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Second edition
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Crop protection equipment — Reciprocating positive displacement pumps and centrifugal pumps — Test method

Matériel de protection des cultures — Pompes volumétriques alternatives et pompes centrifuges — Méthodes d'essai

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Foreword

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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).

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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 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

This second edition cancels and replaces the first edition (ISO 12809:2011), which has been technically revised.

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

— The definitions for the following terms have been modified:
  — 3.1 reciprocating positive displacement pump;
  — 3.2 centrifugal pump;
  — 3.12 air vent line.
— In Clause 4, text has been added to better specify the test on pump installed on the sprayer.
— In Clause 5, more specification about the test liquid has been provided.
— In 7.2, Figure 2 and related text have been added to better specify how to manage test with centrifugal pumps.
— The following subclauses have been improved:
  — 7.3
  — 7.3.1
  — 7.3.2
  — 7.3.3
  — 7.3.3.1

- 7.3.3.2
- 7.3.3.3

— A new Annex B has 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.

Crop protection equipment — Reciprocating positive displacement pumps and centrifugal pumps — Test method

1 Scope

This document specifies test methods and the environmental conditions for evaluating the performance of reciprocating positive displacement pumps and centrifugal pumps designed for crop protection equipment.

This document is applicable when defining the performance of stand-alone pumps or pumps that are installed on a sprayer.

Some of the tests indicated in this document are suited only for specific pump types.

It is not applicable to pesticide metering pumps for injection systems.

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 5681, *Equipment for crop protection — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5681 and the following 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/

3.1
reciprocating positive displacement pump
machine in which liquid is trapped in confined volumes and transported from an inlet connection to an outlet connection by the reciprocating movement of pistons or plungers

3.2
centrifugal pump
non-volumetric pump in which the flow of the liquid is achieved by means of one or more impellers

3.3
suction pressure
pressure at the suction fitting of the pump

3.4
reference suction pressure
value of *suction pressure* (3.3) used for taking into account the pressure drop that is present when the pump is installed on the sprayer

3.5
delivery pressure
pressure at the *delivery fitting* (3.11) of the pump

3.6
rated pressure
maximum pressure at which the pump can be used continuously when installed on the sprayer, as declared by the pump manufacturer

3.7
rotating speed
number of revolutions of the pump shaft in the considered time interval

3.8
flow-rate
volume of liquid that flows through the pump per unit of time

3.9
power consumption
power given to the pump by the power source, measured at the inlet shaft of the pump

3.10
flow-rate adjustment valve
valve for adjusting the liquid flow

3.11
delivery fitting
body of pipelines collecting the liquid coming from the pump and routing it to the delivery pipeline

3.12
air vent line
small hose or tube connected to a *centrifugal pump* (3.2) to bleed off trapped air

Note 1 to entry: For air vent line connection is made from the highest point in the centrifugal pump casing and is routed continually upward to discharge above the highest liquid level in the tank.

4 Accuracy of measurements

Temperatures shall be measured with a maximum error of ±1 °C.

Length shall be measured with a maximum error of ±1 mm.

Suction pressure shall be measured with a maximum error of ±2 kPa.

Delivery pressure shall be measured with a maximum error of ±1 %.

Rotating speed shall be measured with a maximum error of ±1 %.

Flow-rate for stand-alone pumps according to 7.2 shall be measured with a maximum error of ±1,5 %.

Flow-rate for pump installed on a sprayer as in 7.3 shall be measured with a maximum error of ±2 % of the measured value when the flow-rate of the pump is >100 l/min, and ±2 l/min when the flow-rate of the pump is ≤100 l/min.

Load torque shall be measured with a maximum error of ±5 %, at least for values greater than the 25 % of the maximum torque.

The time measurements shall be made to an accuracy of ±1 s, with the exception of measurement indicated in 7.2.7.2 and 7.2.8.2 for which the accuracy shall be of ±0,05 s.

5 Test liquid

5.1 Water, shall be clean and free from solids in suspension with the exception of what might be considered normal for tap water (e.g. lime causing hard water). If an adjuvant or other plant protection products are added, the product identity and properties shall be documented in the test report.

6 General test conditions

6.1 Environmental conditions

The air and testing liquid temperatures shall be not less than +10 °C and not more than +45 °C.

6.2 Suction pressure

The suction pressure, expressed in kilopascals (kPa), shall be measured at the suction fitting, as close as possible to the pump.

6.3 Delivery pressure

The delivery pressure, expressed in kilopascals (kPa), shall be measured at the delivery fitting, before the adjustment valve.

6.4 Rotating speed

The rotating speed shall be expressed in revolutions per minute (r/min).

6.5 Flow-rate

The flow-rate shall be expressed in litres per minute (l/min).

The flow-rate can be determined using a flow meter or alternatively, the liquid flow could be calculated by collecting the liquid in a separate tank, measuring time and mass.

6.6 Power consumption

The power consumption shall be indicated in kilowatts (kW) and can be calculated as the rotating speed multiplied by the load torque measured on the input shaft of the pump, using Formula (1):

$$P = \frac{\pi \times n \times C}{30\,000} \tag{1}$$

where

P is the power, in kilowatts (kW);

n is the rotating speed, in revolutions per minute (r/min);

C is the load torque, in newton metres (N·m), measured on the input shaft of the pump.

Other methods giving the same result can be used when the input shaft of the pump is not accessible.

7 Test methods

7.1 General

Before starting the tests, ensure visually that all connections work properly without leakage at the maximum pressure and without unintended air intake at the maximum depression in the suction line.

If present, set the pressure of the pneumatic pressure pulsation damper as indicated by the manufacturer.

Use the test liquid specified in Clause 5.

7.2 Stand-alone pump

7.2.1 Test bench

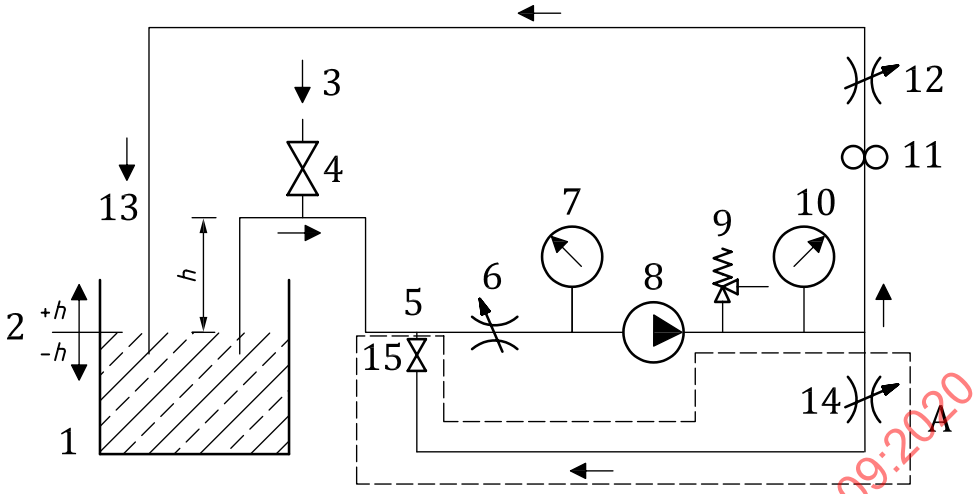
7.2.1.1 The test bench shall have a main circuit containing the devices for flow control and pressure adjustment; see Figure 1 with the scheme of hydraulic circuit for self-priming pump or Figure 2 with the scheme of hydraulic circuit for non-self-priming centrifugal pump. To simulate the installation of positive displacement pump on the sprayer, the test bench shall have an extra circuit (key A in Figure 1) with part of the flow coming back directly to the suction line of the pump.

7.2.1.2 The suction line connects the pump with the tank. It shall be fitted with an air inlet valve (key 4 in Figure 1 or Figure 2), a suction pressure adjustment valve (key 6 in Figure 1 or key 5 in Figure 2) and a suction pressure gauge (key 7 in Figure 1 or key 6 in Figure 2). For self-priming pumps, the h value shall be (400 ± 100) mm (Figure 1). For non-self-priming pumps, the h value shall be (−400 ± 100) mm (Figure 2). The inlet of the suction line shall be free, without non-return valves.

7.2.1.3 The delivery line shall be fitted with a safety valve (key 9 in Figure 1) with appropriate range able to protect the test bench, a pressure gauge (key 10 in Figure 1 or key 8 in Figure 2), a device for flow-rate measurement (key 11 in Figure 1 or key 9 in Figure 2) and a pressure adjustment valve (key 12 in Figure 1 or key 10 in Figure 2). The output of the delivery line shall be connected to the tank in order to guarantee the re-circulation of the test liquid (key 13 in Figure 1 or key 11 in Figure 2). Ensure that the back flow does not create turbulence in the suction line.

7.2.1.4 The extra circuit (key A in Figure 1) shall be fitted with a re-circulation adjustment valve (key 14 in Figure 1) and a shut-off valve (key 15 in Figure 1) able to isolate this part of the circuit.

7.2.1.5 The level of the liquid in the tank (key 2 in Figure 1 or Figure 2) shall be equal (±10 mm) to the top of the pump housing at the beginning of the test. Set the level when all the lines are filled with the test liquid. During the measurement, the level of the liquid in the suction tank shall not change by more than ± 50 mm.

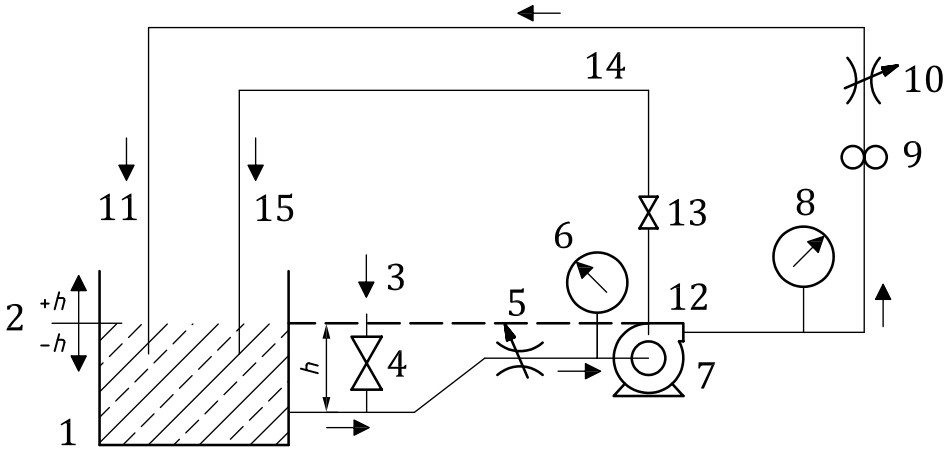


Key

1	tank	9	safety valve
2	water level in the tank	10	delivery pressure gauge
3	air inlet	11	flow-rate measurement
4	air inlet valve	12	delivery pressure adjustment valve / nozzle flow-rate adjustment valve
5	re-circulation input	13	back flow in the tank
6	suction pressure adjustment valve	14	re-circulation adjustment valve
7	suction pressure gauge	15	shut-off valve
8	pump to be tested connected to rpm measuring device		
A	extra circuit to simulate re-circulation for positive displacement pump		
$h(\pm)$	height between the water level in the tank and the air inlet valve (see keys 2 and 3)		

NOTE When using centrifugal pump with air vent lines, ensure its proper connection to the hydraulic circuit of the test.

Figure 1 — Scheme of hydraulic circuit for self-priming pump



Key

1	tank	9	flow-rate measurement
2	water level in the tank	10	delivery pressure adjustment valve / nozzle flow-rate adjustment valve
3	air inlet	11	back flow in the tank
4	air inlet valve	12	air vent connection (top plug on the pump housing)
5	suction pressure adjustment valve	13	shut-off valve for air vent line
6	suction pressure gauge	14	air vent line
7	centrifugal pump to be tested connected to rpm measuring device	15	air vent return to tank, above water level in tank
8	delivery pressure gauge	h(±)	height between the water level in the tank and the air inlet valve (see keys 2 and 3)

Figure 2 — Scheme of hydraulic circuit for non-self-priming centrifugal pump

7.2.2 Installation of pump

The pump shall be fixed on the test bench as indicated by the pump manufacturer, especially those concerning the positioning of the pump and the dimension of the fixing device.

The pump shall be connected to the test bench by non-collapsible pipelines, both at the suction and delivery side.

The internal diameter of the suction line shall be as follows:

— for hoses, equal to or greater than (max. +5 %) the internal diameter indicated by the pump manufacturer;

— for fittings, equal to or greater than (max. +5 %) the internal diameter indicated by the pump manufacturer.

The internal diameter of the delivery line shall be equal to or greater than (max. +50 %) that indicated by the pump manufacturer.

7.2.3 Reference suction pressure

The reference suction pressure value shall be (–25 ± 2) kPa.

The suction pressure valve setting shall be set once at the beginning of the test by means of suction pressure adjustment valve (key 6 in Figure 1 or key 5 in Figure 2) at the maximum rotating speed indicated by the pump manufacturer and with the delivery pressure set to (5 ± 1) % of the rated pressure.

7.2.4 Flow-rate at the reference suction pressure

7.2.4.1 Test conditions

For self-priming pump, ensure that extra circuit valves (key 14 and 15 in Figure 1) are closed.

Set the reference suction pressure as defined in 7.2.3.

For the adjustment of the delivery pressure, use a valve indicated as key 12 in Figure 1 or key 10 in Figure 2.

Before each setting, ensure that the pump is correctly primed.

The tests shall be performed setting the delivery pressure to have the maximum and minimum pressures indicated by the pump manufacturer and at least two other values equally spaced in the range. In every case, the test shall be performed at the maximum and minimum rotating speeds of the pump, as indicated by the pump manufacturer, and at least at two other values equally spaced in the range.

If the pump has variable volume, perform the test at the maximum and minimum volumes, as indicated by the pump manufacturer, and at least at two other values equally spaced in the range.

For each combination of the above parameters, measure the flow-rate.

7.2.4.2 Results

Report the results of the tests in a chart or graph (for examples, see A.1.1 or A.2.1).

7.2.5 Flow-rate at variable suction pressure

7.2.5.1 Test conditions

For self-priming pump, ensure that extra circuit valves (key 14 and 15 in Figure 1) are closed.

The tests shall be performed with the delivery pressure set to (10 ± 1) % of the rated pressure, or at least (100 ± 10) kPa, and at the maximum rotating speed, as indicated by the pump manufacturer.

Start with the suction pressure set to the minimum of:

— the minimum negative value indicated by the pump manufacturer;

— (−60 ± 2) kPa.

Repeat the test at increasing suction pressures in steps of (10 ± 2) kPa up to (−10 ± 2) kPa.

Measure the flow-rate for each suction pressure.

7.2.5.2 Results

Report the results of the tests in a chart or graph (for an example, see A.1.2).

7.2.6 Power consumption

7.2.6.1 Test conditions

The test conditions shall be as specified in 7.2.5.1 and the power consumption is calculated as indicated in 6.6.

7.2.6.2 Results

Report the results of the tests in a chart or graph (for examples, see A.1.3 or A.2.2).

7.2.7 Priming capacity — Without re-circulation

This test is applicable only to self-priming pumps (reciprocating positive displacement pump and centrifugal pumps).

7.2.7.1 Test conditions

The test shall be performed under the following conditions:

— at the maximum rotating speed, as indicated by the pump manufacturer;

— with the delivery pressure set to (5 ± 1) % of the rated pressure or at least (100 ± 10) kPa;

— with the suction pressure set to the reference suction pressure defined in 7.2.3;

— with lengths of suction line equal to (3 ± 0,1) m, (5 ± 0,1) m and (7 ± 0,1) m, and with the suction line section (keys 4 to 8 in Figure 1) in the horizontal position.

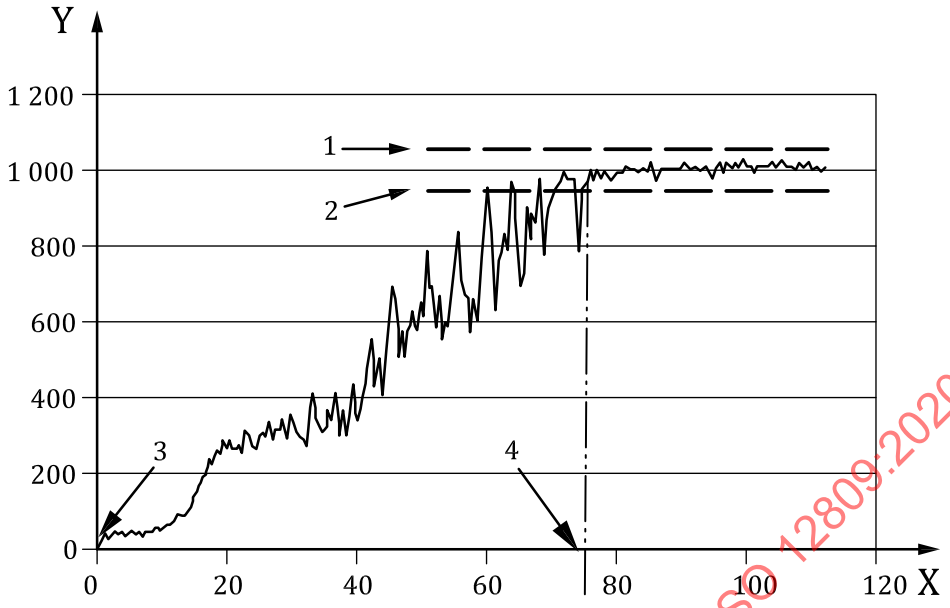
7.2.7.2 Test procedure

Ensure that extra circuit valves (key 14 and 15 in Figure 1) and air inlet valve (key 4 in Figure 1), are closed; if present, air vent lines shall be closed as well.

During the test, record the value of the delivery pressure at intervals not greater than 0,5 s.

Start the pump, wait until it is correctly primed and adjust to reach the specified conditions (suction pressure, delivery pressure, rotation speed). Open the air inlet valve for (30 ± 1) s. Shut off the air inlet valve and simultaneously start the pressure recording. Stop the test when the delivery pressure reaches the set value (±5 %) and remains at that level for at least 5 s (see Figure 3). Determine the time passed between the closure of the air inlet valve and the achievement of the set pressure.

For each length of suction line, repeat the test three times.



Key

X time, s
Y pressure, kPa
1 test pressure +5 %
2 test pressure −5 %
3 closure of air inlet valve
4 test result

Figure 3 — How to determine the time for priming capacity

7.2.7.3 Results

Report, in seconds (s), the three values of time measured and the calculated mean value. Report the results of the tests in a chart or graph (for examples, see A.1.4).

7.2.8 Priming capacity — With re-circulation

7.2.8.1 General

This test is applicable only to positive displacement pump.

7.2.8.2 Test conditions

The test shall be performed under the following conditions:

— at the maximum rotating speed, as indicated by the pump manufacturer;

— with the delivery pressure set to (10 ± 1) % of rated pressure and to at least (100 ± 10 kPa);

— with the suction pressure set to the reference suction pressure defined in 7.2.3;

— with lengths of suction line equal to (3 ± 0,1) m, (5 ± 0,1) m and (7 ± 0,1) m, and with the suction line in the horizontal position;

— with the length of the re-circulation line set to (1 ± 0,1) m, with the same diameter as the suction line. The length of the re-circulation line shall be measured from the centre of extra circuit valves (key 14 and 15 in Figure 1);

— with the output flow-rate set to (10 %, 15 % and 20 %) (±1 l/min) of the maximum volume delivered per minute declared by the pump manufacturer.

7.2.8.3 Test procedure

Ensure that air inlet valve is closed (key 4 in Figure 1).

Open extra circuit valve (key 15 in Figure 1).

Use valves 12 and 14, as indicated in Figure 1, to adjust the delivery pressure and to adjust the output flow-rate.

During the test, record the value of the delivery pressure at intervals not greater than 0,5 s.

Start the pump and adjust to reach the specified conditions (suction pressure, delivery pressure, rotation speed, output flow-rate). Open the air inlet valve (key 4 in Figure 1) for (30 ± 1) s. Shut off the air inlet valve and simultaneously start the pressure recording. Stop the test when the delivery pressure has reached the set value (±5 %) and remains at that level for at least 5 s.

Determine the time passed between the closure of the air inlet valve and the achievement of the set pressure as indicated in Figure 3.

For each length of suction line, repeat the test three times.

7.2.8.4 Results

Report, in seconds (s) the three values of time measured and their mean value for each test. Report the results of the tests in a chart or graph (for examples, see A.1.4).

7.2.9 Wear test

7.2.9.1 Test conditions

Before starting the test measure the flow-rate according to 7.2.4.

For reciprocating positive displacement pumps, the delivery pressure shall be set to (70 ± 2) % of the maximum working pressure.

For centrifugal pumps, the flow-rate shall be set to (70 ± 2) % of the maximum working flow-rate.

The rotating speed shall be the maximum one as indicated by the pump manufacturer. The suction pressure shall be set to the reference suction pressure, as defined in 7.2.3.

Stop the test when any damage appears or after 500 h. At the end of the test, measure the flow-rate according to 7.2.4.

During the test, only regular maintenance is allowed as indicated by the pump manufacturer.

7.2.9.2 Results

Report the flow-rates measured during the test in a chart (for examples, see A.1.5 or A.2.3). Report the calculated percentage of flow-rate reduction in comparison to the value measured before the test, in the same conditions of delivery pressure and rotating speed.

7.3 Pump installed on the sprayer

7.3.1 General

Measurement of pump flow with pump mounted on sprayer may be used by the sprayer manufacturer:

— to determine the pump capacity influenced by the sprayers lines or in inspection of sprayers in use;

— to determine wear or damages that may reduce the intended performance; or

— to determine the real nominal capacity of the pump of a new sprayer to define the performance of this new sprayer.

The pump shall be tested as it is installed on the sprayer.

Connect the instrument for flow-rate measurement as, for example, in Figure 4 to

a) an attachment point indicated by the sprayer manufacturer (if any), or

b) the delivery fitting of the pump, or

c) on delivery line as close as possible to the pump and before any division of flow, valves or filters, ensuring that all other output lines (if present) are closed.

The internal diameter of the delivery line shall be equal to or greater than (max. + 50 %) of those present on the sprayer.

Setup the delivery pressure for example by using valve 6 (see Figure 4).

The sprayer manufacturer can provide a pump flow characteristic for several pressure levels which can be used during the test for selection of the appropriate flow meter size.

7.3.2 Flow-rate

7.3.2.1 Test conditions

Fill the sprayer tank to (50 ± 5) % of its nominal capacity or 2 000 l, whichever is less.

Before each setting, ensure that the pump is correctly primed, with a clean suction filter installed. Dimensions of suction filter as specified by the sprayer manufacturer.

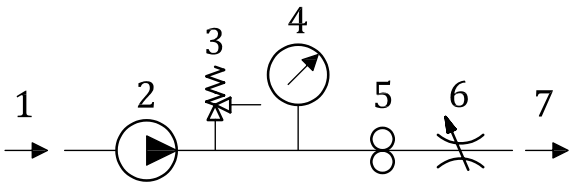
The tests shall be performed by setting the delivery pressure so as to measure the flow-rate at the maximum and minimum pressures indicated by the sprayer manufacturer and at least two other settings equally spaced in the range. In every case, the test shall be performed at the maximum and minimum rotating speeds of the pump, as indicated by the sprayer manufacturer (if available), and at two other values equally spaced in the range or at least at the nominal rotating speed of the pump, as indicated by the sprayer manufacturer.

If the pump has variable volume, perform the test at the maximum and minimum volumes, as indicated by the sprayer manufacturer, and at least at two other values equally spaced in the range.

For both parameters, measure the flow-rate.

7.3.2.2 Results

Report the results of these tests in a chart or graph (for examples, see B.1.1 or B.2.1).



Key

1 suction line
2 pump to be tested
3 safety valve
4 delivery pressure measurement
5 flow-rate measurement
6 delivery pressure adjustment valve
7 return to main tank

Figure 4 — Flow-rate measurement system example

7.3.3 Priming capacity

7.3.3.1 General

This test is applicable only to self-priming pumps.

7.3.3.2 Priming capacity from sprayer tank

7.3.3.2.1 Test conditions

The test shall be performed under the following conditions:

— at the maximum rotating speed (maximum flow-rate for hydraulic driven pump), as indicated by the sprayer manufacturer;

— with the delivery pressure set to (5 ± 1) % of the maximum pressure indicated by the sprayer manufacturer.

7.3.3.2.2 Test procedure

Run the pump until there is no liquid output for example by removing return line from the pump to the main tank. Stop the pump. If needed, reinstall return line of the pump in the main tank (see key 7 of Figure 4).

Fill the sprayer tank to (50+-5)% of its nominal capacity or 2 000l, whichever is less, not using the pump of the sprayer.

Start the pump without pressure and simultaneously start the pressure recording. Stop the test when the delivery pressure reaches the set value (±5 %) and remains at that level for at least 5 s.

Determine the time passed to reach the set pressure.

Repeat the test three times.

7.3.3.2.3 Results

Report the three values of time measured and the mean value for the three tests, in seconds (s) (for examples, see B.1.2 or B.2.2).

7.3.3.3 Priming capacity from outside filling place below the pump level position

7.3.3.3.1 Test conditions

Install a flow meter between the inlet pipeline and the pump to measure the flow-rate.

The test shall be performed under the following conditions:

— at the maximum rotating speed, as indicated by the sprayer manufacturer;

— without delivering pressure.

7.3.3.3.2 Test procedure

Set the suction line for external suction.

Run the pump until there is no liquid output in the tank.

Connect the pump inlet with the filling place using the pipelines indicated by the sprayer manufacturer. Place the pump filling at the maximum depth below the pump level position indicated by the sprayer manufacturer.

Start the pump without pressure and simultaneously start the time recording up to when the flow-rate is stable during 5 s.

Repeat the test three times.

7.3.3.3.3 Results

Report the three values of time measured and the mean value for the three tests, in seconds (s) (for examples, see B.1.2 or B.2.2).

8 Test report

The test report shall include at least the following information:

a) name and address of the organization that carried out the tests;

b) a reference to this document, i.e. ISO 12809:2020;

c) identification of the pump/sprayer tested;

d) date and name of person responsible for test;

e) values of

— environmental temperature,

— nature of testing liquid,

— temperature of testing liquid,

— atmospheric pressure;

f) scheme and description of the test bench/sprayer hydraulic circuit;

g) features of the measuring devices used for the test;

h) the test results in accordance with 7.2.4 to 7.2.9 and/or 7.3.2 to 7.3.3.

Annex A
(informative)

Examples of test results for stand-alone pumps

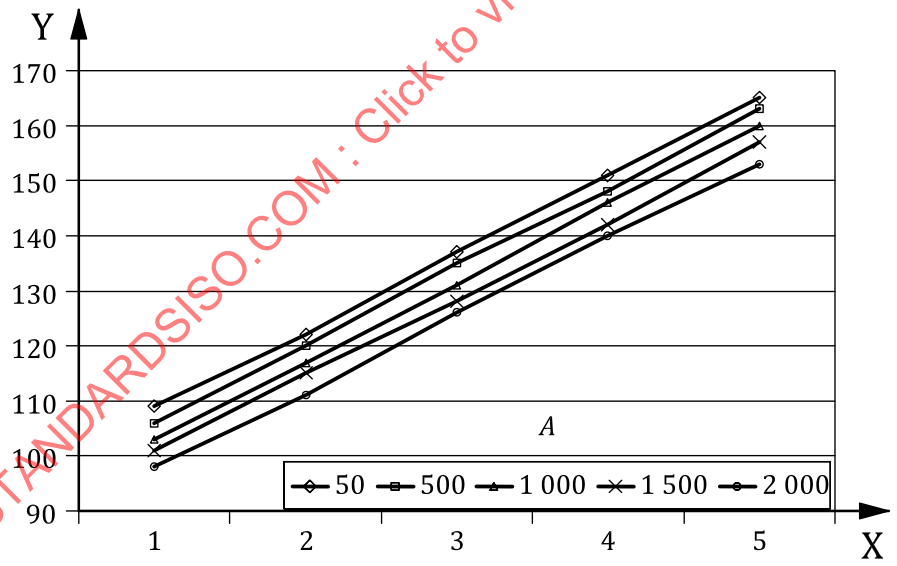
A.1 Reciprocating positive displacement pumps

A.1.1 Flow-rate at the reference suction pressure

See Table A.1 and Figure A.1.

Table A.1 — Flow-rate at the reference suction pressure

Delivery pressure (kPa)	**Rotating speed** (r/min)				
	min. value	**step 1**	**step 2**	**step 3**	**max. value**
	Flow-rate (l/min)				
50	109	122	137	151	165
500	106	120	135	148	163
1 000	103	117	131	146	160
1 500	101	115	128	142	157
2 000	98	111	126	140	153



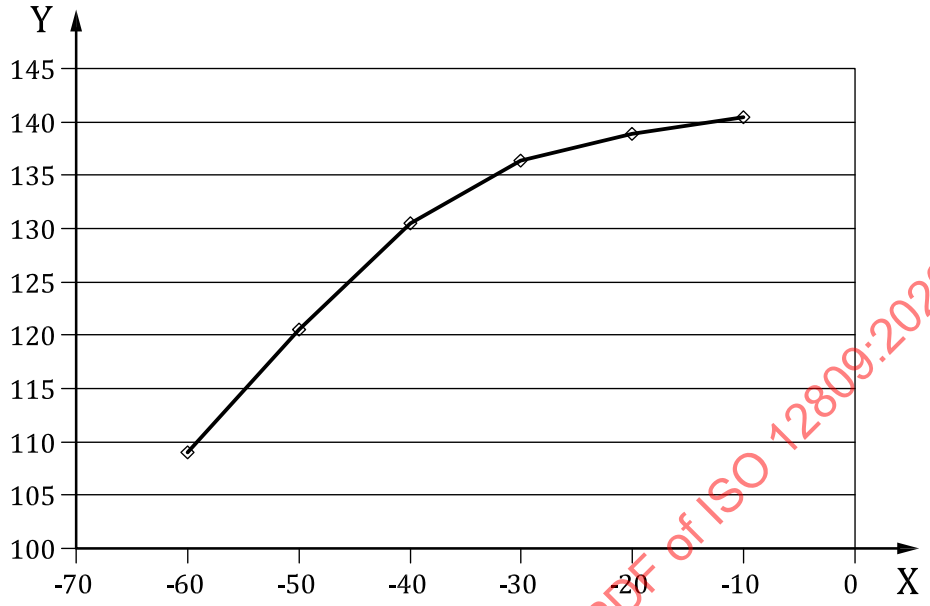
Key

X	rotating speed, r/min	2	step 1
Y	flow-rate, l/min	3	step 2
A	delivery pressure, kPa	4	step 3
1	minimum	5	maximum

Figure A.1 — Flow-rate at the reference suction pressure

A.1.2 Flow-rate at variable suction pressures

See Figure A.2.



Key

X suction pressure, kPa

Y flow-rate, l/min

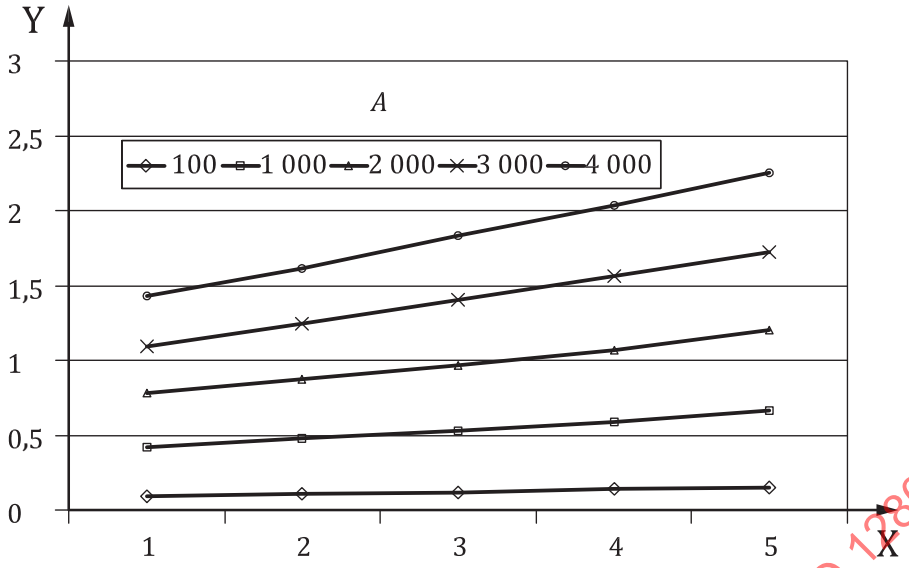
Figure A.2 — Flow-rate at variable suction pressures

A.1.3 Power consumption at reference suction pressure

See Table A.2 and Figure A.3.

Table A.2 — Power consumption at reference suction pressure

Delivery pressure (kPa)	**Rotating speed** (r/min)				
	min. value	**step 1**	**step 2**	**step 3**	**max. value**
	Power consumption (kW)				
100	0,09	0,11	0,12	0,14	0,14
1 000	0,42	0,48	0,53	0,59	0,66
2 000	0,74	0,87	0,97	1,07	1,20
3 000	1,09	1,24	1,40	1,56	1,72
4 000	1,43	1,61	1,83	2,03	2,25



Key

X	rotating speed, r/min	2	step 1
Y	power, kW	3	step 2
A	delivery pressure, kPa	4	step 3
1	minimum	5	maximum

Figure A.3 — Power consumption at reference suction pressure

A.1.4 Priming capacity

See Table A.3.

Table A.3 — Priming capacity

Length of suction line m	Value 1 s	Value 2 s	Value 3 s	Mean value s
3	5,5	6,0	5,9	5,8
5	6,5	6,3	6,7	6,5
7	7,9	8,0	7,5	7,7

A.1.5 Wear test

Rotating speed, r/min.

Delivery pressure (kPa).

See Table A.4.

Table A.4 — Wear test

Working time h	Flow-rate l/min	Reduction %
0	121,0	0
500	118,8	1,8

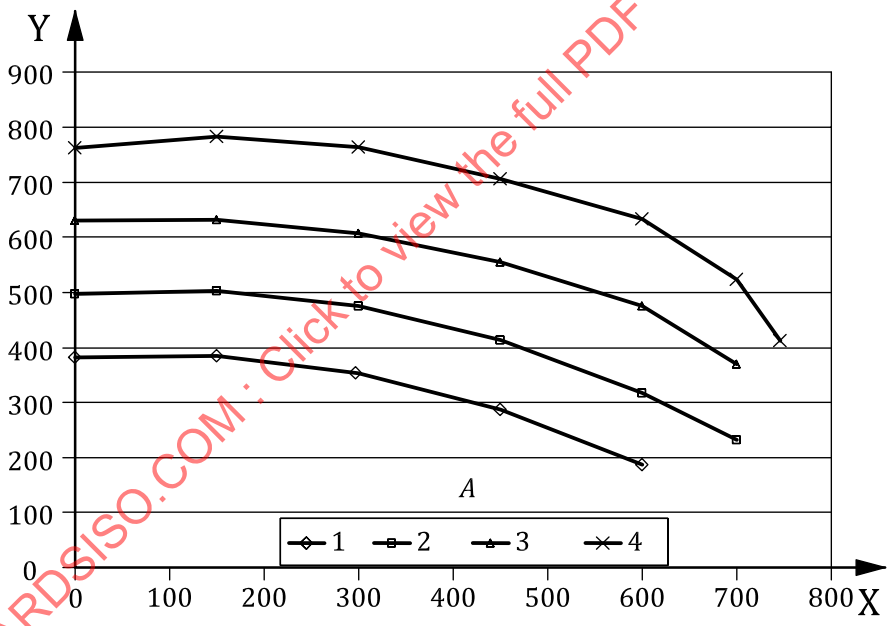
A.2 Centrifugal pumps

A.2.1 Flow-rate at the reference suction pressure

See Table A.5 and Figure A.4.

Table A.5 — Flow-rate at the reference suction pressure

Flow-rate, l/min	**Rotating speed** (r/min)			
	Min. value	**Step 1**	**Step 2**	**Max. value**
	Delivery pressure, kPa, **at the reference suction pressure**			
0	383	499	632	765
150	386	505	634	785
300	354	477	609	766
450	288	415	556	708
600	188	319	476	635
700		233	370	525
746				414



Key

X flow-rate, l/min
Y delivery pressure, kPa
A rotating speed, r/min
1 minimum
2 step 1
3 step 2
4 maximum

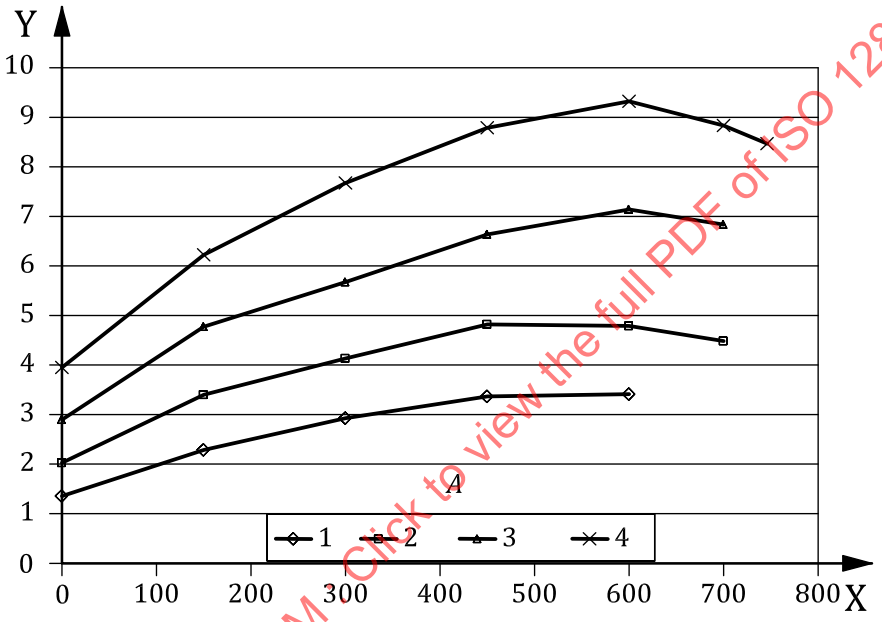
Figure A.4 — Flow-rate at the reference suction pressure

A.2.2 Power consumption at reference suction pressure

See Table A.6 and Figure A.5.

Table A.6 — Power consumption at reference suction pressure

Flow-rate l/min	**Rotating speed**, r/min			
	min. value	**step 1**	**step 2**	**max. value**
	Power consumption, kW			
0	1,36	2,03	2,91	3,97
150	2,29	3,41	4,80	6,25
300	2,93	4,15	5,70	7,70
450	3,36	4,84	6,66	8,82
600	3,40	4,81	7,16	9,35
700		4,51	6,85	8,86
746				8,50



Key

X	flow-rate, l/min	2	step 1
Y	power, kW	3	step 2
A	rotating speed, r/min	4	maximum
1	minimum		

Figure A.5 — Power consumption at reference suction pressure