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Equipment for crop protection — Test methods for air-assisted sprayers for bush and tree crops

Matériel de protection des cultures — Méthodes d'essai des pulvérisateurs à jet porté pour les arbustes et arbres fruitiers

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 9898 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

Annex A forms a normative part of this International Standard.

Equipment for crop protection — Test methods for air-assisted sprayers for bush and tree crops

1 Scope

This International Standard specifies the methods for measuring the characteristics of mounted, towed and self-propelled air-assisted sprayers, including pneumatic sprayers, used for crop protection in bushes, vineyards and tree crops.

This International Standard specifies testing methods to define sprayers' performances in control conditions (laboratory) with respect to minimising the risk of environmental contamination.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 13441-1, *Air-assisted agricultural sprayers — Data sheets — Part 1: Typical layout.*

3 Test conditions

3.1 Sprayer settings

Tests shall be done with the machine in working order (grids, nozzles, deflectors, etc.).

3.2 Sprayer set-up

The deflector positions, the shapes and the orientation of the air outlet, the nozzle orientation and the other device modifying the air or the liquid distribution should be described in the report. Schematic diagrams and photographs can be used to describe the sprayer set-up.

3.3 Sprayer environment

There should be no obstacles within a distance of at least 5 m in the direction(s) of the outlet velocity.

3.4 PTO speed

The test shall be done at least for the nominal PTO (power take-off) speed (540 ± 5) r/min [1)].

1) (1000 ± 10) r/min in the case of sprayers operating at 1000 r/min.

3.5 Sprayer gear box

If the power transmission includes a device providing different speeds for the fan rotation, the tests should be done for all the gear box positions. The PTO speed and the different fan rotation speeds should be measured.

3.6 Fan with variable pitch blades

For the sprayer's fan equipped with variable pitch blades, the test should be done at least with the angle recommended by the manufacturer. Otherwise, the medium position or the nearest medium position of the adjustment range shall be adopted for the test.

3.7 Variable width fan outlet

For the sprayer equipped with a variable outlet, the tests should be done at least with the width recommended by the manufacturer. Otherwise, the central position or the nearest central position of the adjustment range shall be adopted for the test.

3.8 Mounted sprayer equipped with an axial fan

The height of the fan axis should be mentioned in the report.

3.9 Test liquid

Clean water free from solids in suspension. If any tracer or dye is used on the tests, it shall be reported.

3.10 Atmospheric conditions

Temperature and humidity should be reported.

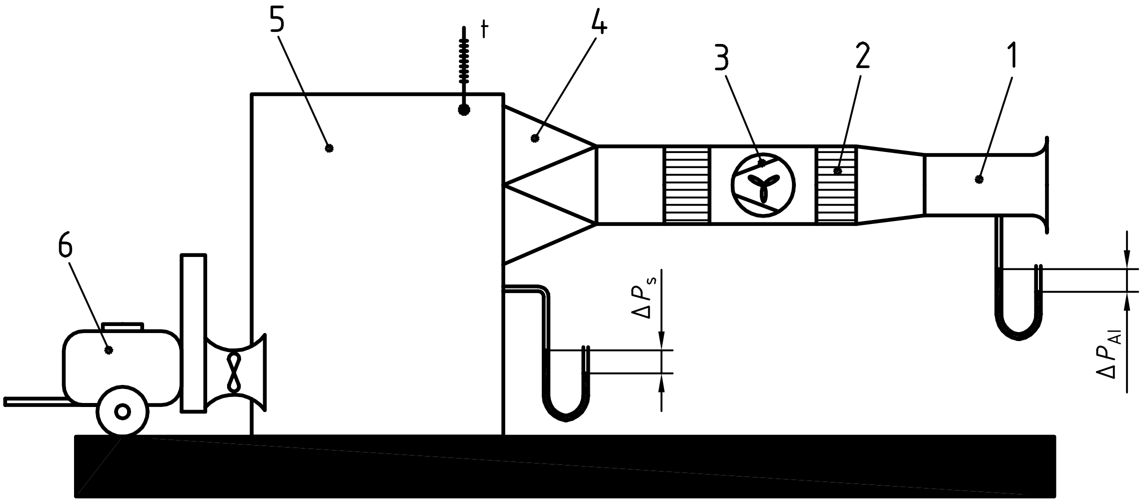
4 Measurement of the sprayer power consumption

The total power consumption in working order (fan, pump, etc.) shall be measured, for example with a torquemeter. During the test the liquid flow from the nozzle shall be switched off. The measurement shall be made with the maximum pressure recommended by the manufacturer.

5 Measurement of the flow rate

5.1 Reference method

A measuring chamber connected to two measuring tubes shall be used as a general method to measure the air flow rate at the inlet or at the outlet of the single or multiple fans of the sprayer. For the basic set-up of the chamber test stand, see Figure 1. For the possible connections between the measuring chamber and the different types of air-assisted sprayers, see Figure 2.



Key

1-4 Measuring tube
1 Calibrated air intake
2 Flow straightener
3 Auxiliary fan
4 Connecting piece
5 Measuring chamber
6 Air-assisted sprayer

Figure 1 — Basic set-up of the chamber test stand

The chamber test stand shall have the following specifications.

Its main parts are a tight chamber and, connected to it, two measuring tubes (measuring range of tube 1 with 900 mm diameter is 20 000 m^3/h to 110 000 m^3/h and for tube 2 with 450 mm diameter it is 2 000 m^3/h to 20 000 m^3/h). The dimensions of the chamber are: width = 4,6 m, length = 6,15 m and height = 3,7 m. One wall of the chamber is made from removable stays and metal plates and allows the sprayer to be connected with the chamber. The fan of the sprayer sucks the air volume out of the chamber and the same amount of air volume is blown into the chamber with the auxiliary fan of one of the measuring tubes. To make sure that the fan operates under the same conditions as outside in the field, its speed shall be controlled and the air flow rate of the auxiliary fan shall be adjusted to the flow rate of the tested fan. This shall be verified by the static pressure difference $\Delta P_S = 0$ between measuring chamber and the ambient atmosphere. The pressure ΔP_{AI} in the calibrated air intakes of the measuring tubes represents the air flow rate. The formulae to calculate the air flow rate from the pressure ΔP_{AI} are:

for tube 1:

$$q_V = 3\,203{,}20 \times \sqrt{\frac{\Delta P_{AI}}{\rho}}$$

for tube 2:

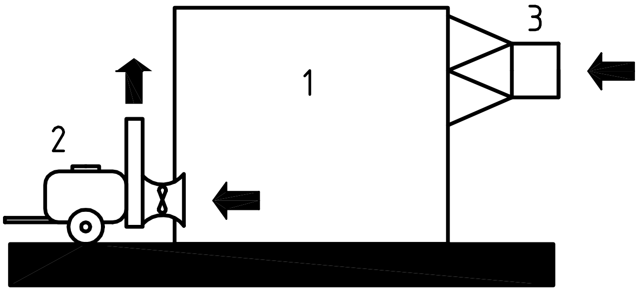
$$q_V = 88{,}288\,3 \times \sqrt{\frac{\Delta P_{AI}}{\rho}}$$

where

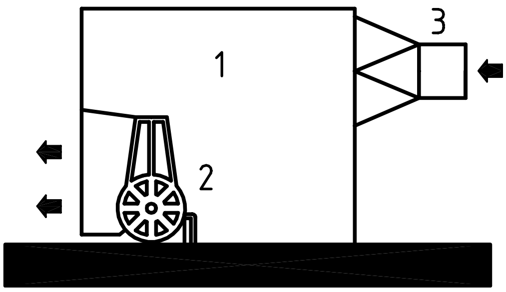
q_V is the flow rate, expressed in cubic metres per hour;

ΔP_{AI} is the pressure in the calibrated air intakes of the measuring tubes, expressed in pascals;

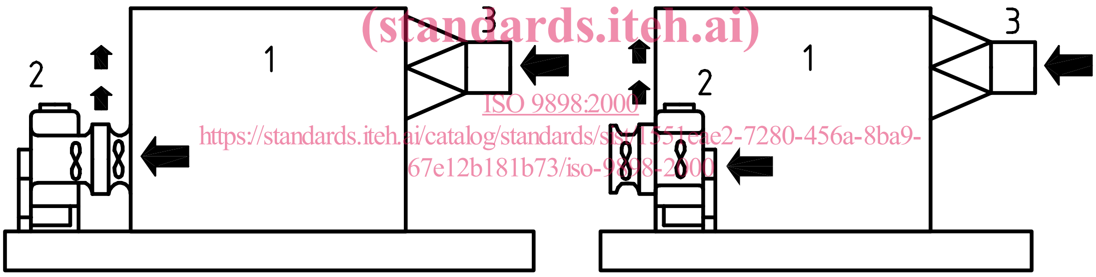
ρ is the air density, expressed in kilograms per cubic metre.



a) Set-up for a one way sucking air-assisted sprayer in the measuring chamber



b) Set-up to measure the half side air flow rate of an air-assisted sprayer



c) Set-up for a two way sucking air-assisted sprayer in the measuring chamber

Key

1 Measuring chamber

2 Sprayer

3 Measuring tube

Figure 2 — Possible connections between the measuring chamber and the different types of air-assisted sprayers

5.2 Other methods

5.2.1 General

The air flow rate of air-assisted sprayers also can be measured at the intake or outlet side of the fan with different instruments for measuring the air velocity. Instruments could be Prandtl tubes, hot wire, small propeller anemometers or laser anemometer. An ultrasonic anemometer could be used to measure the air flow rate at the outlet of the air-assisted sprayers, but not at the intake. In order to provide representative measurements of the air velocity in the cross section area, a minimum number of measuring points shall be taken (see 5.2.2 and 5.2.3). The flow rate shall be calculated by multiplying the air speed in the 90° cross section area by the cross section area of the wind flow. Obstacles like deflectors, nozzles or structural components of the fan, shall be accounted for when the total cross area of the fan is calculated.

For hot wire, small propeller anemometers and laser anemometers, ensure that their measurements agree with Prandtl tube measurements. The number of measuring points to be taken in the cross section area shall be the same as established for Prandtl tube measurements.

For each measurement point, a mean of air velocities for a minimum period of 10 s with a minimum of 100 data samples will be taken.

The higher dimension (length or diameter) of the head including the sensing device to be introduced into the air stream shall be less than 25 mm.

The measuring error shall be less than 5 %.

With Prandtl tubes for each measuring point, air speed shall be calculated by means of the following expression:

$$v = \sqrt{\frac{2 \times \Delta P}{\rho}}$$

where

v is the air velocity, expressed in metres per second;

ΔP is the differential pressure measured by means of the Prandtl tube, expressed in pascals;

ρ is the air density, expressed in kilograms per cubic metre.

To calculate the air density, the atmospheric pressure and the air temperature shall be measured. For the calculation, use the following expression:

$$\rho = 0{,}348 \times p / T$$

where

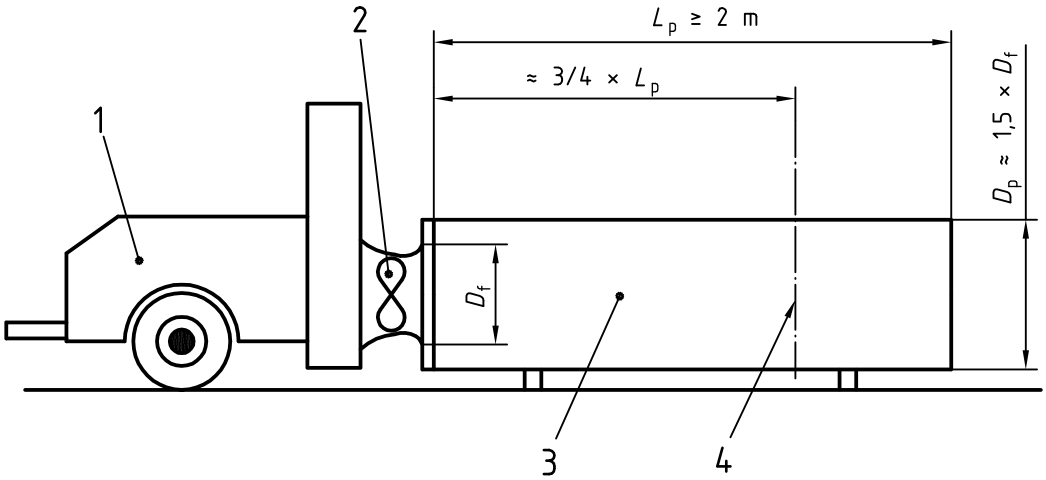
ρ is the air density, expressed in kilograms per cubic metre;

p is the atmospheric pressure, expressed in millibar;

T is the air temperature, expressed in kelvins.

5.2.2 Measurement of air flow rate on the suction side of a fan

The measurement should be done in a pipe connected to the suction side of the fan. In order not to influence the suction of the fan, the diameter of the pipe should be 1,5 times of the suction diameter of the fan. The length of the pipe should be at least 2 m. The measurement of the air velocity should be done with Prandtl Tubes in a cross section of the pipe, ¾ of the pipe length away from the suction opening of the fan (see Figure 3).



D_f suction diameter of fan

D_p diameter of the pipe connected to the fan

L_p length of the pipe connected to the fan

Key

1 Air-assisted sprayer
2 Fan
3 Pipe
4 Cross-section for measurement

Figure 3 — Measurement of air flow rate on the suction side of a fan

The measuring points in the cross section should be positioned on centroidal circles of five circular rings with uniform surface areas. There should be at least three measuring points (every 120°) on each centroidal circle (see Figure 4).

Circular rings are defined by the following formulas:

$$R_i / R = \sqrt{1-(i/n)}$$

$$Y_i / R = 1 - \sqrt{1 - \frac{2i-1}{2n}}$$

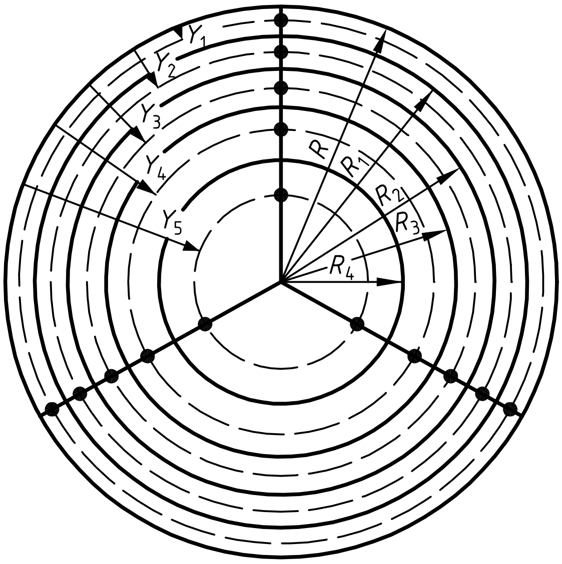
where

Y_i are the distances between the pipe side and the measuring points;

R_i are the radii of the circles;

n is the total number of circular rings;

i is the special number of circular ring.



Key

- • measuring points
- \- - - - concentric circles

Figure 4 — Cross-section for measuring, position of measuring points

For different pipe diameters, divided into 5 circular rings ($n = 5$), the distances Y_1 to Y_5 between the pipe side and the measuring points on centroidal circles are calculated and shown in Table 1.

Table 1 — Distances between the pipe side and measuring points for different pipe diameters

Dimensions in millimetres

Pipe diameter	Distances between the pipe side and measuring points				
	Y_1	Y_2	Y_3	Y_4	Y_5
100	3	8	15	23	34
200	5	16	29	45	68
300	8	25	44	68	103
400	10	33	59	90	137
500	13	41	73	113	171
600	15	49	88	136	205
700	18	57	103	158	239
800	21	65	117	181	274
900	23	74	132	204	308
1000	26	82	146	226	342
1100	28	90	161	249	376
1200	31	98	176	271	410
1300	33	106	190	294	444
1400	36	114	205	317	479
1500	38	123	220	339	513

This method can also be used for measurements on the pressure side if there are circular shaped outlets.

