INTERNATIONAL STANDARD

ISO 10100

Third edition
2020-06

Hydraulic fluid power — Cylinders — Acceptance tests

Transmissions hydrauliques — Vérins — Essais de réception

Reference number
ISO 10100:2020(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

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 of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 3, *Cylinders*.

This third edition cancels and replaces the second edition (ISO 10100:2001), which has been technically revised. It also incorporates ISO 10100:2001/Amd1:2012.

The main changes compared to the previous edition are as follows:

— Normative references have been updated (Clause 2);

— A new clause “Symbols and units” (Clause 4) has been added;

— Test fluids have been updated (6.1);

— New figures showing the identification of a double (Figure 1) and a single rod cylinder (Figure 2) have been added;

— Contamination levels have been updated (6.2.2);

— Fluid temperature requirements have been changed (6.2.3);

— An optional piston seal leakage test (Clause 9) and an optional friction force test (Clause 10) have been added.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure circulating within an enclosed circuit.

One component of such a system is the hydraulic fluid power cylinder. This is a device that converts fluid power into linear mechanical force and motion. It consists of a movable element, i.e. a piston and piston rod, operating within a cylindrical bore.

Hydraulic fluid power — Cylinders — Acceptance tests

1 Scope

This document specifies acceptance and function tests for hydraulic fluid power cylinders.

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

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

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

ISO 7745, *Hydraulic fluid power — Fire-resistant (FR) fluids — Requirements and guidelines for use*

ISO 15380, *Lubricants, industrial oils and related products (class L) — Family H (Hydraulic systems) — Specifications for hydraulic fluids in categories HETG, HEPG, HEES and HEPR*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbols and units

Table 1 lists the symbols and units used in this document.

Table 1 — Symbols and units

Symbol	Characteristics	Unit
AL	bore diameter[a]	mm
MM	piston rod diameter[a]	mm
A_1, A_2	working areas of the cylinder[b]	mm^2
f_s	test frequency at sinusoidal movement	Hz
p_a	working pressure of the cylinder	MPa
p_1, p_2	pressure inside the chambers 1 or 2	MPa
$p_1(t)$, $p_2(t)$	pressure inside the chambers 1 or 2 dependent on time	MPa
F_R	friction force of the cylinder	N

[a] Identification code as per ISO 6099.

[b] Parameter as per ISO 7181.

Table 1 *(continued)*

Symbol	Characteristics	Unit
$F_R(t)$	friction force of the cylinder dependent on time	N
F_H	static friction	N
F_{H1}	static friction extending at sinusoidal movement	N
F_{H2}	static friction retracting at sinusoidal movement	N
F_G	mean dynamic friction extending at constant speed	N
F_{G1}	dynamic friction extending at constant speed	N
F_{G2}	dynamic friction retracting at constant speed	N
t	time	s
T_M	temperature of the fluid during test	°C
v	speed	m/s
v_S	maximum speed retracting at sinusoidal movement	m/s
v_K	speed at constant speed curve	m/s
x	amplitude	mm
x_s	test amplitude	mm
S	total stroke of the cylinder	mm
L_{Ds}, L_{Dk}	stroke length if cushioning on rod or piston side	mm

[a] Identification code as per ISO 6099.

[b] Parameter as per ISO 7181.

5 Identity check and characteristic parameters

5.1 General

The following information about the cylinder to be tested shall be recorded:

a) type;

b) port size, type and orientation;

c) if the cylinder contains cushions, verification of proper location and orientation of throttle screw(s);

d) stroke length;

e) model label;

f) bore;

g) rod diameter;

h) piston rod extension and configuration;

i) mounting type or style and, where applicable, position of the variable mounting surface.

5.2 Double rod cylinder

Figure 1 shows the identification of a double rod cylinder.

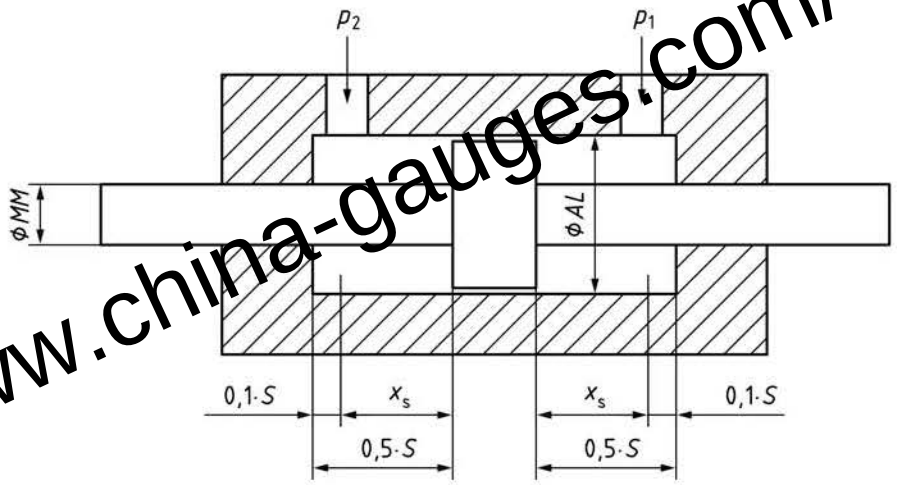

Figure 1 — Identification double rod cylinder

5.3 Single rod cylinder

Figure 2 shows the identification of a single rod cylinder.

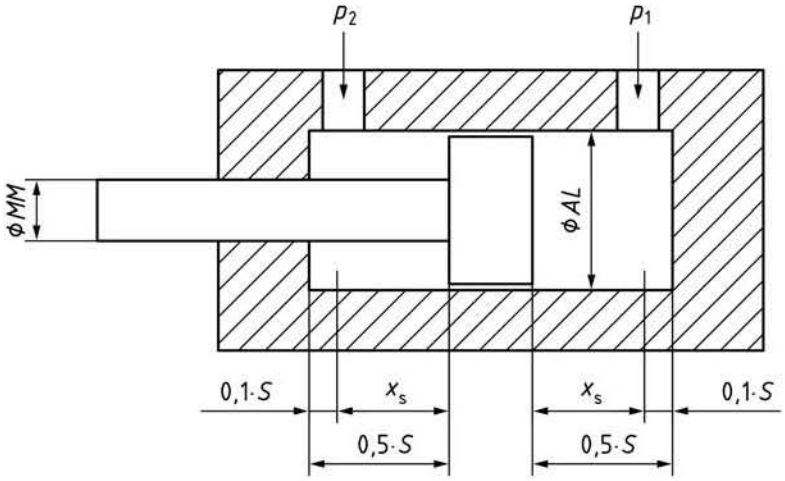

Figure 2 — Identification single rod cylinder

6 Test conditions

6.1 Test fluid

A hydraulic oil (or other liquid on which the cylinder manufacturer and user have agreed) that conforms to ISO 6743-4, ISO 7745 or ISO 15380 and is compatible with sealing materials used in the cylinder under test shall be the test medium.

6.2 Test fluid conditioning

6.2.1 General

The fluid used in the test circuit shall be conditioned according to 6.2.2 to 6.2.4, as applicable.

6.2.2 Contamination level

The contamination level of the fluid shall be 19/16 or 19/16/13, expressed in accordance with ISO 4406, or lower.

For those applications that require a higher fluid cleanliness level, e.g. for cylinders with servo-valves or contamination sensible sealing elements, the contamination level of the fluid shall be 16/13 or 16/13/10 expressed in accordance with ISO 4406.

6.2.3 Fluid temperature

The fluid temperature during test shall be maintained between 35 °C and 55 °C. Other temperature ranges shall be agreed between the manufacturer and the purchaser.

6.2.4 Rust inhibitors

Rust inhibitors to prevent corrosion inside the cylinder may be added to the fluid, provided they are compatible with sealing materials used in the cylinder under test.

7 Test modules

This document describes a basic test for leakage which is obligatory (module L) and additional tests for piston leakage and friction force, which are optional (modules P and F), see Table 2.

Table 2 — Test modules

Test module	Obligatory/optional
Module L — Test for leakage	Basic-test-module, obligatory Required for all cylinders
Module P — Piston seal leakage test	Optional test
Module F –Friction force test	Optional test

8 Module L — Basic tests for leakage

8.1 General

This test is obligatory and is required for all cylinders.

8.2 Test for leakage at low test pressure

8.2.1 Procedure

Cycle the cylinder at a minimum of 500 kPa [5 bar[1)]] for cylinders with bores greater than 32 mm and at 1 000 kPa (10 bar) for cylinders with bores less than or equal to 32 mm, three or more times to the end positions. Pause at one of the end positions for a minimum of 10 s. It is recommended to apply the pressure during the pause longer for larger bore sizes.

8.2.2 Sight test

a) The absence of vibration or crawling during the motion shall be verified.

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

b) When the piston has reached the maximum extension at end stroke, the overall stroke shall be measured.

c) Fluid leakage on rod seal shall be observed. When the test is over, any oil film present on the rod shall be insufficient to form either a drop or a ring of oil on the rod.

d) The absence of fluid leakage on all static seals shall be verified.

e) The absence of fluid leakage on throttle screws or on check valves of end stroke cushion(s) shall be verified.

f) If any cylinder components are sealed by a weld, the absence of fluid leakage at the weld seam(s) shall be verified.

g) If the cylinder incorporates a cushion or cushions and has throttle screws, the screws should be set to a slightly open position. It shall be verified that the piston and rod assembly show a deceleration effect before bottoming on to the cylinder end cap(s).

8.3 Proof/external leakage test

8.3.1 Procedure

A test pressure of 1,5 times the cylinder's rated pressure or recommended operating pressure shall be applied alternately to both ends of the cylinder and held for at least 10 s. It is recommended to apply the pressure longer at both ends for larger bore sizes.

8.3.2 Sight test

a) The structural integrity of the cylinder shall be verified.

b) The absence of fluid leakage on all static seals shall be verified.

c) The absence of fluid leakage on throttle screws or on non-return valves (check valves) of end-of-stroke cushion(s), shall be verified as applicable.

d) If any cylinder components are sealed by a weld, the absence of fluid leakage at the weld seam(s) shall be verified.

9 Module P — Piston seal leakage test (optional)

9.1 General

This test is required only if specified as such by the user.

9.2 Procedure

A test pressure equal to the cylinder's rated pressure or a test pressure as specified by the user shall be applied to the cylinder.

9.3 Sight test

The absence of fluid leakage past piston seals shall be verified.

10 Module F — Friction force test (optional)

10.1 General

This test is required only if specified as such by the user.

The friction force of hydraulic fluid power cylinders shall be determined by the differential pressure measuring in an electrohydraulic circuit.

For this purpose, the piston rod of the hydraulic cylinders shall be moved in a position control loop with an appropriate control valve and a position transducer. In both cylinder chambers suitable pressure transducers are integrated.

Both pressures in the chambers and the piston rod position shall be measured continuously at each pressure stage p_a = 5 MPa, 10 MPa, 15 MPa, 20 MPa and 25 MPa over 2 double strokes.

If the permitted working pressure is below the test pressures mentioned in this document, no measurements should be carried out with these high pressures.

10.2 Test setup

The cylinder under examination shall be mounted horizontally without any additional moved mass.

The pressure ratio of the two chambers shall be the inverse of the ratio of the piston areas in order to balance the forces in both chambers.

The test mounting may be vertically, if the application requires or if otherwise agreed. In this case the weight forces shall be considered when calculating the friction forces.

10.3 Test amplitude

The piston rod shall be moved with a test amplitude x_s.

A spacing of 10 % of the total stroke on each side shall be subtracted from the test amplitude. The length L_{Ds} and L_{Dk} of any existing cushioning shall also be subtracted from the test amplitude.

$$x_s = \frac{S - 0{,}2 \cdot S - L_{Ds} - L_{Dk}}{2}$$

10.4 Motion profile

10.4.1 Measurement with sinusoidal movement

The test frequency, f_s, of the sinusoidal movement shall be chosen in relation to the test amplitude x_s to achieve a maximum test speed of v_S = 0,05 m/s.

$$f_s = \frac{v_s}{2 \cdot \pi \cdot x_s}$$

In the case that the determined test amplitude exceeds 100 mm, the measurement with sinusoidal speed curve shall be performed with an amplitude of 100 mm centred in the middle of the stroke.

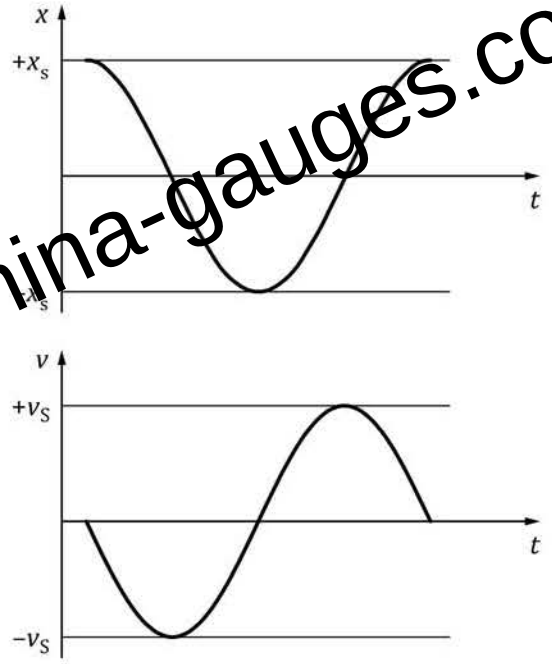

Figure 3 — Motion profile with sinusoidal movement

10.4.2 Measurement at a constant speed

The maximum test speed v_K (see Figure 4) shall be 0,05 m/s and shall be reached within the first 5 % of the amplitude.

In the case that the available motion power is insufficient for the maximum test speed, v_K, the maximum test speed results from the available oil flow.

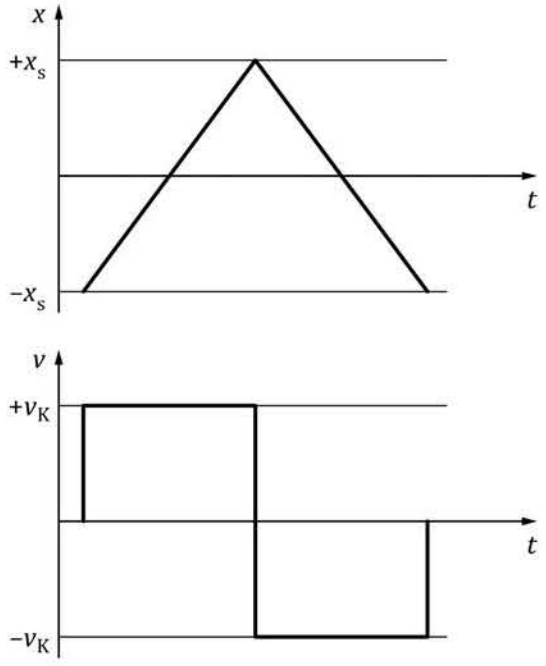

Figure 4 — Motion profile at a constant speed

10.5 Determination of friction force

10.5.1 General

The friction force curve of a hydraulic cylinder shall be calculated from the pressures measured in motion as described under 10.1 to 10.4.

For the calculation of the friction force a pair of pressure values inside the chambers at the same time shall be used.

10.5.2 Double rod cylinders

For cylinders with equal areas A_1 and A_2 (double rod cylinders), the areas and the friction force are calculated at each position and time as:

$$A_1 = A_2 = \frac{\pi}{4} \cdot \left(AL^2 - MM^2 \right)$$

$$F_R(t) = \left(p_1(t) - p_2(t) \right) \cdot A_1$$

10.5.3 Single rod cylinders

For cylinders with different areas A_1 and A_2 (single rod cylinders), the areas and the friction force are calculated at each position and time as:

$$A_1 = \frac{\pi}{4} \cdot AL^2$$

$$A_2 = \frac{\pi}{4} \cdot \left(AL^2 - MM^2 \right)$$

$$F_R(t) = \left(p_1(t) \cdot A_1 - p_2(t) \cdot A_2 \right)$$

10.6 Statement of friction force

10.6.1 General

For friction forces of the cylinder, the friction forces measured in accordance with 10.6.2 and 10.6.3 shall be indicated.

When a friction force is indicated, the real test speed in m/s, the temperature in °C of the measurement and the accuracy of the pressure transducers shall be described, in addition to the characteristic parameters given in Clause 5.

The pressure transducers shall be calibrated appropriately.

10.6.2 Static friction force

The static friction force is the breakaway force at the beginning of the motion.

As static friction force, F_H, the maximum value of the measurement with sinusoidal movement between the two changes in direction as described under 10.4.1 shall be stated (see Figure 5).

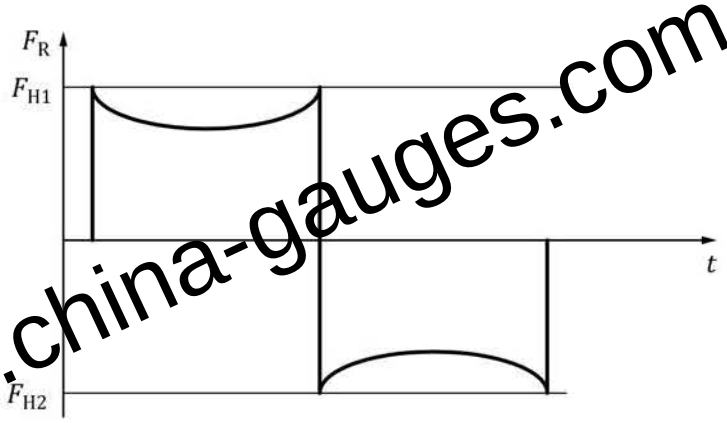

Figure 5 — Friction force curve with sinusoidal movement

10.6.3 Friction force at test speed

The dynamic friction force, F_G, at test speed shall be the result of the arithmetic mean of the friction forces at a motion with constant speed as described under 10.4.2 (see Figure 6).

For this, only the part of the motion with test speed is relevant. Possible acceleration or deceleration phases shall not be considered.

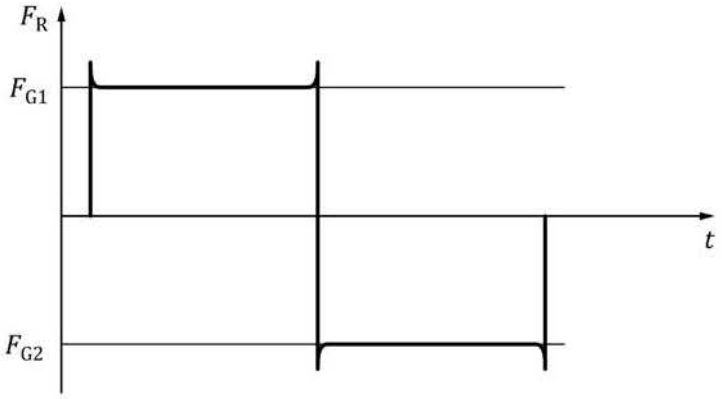

Figure 6 — Friction force curve at a constant speed

11 Identification statement (Reference to this document)

It is recommended that manufacturers use one of the following statements as applicable in test reports, catalogues and sales literature when electing to comply with this document.

— "Hydraulic cylinders tested in accordance with ISO 10100:2020, *Hydraulic fluid power — Cylinders — Acceptance tests"* for cylinders tested with Module L.

— "Hydraulic cylinders tested in accordance with ISO 10100:2020, *Hydraulic fluid power — Cylinders — Acceptance tests"* for cylinders tested with Module L and P.

— "Hydraulic cylinders tested in accordance with ISO 10100:2020, *Hydraulic fluid power — Cylinders — Acceptance tests"* for cylinders tested with Module L and F.

— "Hydraulic cylinders tested in accordance with ISO 10100:2020, *Hydraulic fluid power — Cylinders — Acceptance tests"* for cylinders tested with Module L and P and F.

ICS 23.100.20
Price based on 9 pages