selecting a pump for a given duty.

Hydraulic fluid power — Fixed displacement pumps — Flow degradation due to classified AC Fine Test Dust contaminant — Test method

1 Scope

This International Standard specifies a uniform repeatable test method for determining and reporting the contaminant sensitivity (flow degradation) of a fluid power hydraulic positive fixed displacement pump due to wear caused by silica contaminants using classified AC Fine Test Dust (ACFTD).[1)]

The test is conducted under constant conditions of speed, pressure and temperature. System clean-up between successive injections of ACFTD during the test is not permitted.

The test data will assist in establishing filtration requirements for the protection of a pump when installed and operated in a hydraulic circuit.

This International Standard does not cover pump failure due to

a) causes other than wear as measured by flow degradation;

b) the presence of water and the action of oil chemistry plus water on pump wear surfaces;

c) fatigue, over-pressurization and other catastrophic modes.

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 3448 : —[2)], *Industrial liquid lubricants — ISO viscosity classification.*

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

ISO 4021 : 1977, *Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system.*

ISO 4405 : 1991, *Hydraulic fluid power — Fluid contamination — Determination of particulate contamination by the gravimetric method.*

ISO 4406 : 1987, *Hydraulic fluid power — Fluids — Method for coding level of contamination by solid particles.*

ISO 4572 : 1981, *Hydraulic fluid power — Filters — Multi-pass method for evaluating filtration performance.*

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

ISO 6743-4 : 1982, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (hydraulic systems).*

3 Definitions

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

flow degradation ratio: The ratio of the stabilized flow rate after a contamination injection to the reference flow (initial measured flow), Q_{ref}, of the pump.

1) ACFTD may be obtained from:

AC Spark Plug,
General Motors Corporation,
1300 North Dort Highway,
Flint,
MI 48556, USA.

or

AC Spark Plug,
Sales Department,
Milton Keynes,
Bucks., UK.

2) To be published. (Revision of ISO 3448 : 1975)

4 Symbols and units

4.1 The symbols and units used throughout this International Standard are as follows:

D = inside diameter of the injection chamber, in millimetres

L = overall length of the injection chamber, in millimetres

g_i = quantity of contaminant, in grams

Q_{ref} = reference flow rate of the test pump (see 8.11), in litres per minute

Q_p = flow rate of the test pump at the specified test pressure, in litres per minute.

4.2 The graphic symbols used in figure 1 are in accordance with ISO 1219-1.

5 Test equipment

5.1 The test equipment shall consist of a hydraulic test circuit, as illustrated in figure 1, comprising a reservoir, an injection system, a heat exchanger, a flow meter, pressure gauges, a temperature indicator, control filters, a test pump, a pump drive and hydraulic fluid.

5.2 Ensure that the lines connecting hydraulic components are of such size that turbulent mixing will exist throughout the test circuit.

5.3 Take precautions to prevent contaminant traps, silting areas, and combinations of cyclonic separation zones and quiescent chambers. Also ensure that the test does not exhibit the presence of entrained air.

5.4 Construct the reservoir with a conical bottom having an included angle of less than 90° to ensure sufficient fluid agitation.

5.5 Pressurize the reservoir, or provide a charge pump, to prevent cavitation in the test pump.

5.6 Diffuse the hydraulic fluid entering the reservoir below the surface of the fluid.

5.7 Construct the injection chamber with a volume of approximately 500 ml, an L/D ratio of 10, and a conical bottom having an included angle of less than 90°.

5.8 Use a heat exchanger which does not constitute a contaminant trap.

NOTE — It is recommended that either a one- or two-pass unit be used and be mounted vertically with the oil entering from the bottom. It is also recommended that the oil be circulated through the tube side and the water through the shell side.

5.9 Use a flow meter which is insensitive to contaminant and is accurate to within ± 2 % of the indicated value.

5.10 Use control filters which are capable of providing a contaminant background of code number 15/10 or better in accordance with ISO 4406.

5.11 Provide a facility for gravimetrically measuring the contamination level of the fluid in accordance with ISO 4405.

5.12 Have available a supply of classified ACFTD which has been provided by a recognized commercial classifier using ACFTD as the base stock.

NOTE — The classifier should prepare the test dust in accordance with the manufacturer's recommendations.

The mass of the dust collected in the classified fraction at the end of the classification period shall be within the limits given in table 1.

5.13 Have available a supply of clean fluid sample bottles with a required cleanliness level (RCL) of less than 10 particles greater than 10 µm per millilitre of bottle volume in accordance with ISO 3722.

5.14 Have available a supply of "clean" slurry injection bottles.

5.15 Use mineral oil class L-HM, as defined in ISO 6743-4, as the test fluid having a viscosity grade ISO VG 32, in accordance with ISO 3448 (i.e. 28,8 cSt to 35,2 cSt at 40 °C[1]). Report the brand name, the fluid supplier and the batch identification.

NOTE — If the pump to be tested is known not to operate satisfactorily using an ISO VG 32 fluid at a speed and pressure specified for the test at this viscosity, a higher viscosity grade of fluid may be used provided the grade of fluid and the reasons for using it are stated in the test report.

5.16 Select components for the test circuit which are of a design known to function satisfactorily with contaminated fluid.

Table 1 — Description of classified test dust

Classified size of test dust	Percentage by mass of classified fraction relative to the full distribution of ACFTD		
µm	Minimum	Average	Maximum
0 to 20	70	73	76
0 to 30	82,2	85,2	88,2
0 to 40	88	91	94
0 to 50	91	94	97
0 to 60	93	96	99
0 to 70	94,2	97,2	100
0 to 80	95	98	100

1) 1 cSt = 1 mm²/s

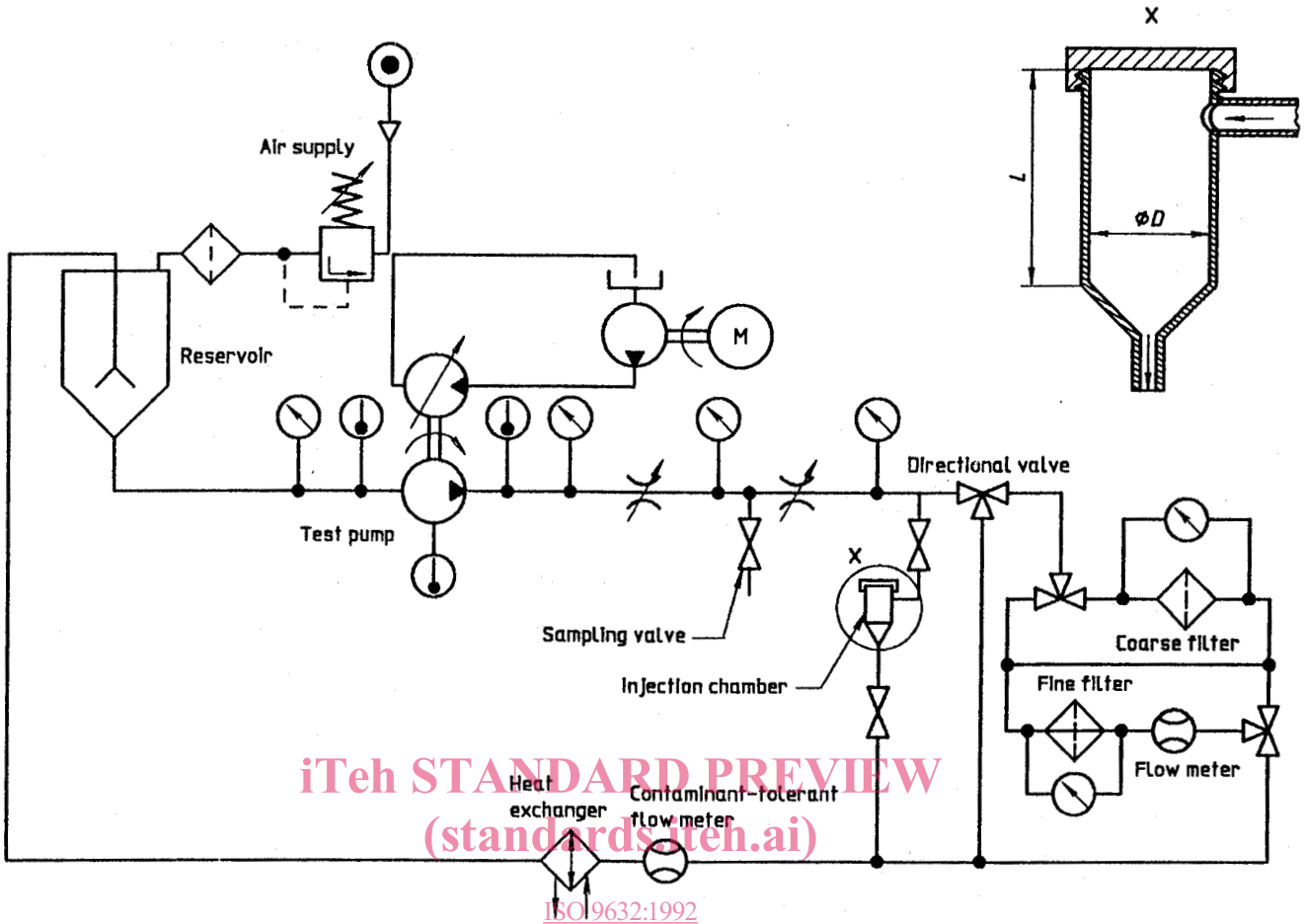

Figure 1 — Typical pump contaminant sensitivity test circuit

6 Test conditions

Unless otherwise stated, the following standard test conditions apply:

a) fluid temperature: 50 °C ±2 °C;

b) test pressure in kilopascals [bars[1)]]: as specified ±2 %;

c) test pump inlet pressure: 100 kPa to 150 kPa (1 bar to 1,5 bar);

d) test pump shaft speed (in revolutions per minute): as specified ±2 %.

7 Qualification of the test equipment

7.1 Install a pump which is known to be relatively insensitive to contamination in the test circuit.

7.2 Adjust the volume of the fluid in the test circuit to approximately the lowest volume flow rate for which the stand is to be used for testing.

7.3 Circulate fluid through the control filter until the contaminant background is code number 15/10 or better, in accordance with ISO 4406.

7.4 By-pass the control filters.

7.5 Prepare a quantity, g_i, of unclassified ACFTD to bring the contamination level of the system up to 300 mg/l ±10 mg/l, using the following expression:

g_i (in grams) = 0,3 × volume of the system (in litres)

7.6 Drain the injection chamber and fill it with the prepared contaminant (see 7.5) in the form of a well-mixed slurry to prevent agglomeration of particles.

7.7 Inject slowly, over a 5-min period, the contents of the injection chamber.

7.8 Operate the system at 70 % of the minimum flow rate at which the test system is intended to be used.

7.9 Extract four fluid samples at 15-min intervals from the system in the manner specified in ISO 4021.

7.10 Measure the contamination level of each sample in accordance with ISO 4405.

7.11 Circulate fluid through the control filters until the contaminant background is code number 15/10 or better.

7.12 Consider the system qualified for testing if the contamination levels (see 7.10) obtained from the four samples (see 7.9) are within 10 % of the initial contamination level of the test dust (see 7.5).

7.13 Repeat this qualification procedure when any modification to the flow path or to the reservoir is made.

8 Test procedure

8.1 With the test pump installed check that

a) the pressure control valve is fully open;

b) the reservoir is pressurized to 100 kPa to 150 kPa (1 bar to 1,5 bar);

c) both the coarse and the fine filters are in circuit;

d) the volume of oil in the test circuit, excluding the filter clean-up circuit, equates to the nominal rated delivery of the pump under test at the specified test speed.

8.2 Start the test pump at its minimum speed or 500 r.p.m, whichever is the greater.

8.3 Gradually increase the test pump speed over a period of 30 min to the specified test speed.

8.4 Whilst maintaining the pump inlet temperature of the hydraulic fluid at 50 °C ± 2 °C, run the test pump at the specified test speed:

a) for 5 min at minimum load;

b) for 15 min at 25 % of the specified test pressure;

c) for 15 min at 50 % of the specified test pressure;

d) for 15 min at 75 % of the specified test pressure;

e) for 60 min at 100 % of the specified test pressure.

8.5 Reduce the system pressure to a minimum and then stop the pump.

8.6 Calculate the quantity of contaminant (g_i) required for each injection using the following expression:

g_i (in grams) = 0,03 × volume of fluid in the system (in litres)

NOTE — The contamination level of the system will be 30 mg/l for each contaminant size range.

8.7 Prepare 12 sample slurries each containing g_i grams of classified contaminant, in clean sample bottles (see 5.13), in the following size ranges:

6 samples of 0 to 20 µm

1 sample of 0 to 30 µm

1 sample of 0 to 40 µm

1 sample of 0 to 50 µm

1) 1 bar = 10^5 Pa = 100 kPa; 1 Pa = 1 N/m^2

1 sample of 0 to 60 µm

1 sample of 0 to 70 µm

1 sample of 0 to 80 µm

8.8 Start the test pump at its minimum speed or 500 r.p.m., whichever is the greater, against minimum system pressure with the coarse and fine filters in circuit.

8.9 Gradually increase the test pump speed to the specified test speed over a period of 15 min.

8.10 Continue running at the specified test speed for 15 min at 50 % of the specified test pressure, followed by 15 min at 100 % of the specified test pressure.

NOTE — This section is open to review depending on whether or not a pump inlet temperature of 50 °C can be attained 10 min before the first injection of contaminant.

8.11 Reduce the system pressure to a minimum, switch filters out of the circuit and record the flow rate. This is the reference flow rate, Q_{ref}, in litres per minute.

8.12 Increase the system pressure to the specified test pressure and record

a) the pump flow rate, Q_p, in litres per minute,

b) the pump inlet temperature,

c) the pump outlet temperature (optional),

d) the pump casing temperature (optional),

whilst maintaining the test conditions specified in clause 6.

8.13 Inject slowly, over a period of 5 min, one of the 0 to 20 µm sample slurries prepared in accordance with 8.7.

8.14 Every 5 min, monitor and record the parameters given in 8.12. If the flow rate has decreased to less than 70 % of its original reference value (Q_{ref}), proceed directly to clause 9.

8.15 Repeat 8.13 and 8.14 every 30 min for a further five times without cleaning the system between injections.

8.16 After completion of the six 0 to 20 µm injections, repeat 8.13 and 8.14 using successive injections of the 0 to 30 µm, 0 to 40 µm, 0 to 50 µm, 0 to 60 µm, 0 to 70 µm and 0 to 80 µm sample slurries prepared in accordance with 8.7.

8.17 Acceptable reasons for premature termination of the test include

a) erratic inlet or outlet pressure;

b) noise level indication of mechanical interference or cavitation damage;

c) shaft seal failure;

d) seizure of mating elements;

e) any similar unusual situation.

9 Clean-up procedure

9.1 With the pump running at test speed, pass fluid through the coarse filter for 45 min and then through the fine filter for a further 45 min.

NOTE — Cleaning up of the system can be performed either on the day of the test or on the following day.

9.2 The cleanliness level required before a new pump can be tested shall be as required in 7.3, i.e. code number 15/10 in accordance with ISO 4406.

10 Data presentation

10.1 Record the pump identification, the operating conditions and the test data as shown in table 2. Include reasons for premature termination of the test and observation of any unusual operation, if applicable.

10.2 Calculate the volumetric efficiencies to a maximum of three significant figures for each injection by dividing the final flow rate (from 8.14) by the reference flow rate Q_{ref} (from 8.11).

10.3 Present the volumetric efficiencies, calculated in 10.2, which show the effect of ACFTD contaminant on the volumetric efficiency $[(Q_p/Q_{ref}) \times 100]$ of the test pump, in tabular and/or graphical form. Figure 2 shows an example of a graphical presentation.

10.4 Give the final flow degradation ratio

$$\frac{Q_{p\ final}}{Q_{p\ initial}} \times 100$$

at the completion of the test as shown in table 2 and figure 2.

11 Identification statement (Reference to this International Standard)

Use the following statement in catalogues and sales literature when electing to complying with this International Standard:

"Contaminant maximum particle size range injected at test termination was ..... µm using a test pressure of ..... kPa (..... bar) in accordance with ISO 9632 : 1992, *Hydraulic fluid power — Fixed displacement pumps — Flow degradation due to classified AC Fine Test Dust contaminant — Test method.*"