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

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A list of organizations represented on this committee can be obtained on request to its secretary.

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**Crop protection equipment —
Reciprocating positive displacement
pumps and centrifugal pumps — Test
methods**

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





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ISO 12809 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

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

1 Scope

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

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

2 Normative references

The following referenced documents are indispensable for the application 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.

3.1

suction pressure

pressure at the suction fitting of the pump

3.2

reference suction pressure

pressure at the suction fitting of the pump, taking into account the pressure drop that is present when the pump is installed on the sprayer

3.3

delivery pressure

pressure at the delivery fitting of the pump

3.4

rated pressure

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

3.5

rotating speed

number of revolutions of the pump shaft in the considered time interval

3.6

volumetric flow rate

volume of the testing liquid that flows through the pump

3.7

power consumption

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

3.8

adjustment valve

valve for adjusting the liquid flow

3.9

delivery fitting

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

4 Accuracy of measurements

Temperatures shall be measured with an accuracy of ± 1 °C.

Length shall be measured with an accuracy of ± 1 mm.

Suction pressure shall be measured with an accuracy of ± 1 kPa.

Delivery pressure shall be measured with an accuracy of ± 1 % of the full scale. The full-scale value shall not exceed twice the maximum value that has to be measured during the test.

Rotating speed shall be measured with an accuracy of ± 1 %.

Flow rate shall be measured with an accuracy of $\pm 1,5$ %.

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

5 Test liquid

Clean water without solids in suspension.

6 General test conditions

6.1 Test bench

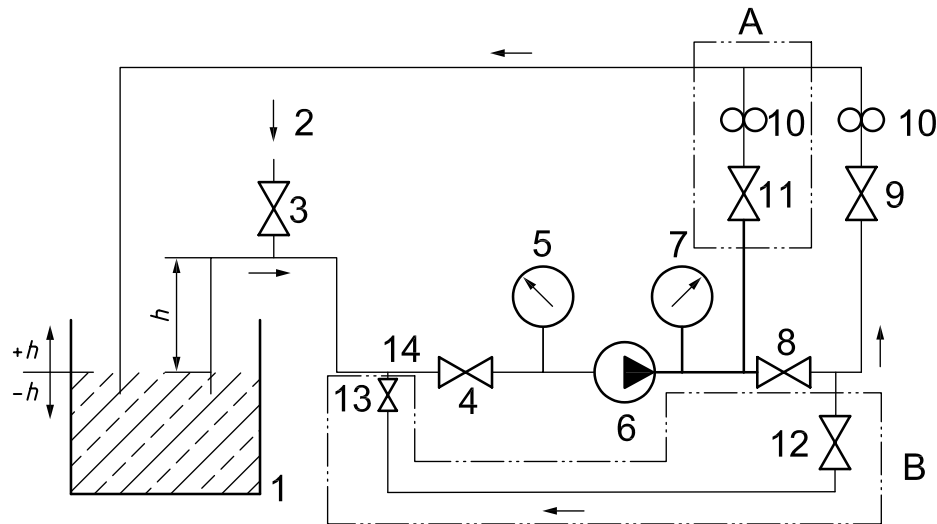
6.1.1 The test bench shall have a main circuit containing the devices for flow control and pressure adjustment. To simulate the installation of the pump on the sprayer, the test bench shall have a "nozzle line" (section A in Figure 1) and an extra circuit (section B in Figure 1) able to simulate the cleaning conditions, with part of the flow coming back directly to the suction line of the pump.

6.1.2 The suction line connects the pump with the tank. It shall be fitted with an air inlet valve, a suction pressure adjustment valve and a suction pressure gauge. For self-priming pumps, the h value shall be (400 ± 100) mm. For non-self-priming pumps, the h value shall be (-100 ± 20) mm. The start of the suction line shall be free, without non-return valves. See Figure 1.

6.1.3 The delivery line shall be fitted with a pressure gauge, a pressure adjustment valve and the device for flow rate measurement (see Figure 1). The output of the delivery line shall be connected to the tank in order to guarantee the re-circulation of the test liquid. Ensure that the back flow does not create turbulence in the suction line.

6.1.4 The extra circuit shall be fitted with a by-pass flow-rate adjustment valve and a shut-off valve able to isolate this part of the circuit.

6.1.5 The level of the liquid in the tank shall be equal (± 10 mm) to the top of the pump housing. Set the level when all the lines are filled with the test liquid.



Key

- | | |
|---|--------------------------------------|
| 1 tank | 8 delivery pressure adjustment valve |
| 2 air inlet | 9 shut-off valve |
| 3 air inlet valve | 10 flow rate measurement |
| 4 suction pressure adjustment valve | 11 nozzle flow-rate adjustment valve |
| 5 suction pressure measurement | 12 shut-off valve |
| 6 pump to be tested | 13 shut-off valve |
| 7 delivery pressure measurement | 14 by-pass input |
| A nozzle line | |
| B extra circuit to simulate the cleaning conditions | |

Figure 1 — Hydraulic circuit

6.2 Installation of pump

The pump shall be fixed on the test bench following the indications given by the manufacturer, and 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 manufacturer;
- for fittings, equal to or greater than (max. + 20 %) the internal diameter indicated by the manufacturer.

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

6.3 Environmental conditions

The air and testing liquid temperatures shall be not less than 10 °C and not more than 35 °C, except for centrifugal pumps, for which the testing liquid temperature shall be not less than 20 °C and not more than 30 °C.

6.4 Pressures

6.4.1 Suction pressure

The suction pressure, expressed in kilopascals (kPa), shall be measured at the suction fitting indicated in 6.1.

6.4.2 Reference suction pressure

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

That reference value shall be set once at the beginning of the test (by means of valve 4, shown in Figure 1) at the maximum rotating speed indicated by the manufacturer and with the delivery pressure set to (5 ± 1) % of the rated pressure. It will rise during the test, reducing the rotating speed, because of the reduction of the pressure drop.

6.4.3 Delivery pressure

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

6.5 Rotating speed

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

6.6 Flow rate

The flow rate shall be expressed in cubic decimetres per minute ($\text{dm}^3 \cdot \text{min}^{-1}$).

The flow rate can be determined using a flow meter or by collecting the liquid in a separate tank for a measuring time and weighing.

During the measurement, the level of the liquid in the suction tank shall not change by more than ± 50 mm from the level specified in 6.1.5.

6.7 Load torque

The load torque, expressed in newton metres (N·m), shall be determined by measurements on the inlet shaft of the pump.

6.8 Power consumption

The power consumption, indicated in kilowatts (kW), shall be calculated as the rotating speed multiplied by the load torque, using the following equation:

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

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).

7 Test methods

7.1 General

After installation of the pump on the test bench and before starting the tests, ensure visually that all connections work properly without leakage at the maximum pressure and without air inlet at the maximum depression in the suction line.

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

Use the test liquid specified in Clause 5.

7.2 Flow rate at the reference suction pressure

7.2.1 Test conditions

Ensure that valves 11, 12 and 13, as indicated in Figure 1, are closed.

Set the reference suction pressure as defined in 6.4.2 by means of valve 4, as indicated in Figure 1.

Use valve 8, as indicated in Figure 1, for the adjustment of the delivery pressure.

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

The tests shall be performed setting the delivery pressure so as to have the maximum and minimum pressures indicated by the 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 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 manufacturer, and at least at two other values equally spaced in the range.

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

7.2.2 Results

Report the results of these tests in a chart or graph (for an example, see A.1).

7.3 Flow rate at variable suction pressure

7.3.1 Test conditions

Ensure that valves 11, 12 and 13, as indicated in Figure 1, are closed.

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

Start with the suction pressure set to (-60 ± 2) kPa and 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.

7.3.2 Results

Report the results of these tests in a chart or graph (for an example, see A.2).

7.4 Power consumption

7.4.1 Test conditions

The test conditions shall be as specified in 7.2.1.

7.4.2 Results

Report the results of these tests in a chart or graph (for an example, see A.3).

7.5 Priming capacity — Normal flow

7.5.1 Test conditions

The test shall be performed under the following conditions:

- at the maximum rotating speed, as indicated by the manufacturer;
- with the delivery pressure set to (5 ± 1) % of the rated pressure and to at least (100 ± 10) kPa;
- with the suction pressure set to the reference suction pressure defined in 6.4.2;
- with lengths of suction line equal to $(3 \pm 0,1)$ m, $(5 \pm 0,1)$ m and $(7 \pm 0,1)$ m, and with the suction line in the horizontal position.

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

7.5.2 Test procedure

Ensure that valves 11, 12 and 13, and air inlet valve 3, as indicated in Figure 1, are closed.

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.

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.

7.5.3 Results

Report the three values of time measured and their mean value for each test, in seconds (s).

7.6 Priming capacity — Re-circulation circuit

7.6.1 Test conditions

The test shall be performed under the following conditions:

- at the maximum rotating speed, as indicated by the 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 6.4.2;
- with lengths of suction line equal to $(3 \pm 0,1)$ m, $(5 \pm 0,1)$ m and $(7 \pm 0,1)$ m, and with the suction line in the horizontal position;
- with the length of the by-pass line set to $(1 \pm 0,1)$ m, with the same diameter as the suction line and with the length of the by-pass line measured from the centre of valves 12 and 13, as indicated in Figure 1;
- with the output flow rate set to 10 %, 15 % and 20 % (± 1 dm³·min⁻¹) of the maximum volume delivered per minute declared by the manufacturer.

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

7.6.2 Test procedure

Ensure that air inlet valve 3, as indicated in Figure 1, is closed.

Open valves 11, 12 and 13, as indicated in Figure 1, and close valve 9.

Use valve 8, as indicated in Figure 1, to adjust the delivery pressure and valve 11 to adjust the output flow rate.

Start the pump and adjust to reach the specified conditions (suction pressure, delivery pressure, rotation speed, output flow rate). 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 has reached the set value ($\pm 5\%$) 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.

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

7.6.3 Results

Report the three values of time measured and their mean value for each test, in seconds (s).

7.7 Wear test

7.7.1 Test conditions

For diaphragm pumps and piston pumps having a maximum working pressure of up to 2 MPa, the delivery pressure shall be set to (800 ± 10) kPa; for the same types of pumps whose maximum working pressure is above 2 MPa, the delivery pressure shall be set to $(70 \pm 1)\%$.

For centrifugal pumps, the delivery pressure shall be set to (100 ± 10) kPa.

The rotating speed shall be the maximum one as indicated by the manufacturer. The suction pressure shall be set to the reference suction pressure, as defined in 6.4.2.

At the end of the test, measure the flow rate.

Stop the test when any damage appears or after 500 h.

7.7.2 Results

Report the flow rates measured during the test in a chart (for an example, see A.4). Report, too, the percentage of flow rate reduction in comparison to the value measured before the test, in the same conditions of delivery pressure and rotating speed.

8 Test report

The test report shall include the following information:

- a) name and address of the laboratory that carried out the tests;
- b) reference to this International Standard (i.e. ISO 12809);
- c) identification of the pump tested;
- d) date and name of the operator responsible for the tests;
- e) values of
 - environmental temperature,
 - nature of testing liquid,
 - temperature of testing liquid, and
 - atmospheric pressure;

- f) scheme and description of the test bench;
- g) features of the measuring devices used for the test;
- h) the test results in accordance with 7.2 to 7.7;
- i) notes (if any).

Annex A (informative)

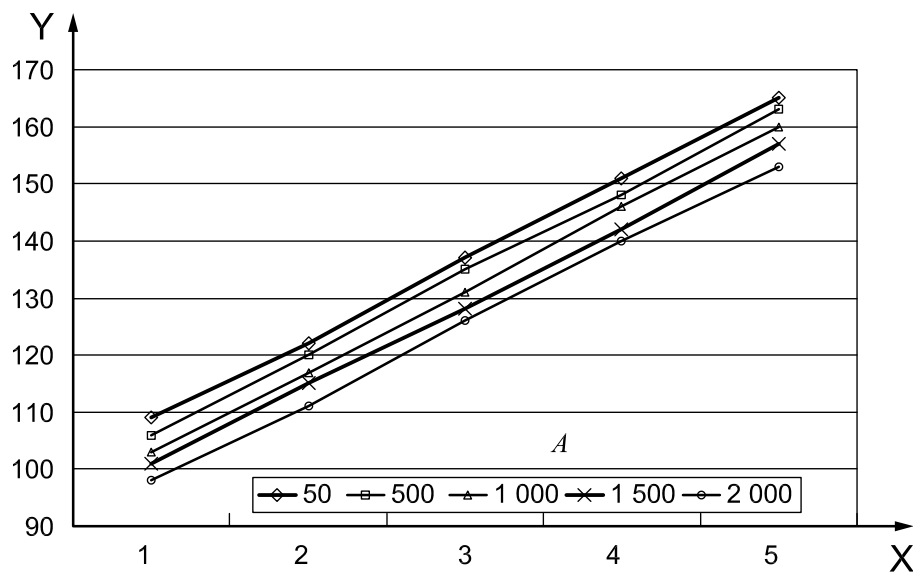
Examples of test results

A.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.	Step 1	Step 2	Step 3	Max.
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



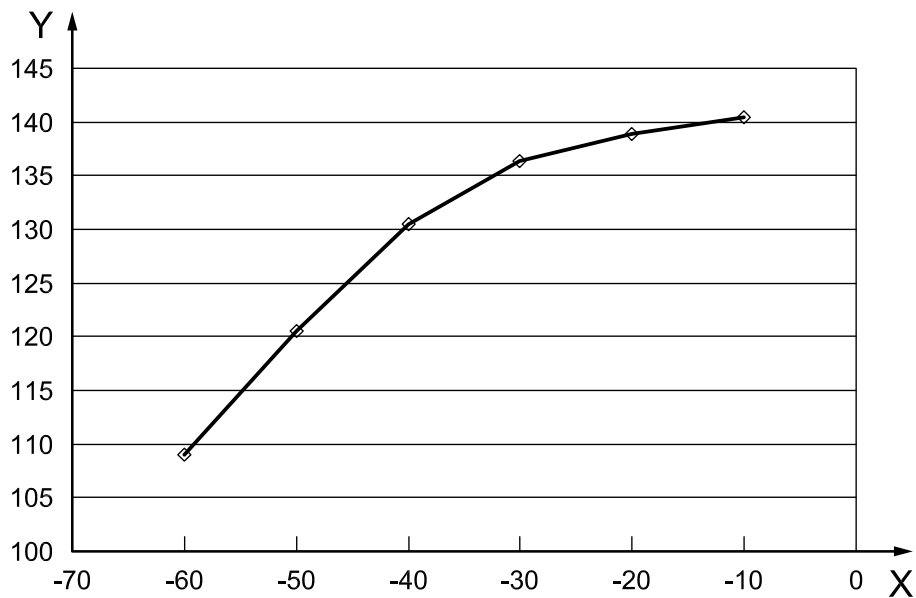
Key

- X rotating speed, r/min
- Y flow rate, $\text{dm}^3 \cdot \text{min}^{-1}$
- A delivery pressure, kPa
- 1 minimum
- 2 step 1
- 3 step 2
- 4 step 3
- 5 maximum

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

A.2 Flow rate at variable suction pressures

See Figure A.2.



Key

X suction pressure, kPa
Y flow rate, dm³·min⁻¹

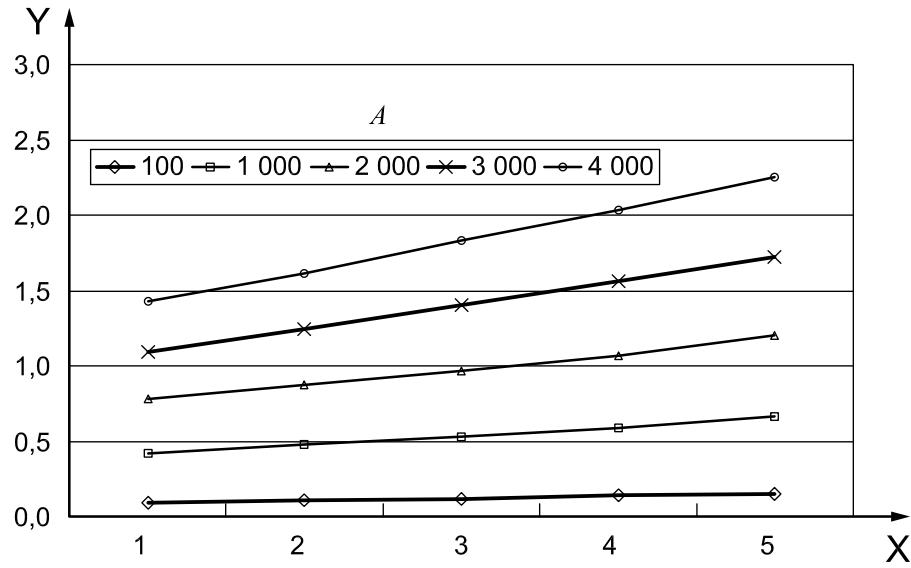
Figure A.2 — Flow rate at variable suction pressures

A.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.	Step 1	Step 2	Step 3	Max.
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
- Y power, KW
- A delivery pressure, kPa
- 1 minimum
- 2 step 1
- 3 step 2
- 4 step 3
- 5 maximum

Figure A.3 — Power consumption at reference suction pressure

A.4 Wear test

Rotating speed, r/min:

Delivery pressure (kPa):

See Table A.3.

Table A.3 — Wear test

Working time h	Flow rate dm ³ ·min ⁻¹	Reduction %
0	121,0	0
500	118,8	1,8

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