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Equipment for crop protection — Knapsack motorized air-assisted sprayers — Test methods and performance limits

Matériel de protection des cultures — Pulvérisateurs à dos motorisés à jet porté — Méthodes d'essai et limites de performance

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Foreword

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The main task of technical committees is to prepare International Standards. 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.

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.

ISO 10988 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

Equipment for crop protection — Knapsack motorized air-assisted sprayers — Test methods and performance limits

1 Scope

This International Standard specifies the requirements, test methods and minimum performance limits for knapsack motorized air-blast (twin-fluid) sprayers and air-assisted centrifugal sprayers as defined in ISO 5681.

It is applicable to those integrally powered knapsack sprayers, equipped with an engine and carried by the operator, intended primarily for use in agriculture and horticulture (hereafter referred to as "sprayers").

It is not applicable to hydraulic pressure sprayers, thermal sprayers or cold foggers; nor is it applicable to sprayers adapted for the application of dry material.

It addresses general operating parameters as well as the potential deposition of spray droplets under specified controlled conditions. It does not deal with the safety of the operator in the use of the sprayers (see ISO 28139).

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*

ISO 9357:1990, *Equipment for crop protection — Agricultural sprayers — Tank nominal volume and filling hole diameter*

ISO 19932-1:2006, *Equipment for crop protection — Knapsack sprayers — Part 1: Requirements and test methods*

ISO 28139:2009, *Agricultural and forestry machinery — Knapsack combustion engine-driven mistblowers — Safety requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5681, ISO 19932-1 and ISO 28139 apply.

4 Requirements

4.1 General

Knapsack motorized sprayers shall be so designed that they can be safely used in accordance with their intended purpose, achieve minimal exposure levels to the operator and avoid unnecessary waste of pesticides into the environment.

The sprayer shall be designed such that the liquid flow can be activated and switched off in accordance with ISO 28139:2009, 5.6.6.

It shall comply with the following requirements and shall meet the specifications in accordance with ISO 19932-1 as applicable.

The sprayer with the tank filled at nominal volume shall be designed such that the operator shall be able to pick it up, carry it and put it down in accordance with the instruction handbook and without any spillage.

It shall have an adjustable and reproducible spray liquid output.

Any components of the sprayer subject to maintenance, as specified in the instruction handbook, shall be changeable without special tools, unless these are provided with it.

The sprayer shall be designed such that the filled sprayer can be carried in the upright position.

It shall not be possible to displace any gasket or seal from its seated position by tightening.

4.2 Material of construction

All components of the sprayer made from plastic and elastomers coming into direct contact with the spray solution shall be capable of operating satisfactorily after the immersion test specified in 5.12.

4.3 Straps and their fixation points

Straps shall be made of non-absorbent material.

The straps shall be adjustable in length to meet the needs of the operator while on the operator's back. Each strap shall be adjustable to a length of at least 75 cm, as measured between the fixing points of each strap.

The load-bearing width of the straps shall be at least 50 mm.

4.4 Spray tank

In order to avoid chemical spillage during filling, the diameter of the filling opening shall be in accordance with ISO 9357:1990, Table 1.

Hose nipples fitted to the tank shall be able to withstand a test force of (13 ± 1) N, so as to avoid unintentional disconnection.

The spray tank shall have a volumetric content gauge scale as specified in ISO 9357.

The filling tank opening shall be fitted with a lid, which shall

— have a retainer,

— be able to be opened and closed without the use of a special tool, and

— be fitted with a holding device ensuring a closed position by means of a positive mechanical action (e.g. lids fixed by screw action).

It shall be possible to empty the tank of the sprayer without the need to invert the sprayer.

It shall be possible to empty the tank without contaminating the operator or parts of the sprayer.

The exit flow shall not be directed towards the operator.

The emptying device shall be guarded against unintentional opening.

The emptying device shall be able to be operated without the use of tools.

4.5 Strainers and filters

The sprayer tank shall have a strainer with a mesh width not greater than 2 mm.

Gaps between the spray tank filling opening and strainer, as well as openings within the strainer, shall not exceed 2 mm.

The liquid going from the tank to the nozzles shall be filtered. The mesh width of these filters shall be less than the narrowest diameter of the smallest size of nozzle to be used.

Filters shall be installed at a freely accessible place and shall have a surface area of at least 1 000 mm^2 to prevent frequent filter clogging. They shall be capable of being removed and easily cleaned without draining of the tank.

4.6 Nozzles

The pattern of sprayed liquid shall not change unintentionally during operation.

The nozzle shall be protected from external clogging during the storage and filling of the sprayer.

4.7 Air hoses and chemicals hoses

The ratio of the hose bends shall meet the limits established by the manufacturers of the hoses in the normal working position.

The hoses shall have no bends which hinder the flow of liquid or air.

The distance between the shut-off valve and the air-outlet section shall be no less than 400 mm.

The air hoses shall be flexible in order to be easily adjustable.

The fan inlet shall be designed such that the ingestion of foreign materials is avoided when the sprayer is on the ground.

5 Tests

5.1 Test liquids and equipment

5.1.1 Test liquids

5.1.1.1 **Clean water**, free from solids.

5.1.1.2 **Petrol**, as indicated by the manufacturer.

5.1.2 **Measuring cylinders** for measuring volumes up to 1 l with a maximum error of ±10 ml.

5.1.3 Weighing device, able to weigh up to 2 kg with a maximum error of ±0,1 g.

5.1.4 Timer (stopwatch), for measuring periods up to 5 min with a maximum error of ±0,5 s.

5.1.5 Temperature measurement device, able to measure temperatures up to 35 °C with a maximum error of ±0,5 °C.

5.1.6 Artificial targets

5.1.6.1 Petri dishes with an internal diameter ≥150 mm. Other artificial collectors which can ensure the same results may be used, in which case they shall be described in the test report.

5.1.6.2 Sponges (e.g. 200 mm × 200 mm × 10 mm).

5.1.7 Filling device (for an example, see ISO 19932-1:2006, Annex C).

5.1.8 Air velocity measuring device with a maximum error of 5 % of the measurement value.

5.1.9 Sprayer locking device with a minimum mass of 150 kg and able to guarantee the locking of the sprayer and its air tube in the test position (for an example, see Annex A).

5.1.10 Droplet size analyser, capable of characterizing droplet size spectra (e.g. laser light diffraction particle analyser).

5.1.11 Device for detecting potential vertical deposits, consisting of a frame (2 × 2) m with 16 sponges spaced across a length of 200 mm (see Annex B).

5.2 Test conditions

5.2.1 General

Assemble the sprayer following the instruction handbook. Inspect for tightness the filling cap and all other operator-controlled couplings.

Before starting each test, ensure that the engine has been properly warmed up.

The tests shall be performed with one new specimen of the sprayer type at an air temperature of 10 °C to 30 °C and a relative air humidity of at least 50 %, without influence of wind or sunlight.

The test site shall be such as to ensure that the natural course of the jet produced by the machine being tested is not altered. The surface on which the tests are carried out shall be level and free of obstacles.

5.2.2 Sprayer position

See the indications reported for each test.

5.2.3 Engine speed

If the engine speed cannot be regulated, all tests shall be carried out at the maximum allowable engine speed.

If the engine has an adjustable throttle, additional tests shall be carried out at the engine speed recommended by the manufacturer in the instruction handbook.

WARNING — Running the engine in a closed environment can create an inhalation hazard.

5.3 Liquid flow rate

The sprayer shall be locked in the horizontal position using the sprayer locking device (5.1.9).

Position the sprayer in the upright position with the tank filled to its nominal volume, the air delivery tube horizontal, then at 80° above the horizontal, and with the tube fully extended. Run it at a number of engine revolutions per minute in accordance with 5.2.3.

Activate the sprayer in the operating position. Recover the liquid output for a pre-established time. Determine the amount of recovered liquid using a balance (5.1.3) or graduated cylinder (5.1.2).

The flow rate of the sprayer for each type/number of nozzles — both traditional and ULV (ultra-low volume), with and without flow-rate-boosting device, if any — shall be measured with a maximum error of 1 %. Record the flow rates in litres per minute (l/min). Repeat the test with the tank filled to half its nominal volume.

Alternatively:

a) fill the tank to its nominal volume;

b) activate the sprayer for the time necessary to empty half tank;

c) determine the amount of liquid sprayed by tank re-filling.

The liquid flow from the sprayer output shall be guaranteed in all intended working conditions specified by the manufacturer.

5.4 Volume of total residual liquid

This test shall be carried out on a complete, empty sprayer.

Fill the spray tank with water to its nominal volume and, using the sprayer locking device (5.1.9), fix the sprayer in the upright position with the air delivery tube in the horizontal position. Activate the sprayer in operating conditions in accordance with 5.2.3. Close the shutoff valve when the spray cloud is visibly interrupted.

Determine the total quantity of liquid in the sprayer by emptying the tank and all parts potentially containing spraying liquid.

5.5 Stability

Position the empty sprayer on a flat, hard surface with an incline of (8,5 ± 0,2)° (see Annex C).

Check the stability of the sprayer by rotating it at 90° intervals along its vertical axis.

Repeat the test with the spray tank filled to its nominal volume.

5.6 Contents gauge scale and total tank volume

Place the empty sprayer in the upright position and fix it using the sprayer locking device (5.1.9).

Measure and register the volume between the marks when filling the spray tank using a measuring cylinder (5.1.2). Continue until the spray tank is filled to its nominal volume.

Determine the scale error, E, for each graduation as a percentage in accordance with ISO 19932-1, using the following equation:

$$E = \frac{V_\mathrm{s} - V_\mathrm{m}}{V_\mathrm{s}} \times 100$$

where

V_s is the volume according to the spray tank scale, in litres;

V_m is the measured volume of water poured into the tank, in litres.

As a second part to the test, fill the spray tank to the upper edge of the filling opening. Calculate the additional volume, V_A, of the spray tank as a percentage from:

$$V_A = \frac{V_t - V_n}{V_n} \times 100$$

where

V_t is the total volume, in litres;

V_n is the nominal volume, in litres.

5.7 Filling

This test shall be carried out on a complete, empty sprayer using the test procedure specified in ISO 19932-1:2006, 5.3.8.

Remove the lid while keeping the strainer in position.

Position a filling device (5.1.7) with its outlet placed (100 ± 5) mm above the filling opening. Position the sprayer with its straps opposite the filling device and with the line connecting the upper strap fixing points oriented perpendicularly to the axis of the filling device (see ISO 19932-1:2006, Annex C). The impact point of the test liquid shall be the centre of the filling opening.

Pour a volume of test liquid equal to the nominal spray tank volume from the filling device into the filling opening of the sprayer.

Determine the volume of the splash liquid.

5.8 Air velocity and air volume

The sprayer shall be locked in the upright position, with its air delivery tube in the horizontal position, using the sprayer locking device (5.1.9) such that the height of the centre of the sprayer spray outlet is (1 000 ± 20) mm from the ground.

Run the sprayer at an engine speed in accordance with 5.2.3.

Position the air velocity measuring device (5.1.8) at the centre of the air-outlet section.

Activate the sprayer and verify that the sprayer positioning is correct.

Perform the detection of the air velocity at distances of (3 000 ± 20) mm and (6 000 ± 20) mm from the air-outlet section, working on a grid sample of (100 × 100) mm ± 5 mm (see Annex D) and stopping the procedure when the air velocity value is lower than 2 m/s.

5.9 Droplet size

This test provides information on the droplet size spectra produced by the sprayer.

Using the sprayer locking device (5.1.9), lock the sprayer in the upright position with its air delivery tube in the horizontal position.

The droplet size spectrum can be measured with any non-intrusive system appropriate for the range of droplet size and velocity within the spray and the properties of the spraying liquid using measurement systems based on phase Doppler light scatter, laser diffraction or imaging principles. Other non-intrusive measurement systems may also be appropriate if they have a resolution and dynamic measurement range similar to the aforementioned laser instruments. The instrument and measurement system shall enable repeatable measurements for the reference sprays with a maximum deviation of $D_{v0,5}$ (volume median diameter) between replicate measurements of ±5 % for the same setting and measuring situation.

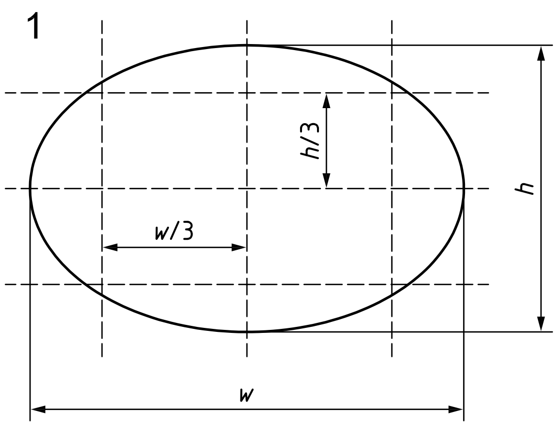
During the measurement of all sprays, the spraying liquid shall have a temperature within ±5 °C of the ambient air temperature. The air and liquid temperatures and humidity shall be recorded at the time of measurement.

A representative cross-section average sample shall be obtained across the entire spray cloud, with droplet size measurement being conducted at a distance of 1 m from the nozzle outlet or at an appropriate distance when measuring a fully atomized spray.

For measuring systems using a point-wise measuring principle, such as phase Doppler devices, continuous or stepwise movement of the point of measurement relative to the spray is required in order to obtain a representative sample of droplets. These relative movements shall follow along one of the central axes of the spray cloud. One additional movement line shall be used at each side of one of the main axes, as shown in Figure 1. In the case of continuous relative movement, the forward speed shall be constant for all movement lines. For stepwise movement, the measuring time shall be the same at each measuring position. Forward speed, measuring time and/or number of discrete movement lines shall be adjusted to obtain a maximum deviation of $D_{v0,5}$ between replicate measurements of not more than ±5 % and, where possible and appropriate, to sample at least 10 000 droplets per sprayer.

The height, h, and the width, w, of the spray plume at the measuring distance shall be determined visually or using water-sensitive paper.

The values of $D_{v0,1}$, $D_{v0,5}$ and $D_{v0,9}$ shall be reported.



Key

h height of spray cloud

w width of spray cloud

1 spray cloud section

Figure 1 — Spray cloud section with lines of relative movement of point of measurement

