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SPRAYING EQUIPMENT
PART 1: TEST METHODS FOR SPRAYER NOZZLES

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard
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Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This Standard does not purport to include all the necessary provisions of a contract

Sri Lanka Standard
SPRAYING EQUIPMENT
PART 1: TEST METHODS FOR SPRAYER NOZZLES

NATIONAL FOREWORD

This Sri Lanka Standard was approved by the Sectoral Committee on Agriculture and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2018-08-10.

This Sri Lanka Standard is identical with **ISO 5682-1: 2017** Equipment for crop protection - Spraying equipment - Part 1: Test methods for sprayer nozzles, published by the International Organization for Standardization (ISO).

ISO 5682-1: 2017 specifies test methods to assess the performance of sprayer nozzles with the exception of droplet characteristics.

Terminology and conventions

The text of the International Standard has been accepted as suitable for publication, without deviation, as a Sri Lanka Standard. However, certain terminology and conventions are not identical with those used in Sri Lanka Standards. Attention is therefore drawn to the following:

a) Wherever the words “International Standard” appear referring to this standard, they should be interpreted as “Sri Lanka Standard”.

b) The comma has been used throughout as a decimal marker. In Sri Lanka Standards it is the current practice to use a full point on the baseline as the decimal marker.

c) Wherever page numbers are quoted, they are ISO page numbers.

The test temperature adopted in Sri Lanka is 27 ± 2 ^{0}C and relative humidity 65 + 5 per cent is recommended.

Cross references

International Standard	Corresponding Sri Lanka Standard
ISO 5681 Equipment for crop protection - Vocabulary	SLS 1603:Vocabulary for crop protection equipment
ISO 8486-2 Bonded abrasives - Determination and designation of grain size distribution - Part 2: Microgrits F230 to F2000	No corresponding Sri Lanka Standard

INTERNATIONAL STANDARD

ISO 5682-1

Third edition
2017-05

Equipment for crop protection — Spraying equipment —

Part 1: **Test methods for sprayer nozzles**

Matériel de protection des cultures — Équipement de pulvérisation —

Partie 1: Méthodes d'essai des buses de pulvérisation

Reference number
ISO 5682-1:2017(E)

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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 on 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 the following URL: 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 third edition cancels and replaces the second edition (ISO 5682-1:1996), which has been technically revised as follows:

— clarity for the construction of the patternator;

— addition of a multiple nozzle setup to nozzle test methods;

— broadening of the scope of nozzle types covered;

— removal of drop size measurement using a Petri dish;

— clarification on the methods;

— clarification on sampling;

— update of instrumentation;

— several new informative annexes.

A list of all the parts in the ISO 5682 series can be found on the ISO website.

Equipment for crop protection — Spraying equipment —

Part 1:
Test methods for sprayer nozzles

1 Scope

This document specifies test methods to assess the performance of sprayer nozzles with the exception of droplet characteristics. Applicable tests by nozzle type are described in an informative annex as a guide, but this is not required for use of this document.

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*

ISO 8486-2:2007, *Bonded abrasives — Determination and designation of grain size distribution — Part 2: Microgrits F230 to F2000*

3 Terms and definitions

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

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

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

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

4 Measuring equipment

4.1 General

The working range of the measuring equipment shall be within the intended range of the measurements to be taken. The equipment used shall be recorded in the test report.

4.2 Horizontal patternator

4.2.1 General

The details for a horizontal patternator are described in 4.2. Annex B includes informative construction details, but is not required for equipment construction. For non-laboratory conditions, exceptions shall be noted on the report.

4.2.2 Groove characteristics

a) The distance between two consecutive groove walls (*E* in Figure 4) when measuring single nozzles shall be either 25 mm or 50 mm.

b) If the horizontal patternator is intended for the measurement of distribution evenness across multiple nozzles or complete spray booms, the distance between two consecutive groove walls (*E* in Figure 4) can be a distance of 25 mm, 50 mm, or 100 mm.

c) The deviation of the leading edges of the groove walls from horizontal shall not exceed a slope of ± 1 % (10 mm/m) across the width (*A* in Figure 1).

d) The variation in height of the grooves shall not exceed 2 mm as measured with a straight edge of at least 1 m length (*B* in Figure 2).

e) The inclination of the leading edge of the grooves shall not exceed a slope of 10 % from horizontal (*C* in Figure 3).

f) Grooves shall allow liquid to properly drain into the collection areas.

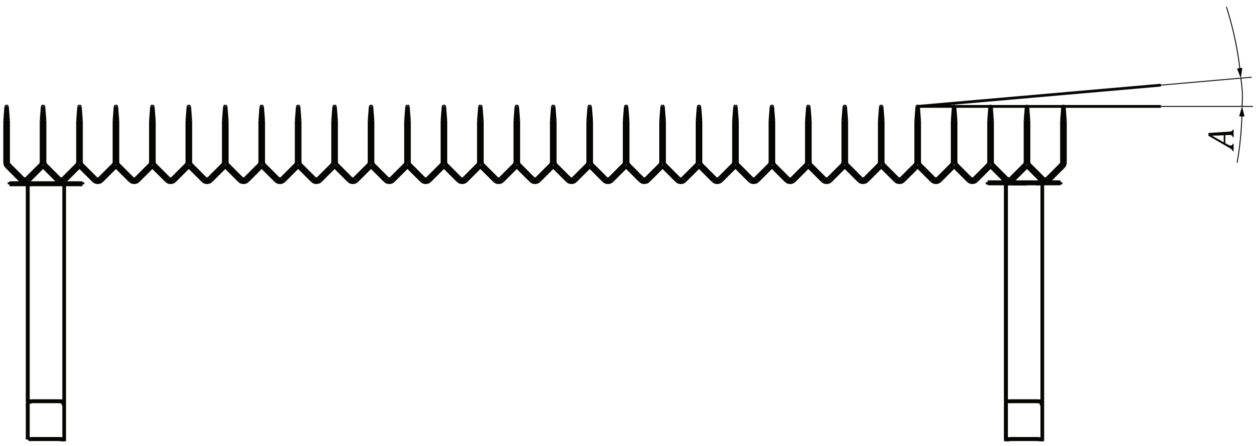
g) Groove depth (*F* in Figure 4) and groove width (*E* in Figure 4) shall be as specified in Table 1; this is to minimize the potential redistribution due to splashing. The depth and slope of the grooves may need to be adjusted in case of higher flows.

Table 1 — Groove depth

Groove width (*E*)	25 mm	50 mm/100 mm
Groove depth (*F*)	≥ 50 mm	≥ 75 mm

h) The straightness of each groove wall at the leading edge (*J* in Figure 5) shall be within ± 1,5 mm/m of the intended location (*H* in Figure 5) for horizontal patternators where the groove width (*E* in Figure 4) is 25 mm or 50 mm; the straightness of each groove wall at the leading edge shall be within ± 2,0 mm/m where the groove width is 100 mm.

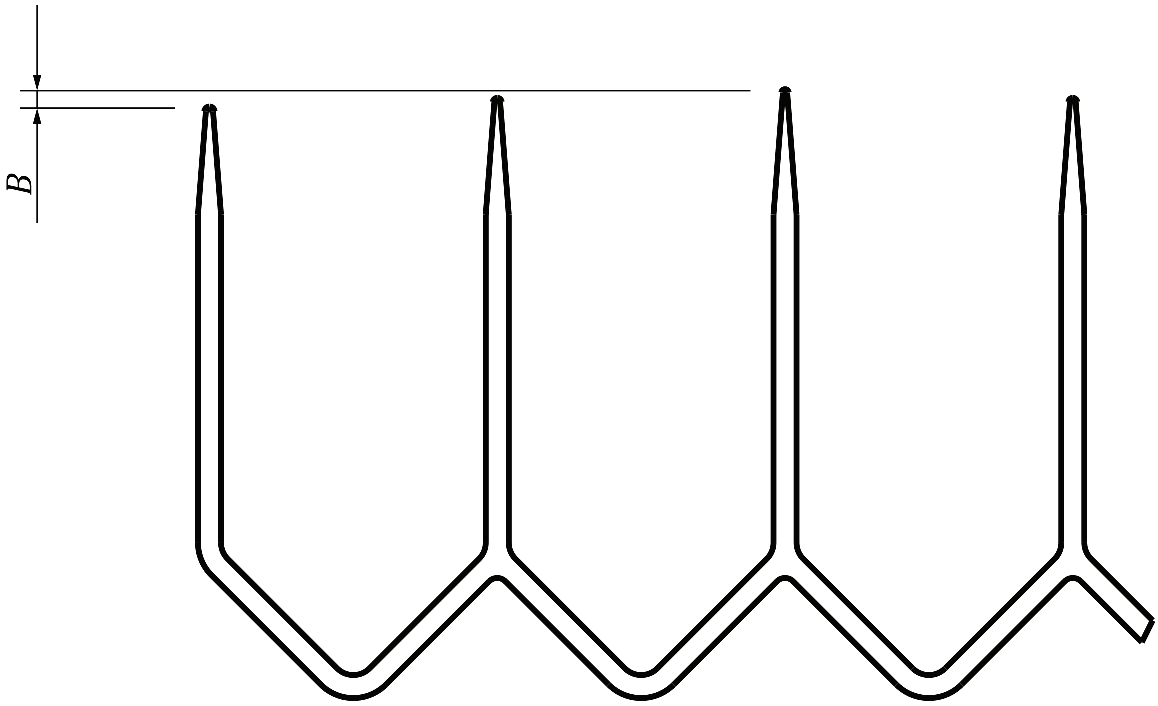
i) The deviation of the distance between the leading edges of two consecutive groove walls (*E* in Figure 4) shall be within ± 1,5 mm for 25 mm and 50 mm grooves and ± 2 mm for 100 mm grooves.



Key

A slope deviation from horizontal

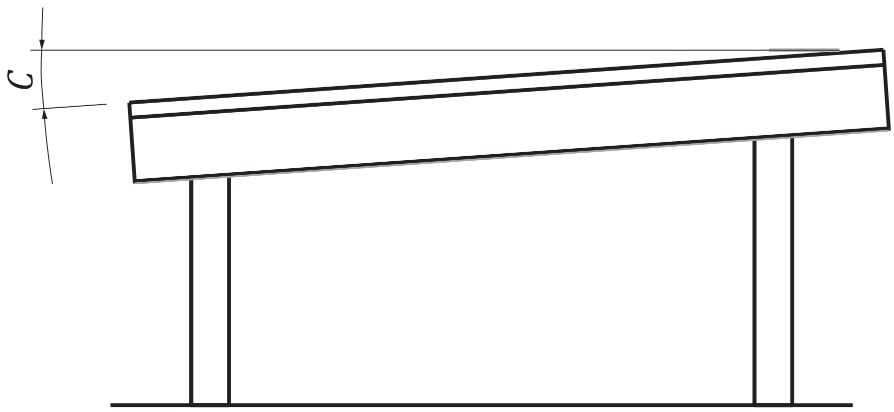
Figure 1 — Transverse angle of leading edges of grooves



Key

B deviation of groove leading edges height

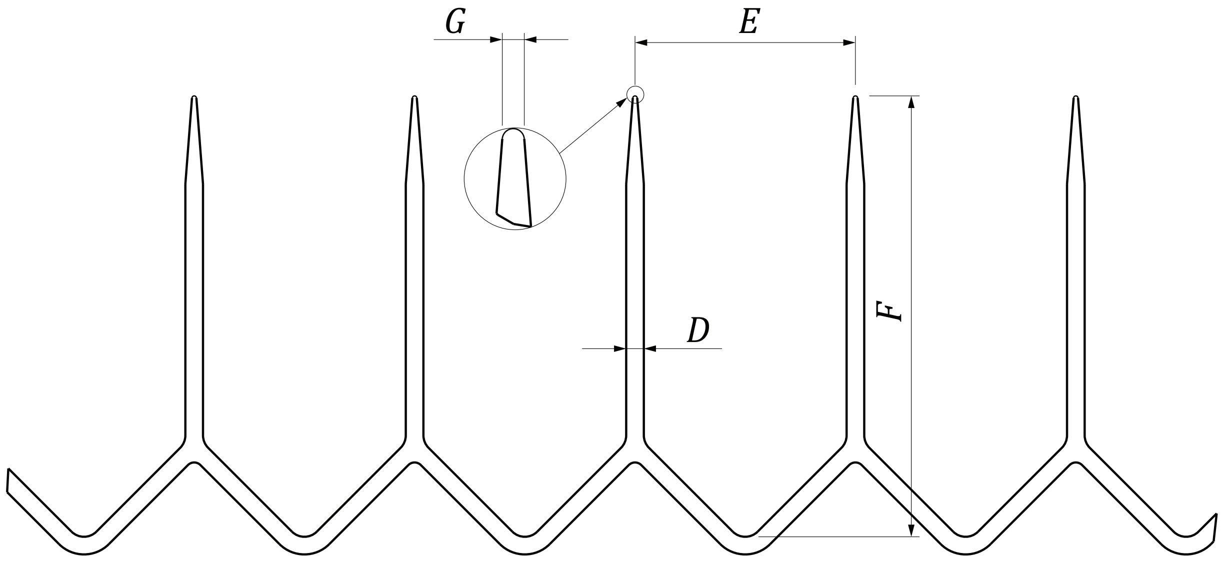
Figure 2 — Variation of groove leading edges heights



Key

C inclination of the leading edge of the grooves from horizontal

Figure 3 — Inclination of leading edges



Key

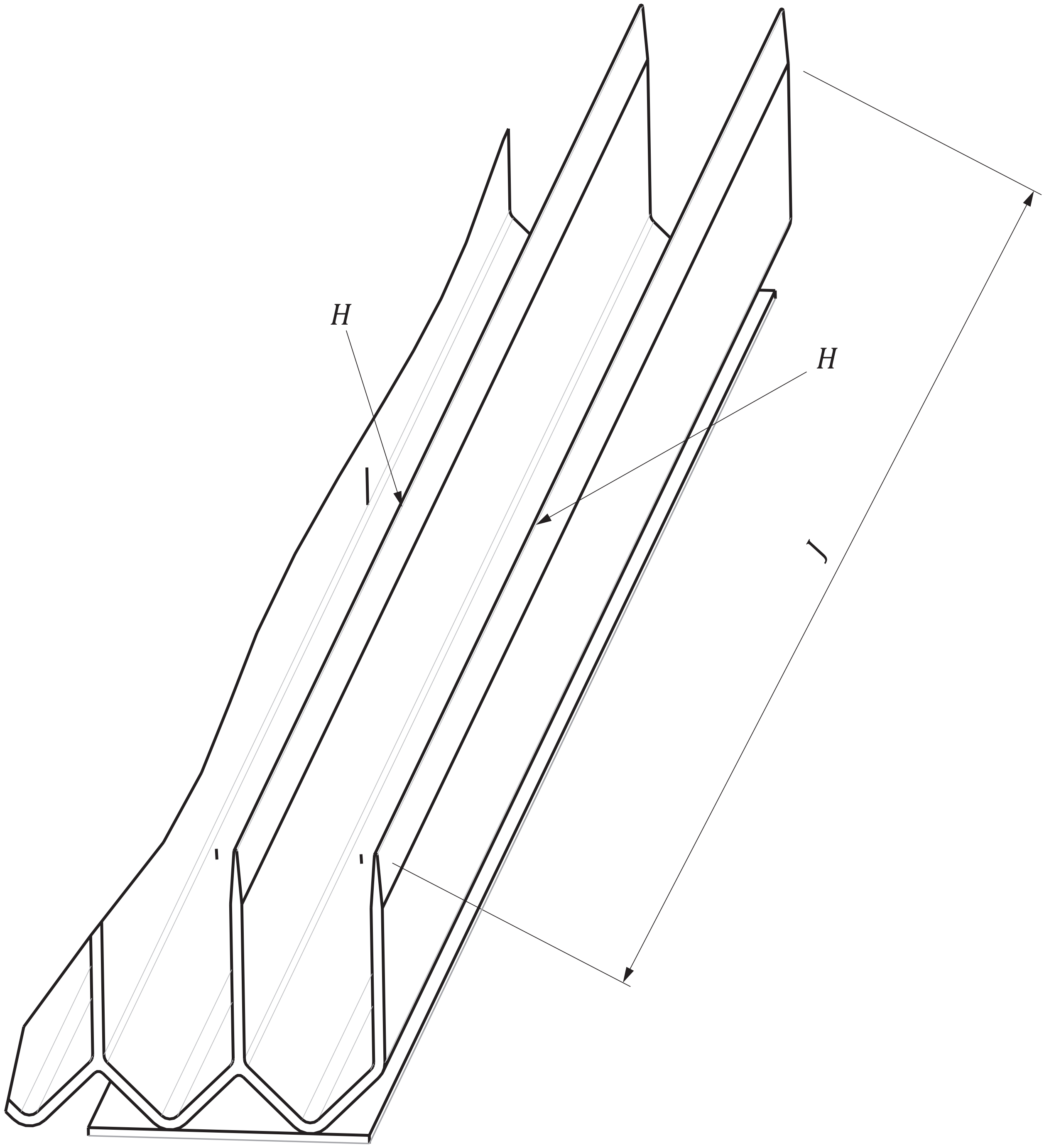
D lower groove wall thickness

E distance between two consecutive groove walls (groove width)

F groove depth

G upper groove wall thickness

Figure 4 — Groove section



Key

H intended location of wall leading edge

J full length of wall

Figure 5 — Straightness of groove walls

4.2.3 Upper part of the groove walls

a) The upper part of the groove walls (*G* in Figure 4) shall be less than 1,6 mm in width.

b) The lower part of the groove walls (*D* in Figure 4) may vary in thickness.

4.2.4 Overall dimensions

The overall dimensions of the bench can vary depending on the need (i.e. number of nozzles, boom size). The length and width of the bench shall be sufficient to capture the intended spray area.

In cases where a bench cannot be constructed to capture the entire spray pattern of all of the nozzles intended to be measured, a means such as traversing step by step in the direction of the boom is allowed.

The tolerance of the overall width of the bench shall be as specified in Table 2.

Table 2 — Tolerance of the width

Table width (W)	$W \leq 1$ m	$1 < W \leq 3$ m	$3 < W \leq 5$ m	$5 < W \leq 10$ m	$10 < W$
Tolerance as percentage of nominal width	±1 %	±0,75 %	±0,6 %	±0,4 %	±0,3 %

4.2.5 Traversing systems

If the transverse distribution is measured by means of successive transverse measurements (e.g. a scanner using a patternator cart on rails), the tolerance of the movement from one position to the next shall be held within ± 10 mm per meter.

4.3 Distance

Distance measurement equipment up to 1 m in length shall have a maximum error of ± 1 mm. For measurement equipment that measures greater than 1 m, the maximum error shall be 0,1 % of the measured value.

4.4 Pressure

Minimum requirements on liquid pressure measurements are given in Table 3. The pressure indicator may be either analogue or digital. Analogue pressure indicators with a needle readout shall have a minimum diameter of 100 mm and shall be damped.

Table 3 — Characteristics of pressure indicators used for testing

Pressure to measure (ΔP) bar	**Scale unit max.** bar	**Accuracy** bar	**Class required** (% accuracy of full scale value)	**Full scale value** bar
$0 < \Delta P \leq 6$	0,1	±0,1	1,6	6
			1,0	10
			0,6	16
$6 < \Delta P \leq 16$	0,2	±0,25	1,6	16
			1,0	25
$\Delta P > 16$	1,0	±1,0	2,5	40
			1,6	60
			1,0	100

NOTE 1 bar equals 100 kPa for conversions of Table 3.

Table derived from EN 837-1

4.5 Time

Time measurement equipment shall have a maximum error of 0,5 % of the duration of the measurement.

4.6 Flow rate

Flow rate measurement equipment shall have a maximum error of ± 1,5 % of the full range of the device. Alternatively, use equipment specified in 4.5 and 4.9 to determine the flow rate.

4.7 Angle

Angle measurement through a protractor, angle meter, or digital instrument shall have a maximum error of ± 0,5°.

4.8 Temperature and humidity

Temperature measurement equipment shall have a maximum error of ± 1 °C. Relative humidity measurement equipment shall have a maximum error of ± 5 percentage units.

4.9 Volume and mass

Volume and mass measurement equipment shall have a maximum error of ± 1 % of the nominal value.

4.10 Air pressure

For systems that use pressurized air as part of the atomization process, the pressure indicator shall have a maximum error of ± 5 % of the measured value.

4.11 Standard laboratory horizontal spray boom

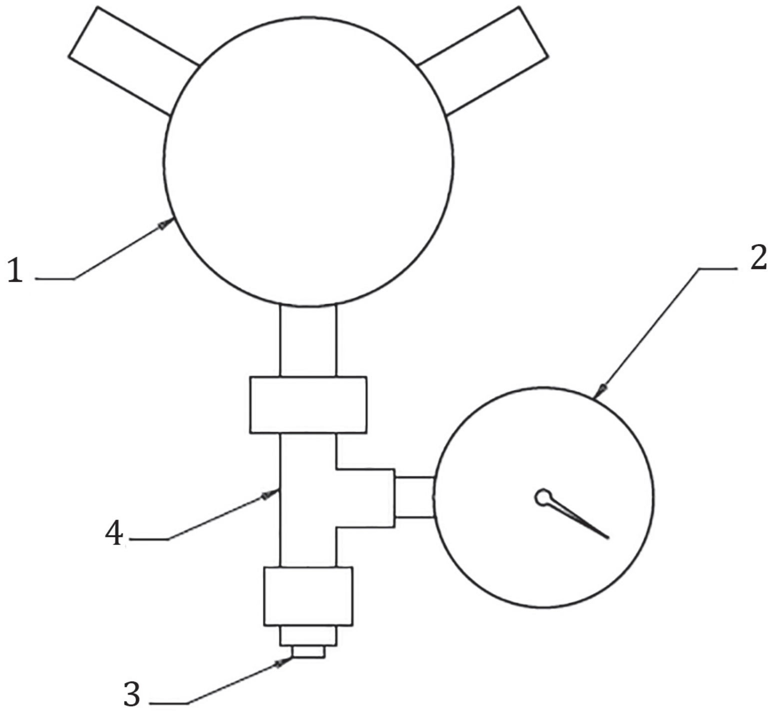
The standard horizontal spray boom setup for a horizontal patternator in the laboratory is described below. Annex G also includes informative details, but is not required for the setup.

The lateral position of the nozzles shall be over the top of the groove wall within ± 5 mm.

A pressure indicator according to 4.4 shall be arranged at a suitable position in the liquid supply system. The nozzle flow rate shall not vary more than ± 1,0 % at each nozzle position on the boom.

If an anti-drip device is present, the pressure shall be measured at a point downstream of the anti-drip device. The measurement shall be performed without the nozzle filter unless the nozzle filter is considered to be integral to the nozzle.

Figure 6 shows an example of a pressure indicator used immediately before the nozzle tip to avoid pressure drop from anti-drip devices or passageways in the nozzle holder. The test instrument shall not create a restriction between the nozzle holder and nozzle tip that would alter the flow or pressure.



Key

1 nozzle holder

2 pressure indicator (test equipment)

3 nozzle tip

4 adapter tee (test equipment)

Figure 6 — Example of nozzle tip pressure measurement

5 General test conditions

5.1 General

The operational data and test parameters shall be stated in the test report. Annex E provides an example of a report, but is not required for reporting.

5.2 Test liquids

5.2.1 Water

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.

5.2.2 Abrasive liquid

The liquid mixture shall be water, as stated in 5.2.1, with 20 g/l of micro grains of aluminium oxide added. The aluminium oxide shall meet requirements according to Annex D. The abrasive liquid shall be renewed after a time duration (t) corresponding to 50 passages according to the following formula:

$$t = \frac{50 \times V}{q}$$

where

t is the time expressed in hours (h);

V is the volume of mixture expressed in litres (l);

q is the flow rate expressed in litres per hour (l/h).

5.3 Temperature and relative humidity

The temperature of the test liquid and the air temperature of the test premises shall be between 5 °C and 35 °C during the test. The relative humidity of the test premises shall be not less than 30 %. The temperature and the relative humidity shall be stated in the test report.

5.4 Nozzle flow rate setting

During the test, the nozzle pressure shall not vary more than ± 2,5 % from the intended value. In the case of a nozzle pressure setting less than 200 kPa (2 bar), ± 5 % variation from the intended value is allowed. If other parameters are used to control the nozzle flow rate, they shall not vary the flow rate more than ± 1,5 % of the intended flow rate as stated by the nozzle manufacturer. The nozzle flow rate setting (e.g. pressure) shall be stated in the test report.

6 Determination of sprayer nozzle characteristics

6.1 Nozzle sampling

6.1.1 General

The sampling conditions shall be stated in the test report noting the size of the lot, the place of sampling and so on. In addition, the complete designation of the nozzles, including the discs and tips for the cone spray nozzles, shall be stated in the test report.

6.1.2 Nozzle samples

The sample shall be at least 20 nozzles of the same type taken out of a lot of 200 nozzles. Identify and mark each nozzle prior to starting the test. If designed to be used as an individual nozzle (e.g. for band spraying), then the sample size and lot can be less. The sample size and lot size shall be stated in the test report.

6.2 Nozzle flow rate uniformity

6.2.1 General

The measurement of the flow rate of each nozzle shall be carried out on a test bench using the nozzles from the sample according to 6.1.2.

The test bench consists of:

— a pump by which water with a certain pressure can be pumped through the nozzle;

— a pressure regulator;

— a pressure indicator (as given in 4.4) in which the actual pressure can be monitored;

— a flow meter or liquid collection device (as given in 4.6) in which the actual flow rate can be measured.

The liquid collection system, adapters and so on shall not have an influence on the flow rate.

6.2.2 Test liquid

The test liquid described in 5.2.1 shall be used for the test.

6.2.3 Nozzle flow rate setting

The tests shall be performed at the rated nozzle pressure indicated by the nozzle manufacturer. For nozzles where no recommendation is given, use 0,3 MPa (3 bar). The test shall be performed at the maximum and minimum nozzle pressure as indicated by the nozzle manufacturer and at least one intermediate pressure. One of the intermediate pressures shall be the nozzle manufacturer's rated nozzle pressure. The error of the pressure shall be as stated in 5.4. If no rated pressure is provided, then use the median point between the minimum and maximum. If other parameters are used to control the nozzle flow rate, they shall be substituted in place of the term "pressure".

6.2.4 Measurements

The nozzle flow rate shall be measured individually for each nozzle using equipment specified in 4.6. If the flow is greater than 200 ml per minute and uses instrumentation to collect by volume or mass in conjunction with a measurement of time, the minimum volume collection shall be 1 l and the minimum time measurement shall be 2 min.

If air pressure is used as part of the atomization process, the air pressure shall be measured using the equipment specified in 4.10.

6.2.5 Results

The results shall be presented in the test report in the form of a table in which the flow rate of each nozzle is given and expressed as percentage deviation compared to the nominal value as indicated by the nozzle manufacturer, as well as to the mean of the measured flow rates of the 20 nozzles. The control pressure shall also be included in the report.

6.3 Nozzle flow rate as a function of pressure adjustments

6.3.1 General

This test shall be performed with the five nozzles of the 20 nozzle sample according to 6.1.2 for which the flow rate is closest to the mean value determined in 6.2.5, using the intermediate flow rate setting.

6.3.2 Test liquid

The test liquid described in 5.2.1 shall be used for the test.

6.3.3 Nozzle flow rate settings

The tests shall be performed at the maximum, minimum and rated nozzle pressures as indicated by the nozzle manufacturer. The error of the pressure shall be as stated in 5.4. If other parameters are used to control the nozzle flow rate, they shall be substituted in place of the term "pressure".

6.3.4 Measurements

The flow rate shall be measured, in l/min at each of the nozzle pressures indicated in 6.2.3 using the equipment specified in 4.6. If air pressure is used as part of the atomization process, the air pressure shall be measured using the equipment specified in 4.10.

6.3.5 Results

The results shall be presented in the test report in the form of either a graph, in which the flow rate is indicated on the x-axis and the pressure on the y-axis, or a table.

6.4 Spray distribution on a horizontal patternator

6.4.1 General

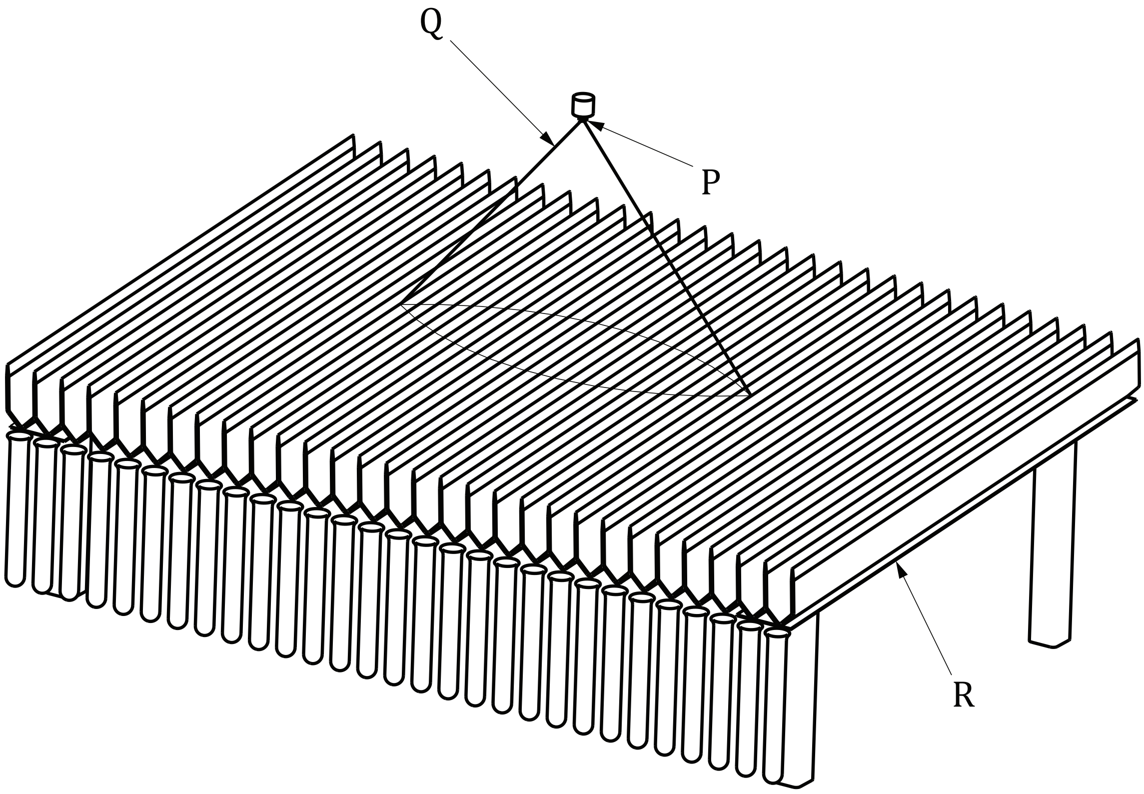
The setup for laboratory nozzle spray distribution tests can be a single nozzle or multiple nozzles. The deviations for the single nozzle setup are stated in 6.4.1.1 and 6.4.8.1. The deviations for the multiple nozzle setup are stated in 6.4.1.2 and 6.4.8.2.

6.4.1.1 Single nozzle setup

The horizontal patternator shall be used to evaluate the spray pattern transverse distribution of a single nozzle. Figure 7 shows an example of a single nozzle setup.

This test shall be performed with five nozzles from the 20 nozzle sample according to 6.1.2 for which the flow rate is closest to the mean value of the results determined in 6.2.5.

A horizontal patternator with 25 mm or 50 mm grooves shall be used. In the case of a distribution bench composed of grooves spaced at 25 mm intervals, two adjacent grooves may be summed to compare with 50 mm groove patternators. The nozzle shall be positioned laterally over the top of a groove wall with a tolerance of ± 5 mm.



Key

P nozzle

Q spray pattern

R horizontal patternator

Figure 7 — Example single nozzle setup

6.4.1.2 Multiple nozzle setup

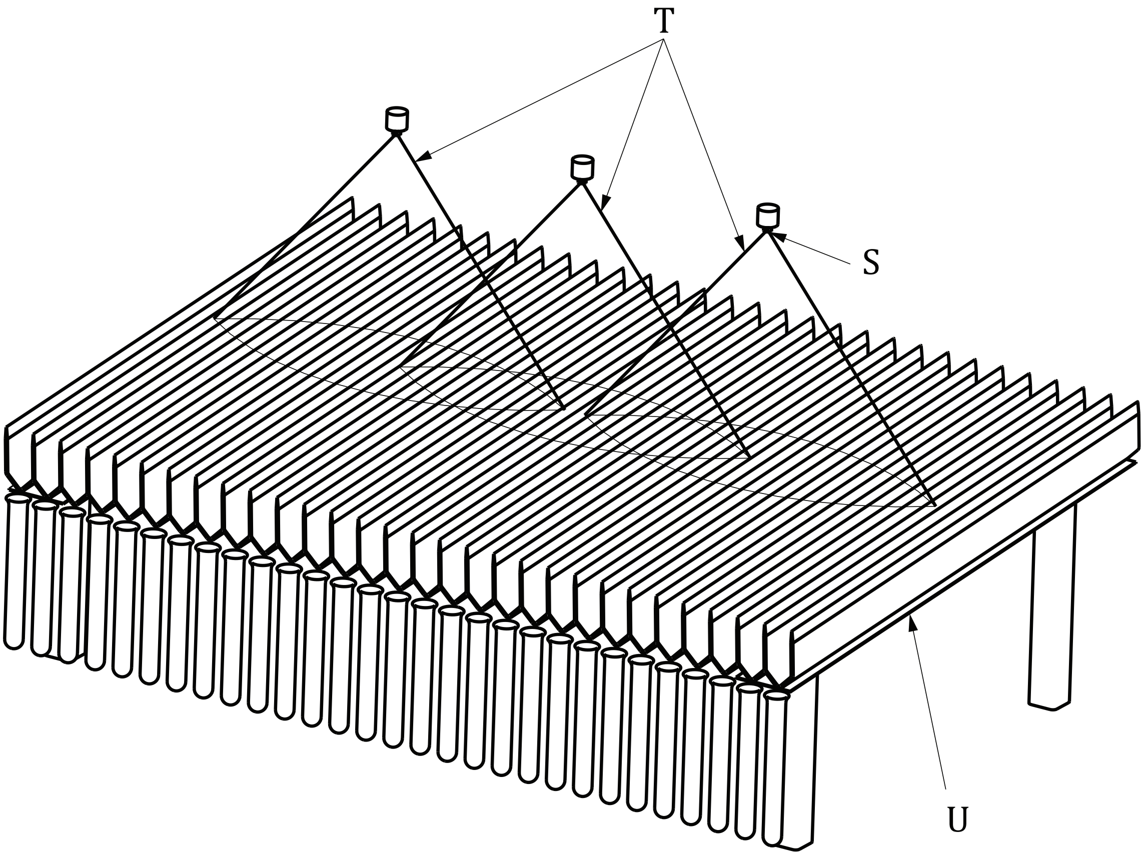
The horizontal patternator shall be used to evaluate the spray pattern transverse distribution of overlapping spray patterns intended to provide even transverse distribution. Figure 8 shows an example of a multiple nozzle setup with overlapping spray patterns.

This test shall be performed with all nozzles of the sample according to 6.1.2. Multiple runs are allowed in the case where the patternator cannot support the full sample size.

A horizontal patternator with 25 mm, 50 mm or 100 mm grooves shall be used. In the case of a distribution bench composed of grooves spaced at 25 mm intervals, two adjacent grooves may be summed to compare with 50 mm groove patternators or four adjacent grooves may be summed to compare with 100 mm groove patternators. Likewise, for a 50 mm patternator, two adjacent grooves may be summed to compare with 100 mm groove patternators.

The multiple nozzle setup shall be arranged on a standard laboratory horizontal spray boom according to 4.11.

NOTE This setup is not intended for whole spray boom configurations, which are addressed in ISO 5682-2.



Key

S nozzles

T spray pattern

U horizontal patternator

Figure 8 — Example of multiple overlapping nozzle setup

NOTE Figure 8 shows three nozzles to demonstrate an example. In most cases, the setup will have more than three nozzles.

6.4.2 General test conditions

The nozzles shall be stationary during the test. Nozzles shall be in the usual operating position as described by the nozzle manufacturer, using the horizontal patternator as defined in 4.2. The environmental conditions shall be such that wind or air currents do not disrupt the spray patterns or produce spray drift that could not be collected in the grooves. The collection device shall be capable of capturing all of the nozzles flow and be capable of measuring the flow rate of every individual groove as described in 4.6.

6.4.3 Test liquid

The test liquid described in 5.2.1 shall be used for the test.

6.4.4 Nozzle flow rate settings

The test shall be performed at the maximum, intermediate and minimum nozzle pressures stated by the nozzle manufacturer. The intermediate nozzle pressure is preferably the nozzle manufacturer's rated pressure. The pressure shall be stabilized. The error of the pressure shall be as stated in 5.4. If other parameters are used to control the nozzle flow rate, they shall be substituted in place of the term “pressure”.

6.4.5 Nozzle orientation

6.4.5.1 General

During the test, the nozzle(s) shall be positioned vertically above the distribution bench and in its normal working position such that the travel direction is parallel to the grooves. If the nozzle manufacturer indicates another position, the test shall be made in this position.

6.4.5.2 Flat fan nozzle(s)

Flat fan nozzle(s) shall be positioned for the test so that the widest dimension of the spray pattern is perpendicular to the grooves or in its normal working position as defined by the nozzle manufacturer.

A normal working position may, for example, have a twist of 5° to 15° from perpendicular to avoid spray pattern interferences to adjacent nozzles.

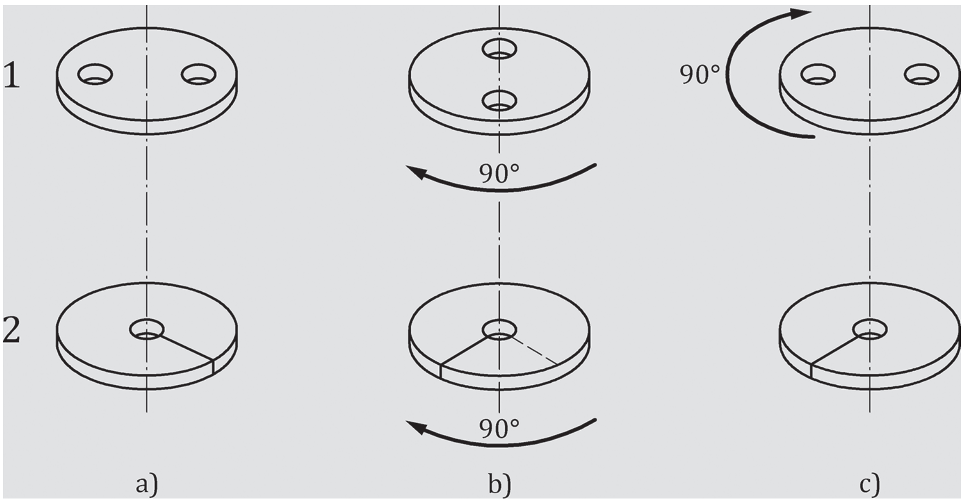
6.4.5.3 Cone nozzles(s)

Cone nozzles shall be tested in the following configurations unless the manufacturer recommends an alternative (see Figure 9):

a) in their initial configuration;

b) in a second configuration resulting from a 90° rotation of the nozzle disc or nut in its assembly;

c) when the spiral can turn in relation to the disc with the nozzle reassembled with the swirl plate turned through 90° in relation to configuration b).



Key

1 swirl plate

2 disc

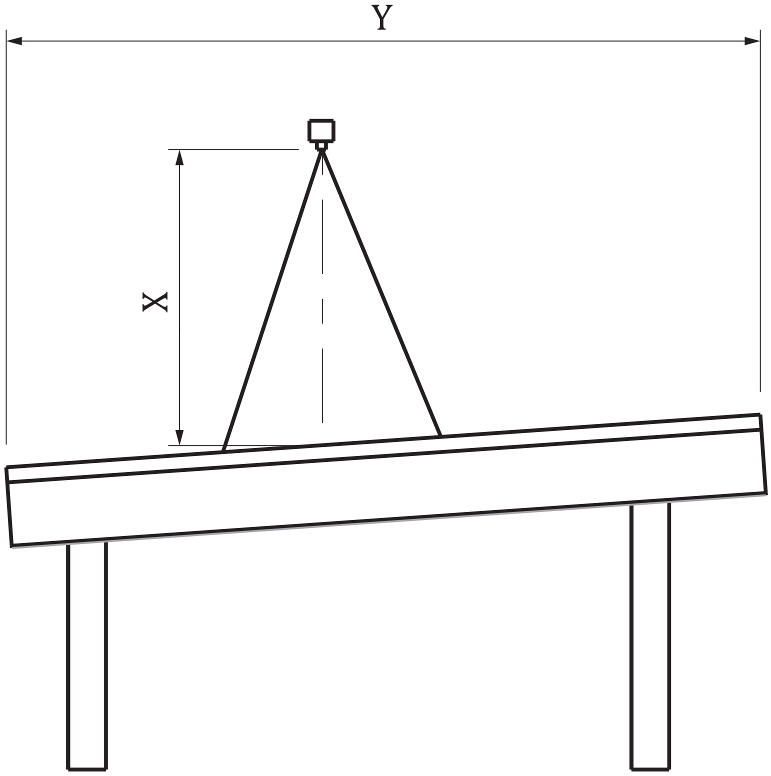
Figure 9 — Configuration for testing cone nozzles

6.4.5.4 Other nozzle(s)

Other nozzle types shall be tested as recommended by the manufacture.

6.4.6 Nozzle height

The height shall be measured vertically between the top of the groove wall and the nozzle tip(s) (X in Figure 10). If the nozzle manufacturer states an optimum height (X in Figure 10), the test shall be carried out at this stated height and at heights 80 % and 120 % of the stated height. If the nozzle manufacturer does not indicate any height, the tests may be carried out at a nominal height from Annex C for intended application and at 80 % and 120 % of this nominal height. Annex C provides an informative table that does not have to be adhered to. Annex C gives height recommendations with the intent of providing uniform spray pattern transverse distribution for overlapping nozzles based on the relationship between nozzle spray angle, spacing, and height. The tolerance of the height shall not exceed ± 1 % of the intended height. This height shall be verified all along the standard spray boom in the case of multiple nozzle setups.



Key

X nozzle height

Y overall depth

Figure 10 — Profile view of nozzle height

6.4.7 Measurements

Measure the volume collected from each groove using a period of time that provides the accuracy required in 4.6. A total of nine measurements shall be performed at all three pressures and all three nozzle heights as stated in 6.4.4 and 6.4.6 respectively.

The spray shall not be collected or measured until the flow rate out of the grooves has stabilized.

If the transverse distribution is measured by means of successive transverse measurements (e.g. one boom section at a time), then the measurements shall all be of the same width and for the same time period. Be aware that stopping the spray between successive transverse measurements may not yield accurate results if the system is not able to achieve consistent flow rates from measurement to measurement.

6.4.8 Results

6.4.8.1 Single nozzle setup

The transverse distribution of the spray shall be represented by a graph or a table indicating the actual values in each groove (for example volume and flow rate) for each sample. An example of an alternative method of reporting for cone nozzles is given in Annex F. Annex F is informative and not required for reporting. In addition, but not required, the distribution of the spray may also be calculated for each groove as the percentage of the total quantity of liquid collected.

6.4.8.2 Multiple nozzle setup

The transverse distribution of the spray shall be represented by a graph or a table indicating the actual values in each groove (for example volume and flow rate) and the coefficient of variation of all of the groove values. A coefficient of variation (CV) of all of the groove values shall be established only for the full overlapped zone. The width and location of the zone should be stated. In addition, but not required, the distribution of the spray may also be calculated for each groove as the percentage of the total quantity of liquid collected. Be aware that the CV for ‘larger’ booms may be lower than for ‘smaller’ booms.

In the case where multiple runs are used, a graph or table shall be provided for each run. The data from the multiple runs shall be summed together to provide the coefficient of variation of all of the grooves. Be aware that multiple runs may introduce more error to the results.

NOTE The comparability of results from different test bench designs is not demonstrated.

6.5 Nozzle flow rate and distribution changes due to abrasion (accelerated wear test)

6.5.1 General

This test is intended only for some nozzles. Guidance on intended nozzles are described in informative Annex A, but Annex A is not required.

The test shall be performed with five nozzles from the 20 nozzle sample according to 6.1.2. This test does not prejudge the life of the nozzle(s) in the actual conditions of use, but is used to compare the resistance of the nozzles to wear and the resulting deterioration in their transverse distribution.

6.5.2 Test liquid

The test liquid described in 5.2.2 shall be used. The temperature of the liquid shall be (5 to 35) °C throughout the test. The concentration of the abrasive material shall not change more than ± 5 % throughout the test, primarily due to evaporation or inadequate agitation.

NOTE Nozzle wear occurs faster at higher temperatures.

6.5.3 Nozzle flow rate setting

The test pressure shall be the rated nozzle pressure used in 6.2.3. If other parameters are used to control the nozzle flow rate, they shall be substituted in place of the term “pressure”.

6.5.4 Abrasion test duration

Each of the five nozzles shall spray continuously and with flow rate measurements at intervals based on the knowledge of the likely wear of the material type.

The test shall be stopped when the increase of the nozzle flow rate is at least 15 % or when the duration of the wear test reaches 100 h.

6.5.5 Measurements

Determine the nozzle flow rate according to 6.2, as well as the distribution of the spray according to 6.4, for a single nozzle setup as stated in deviations 6.4.1.1 and 6.4.8.1. The measurements shall be done at the rated nozzle pressure and the optimum height at the start and at the end of the test and using the test liquid according to 5.2.1.

6.5.6 Results

6.5.6.1 Nozzle flow rate variation

For all measurements, state in a table or graph:

a) the flow rate for each of the five nozzles at the end of the test in l/min;

b) the flow rate variation for each of the five nozzles, defined as the flow rate at the end of the test expressed as a percentage of initial flow rate at the start of the test;

c) the mean of a) and of b);

d) the mean flow rate variations as a function of the wear test duration.

6.5.6.2 Transverse spray distribution

The transverse distribution of the spray for each sample at the end of the test shall be represented by a graph or a table indicating the values as percentages of the mean quantity of liquid collected in all the grooves compared to the initial distribution at the start of the test. The overlapping zones of end of test and start of test shall be the same.

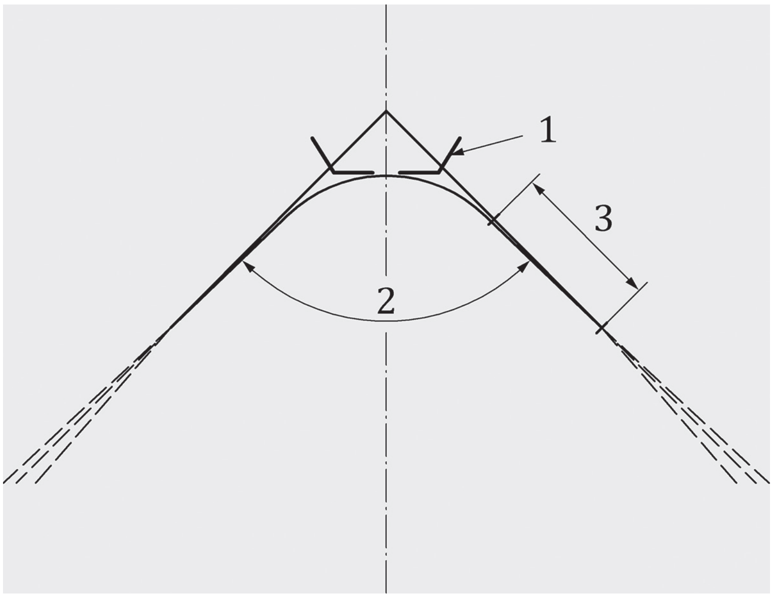
6.6 Spray angle

Using suitable equipment as defined in 4.2 or 4.7, measure the spray angle (see Figure 11) for which the nozzle flow rate is closest to the mean value determined in 6.2. Test with five nozzles out of the sample specified in 6.1.2. When using equipment as defined in 4.2, the angle calculation will be determine by the size and number of grooves as well as the height of the nozzles from the leading edge of the groove walls.

For multiple pattern nozzles (i.e. multiple tips), the pattern can be measured as a whole on the patternator or the individual patterns can be measured with an angle meter.

The tests shall be performed at the rated nozzle pressure indicated by the nozzle manufacturer. For nozzles where no recommendation is given, use 0,3 MPa (3 bar).

The tolerance of the measurement shall be ±10°.



Key

1 nozzle

2 spray angle

3 well-defined straight limit of the jet

Figure 11 — Diagram of the principle of measuring spray angle

7 Test report

The results shall be presented in a test report. Annex E provides an example of a report, but is not required for reporting.

Annex A
(informative)

Applicable tests by nozzle type

The list of nozzles in Table A.1 comes from the list of nozzle definitions as specified in ISO 5681.

Table A.1 — Applicable tests by nozzle type

Nozzle type	6.2 Uniformity of flow	6.3 Variations in flow rate as pressure varies	6.4 Distribution	6.5 Wear test	6.6 Spray angle
Hydraulic energy nozzle	Yes	Yes	Yes	Yes	NA
Flat fan nozzle	Yes	Yes	Yes	Yes	Yes
Double flat fan nozzle	Yes	Yes	Yes	Yes	Yes
Pre-orifice nozzle	Yes	Yes	Yes	Yes	Yes
Air induction nozzle	Yes	Yes	Yes	Yes	Yes
Even spray nozzle	Yes	Yes	Yes – single nozzle	Yes	Yes
Off-centre fan nozzle	Yes	Yes	Yes – one side only	Yes	Yes
Cone nozzle	Yes	Yes	Yes	Yes	Yes
Hollow cone nozzle	Yes	Yes	Yes	Yes	Yes
Solid cone nozzle	Yes	Yes	Yes	Yes	Yes
Solid stream nozzle	Yes	Yes	No	Yes	Yes – for multiple streams
Adjustable nozzle	Yes	Yes	Yes	Yes	Yes
Variable orifice nozzle	Yes	Yes	Yes	Yes	Yes
Deflector nozzle	Yes	Yes	Yes	Yes	Yes
Air atomizing nozzle	Yes	Yes – both air and liquid pressure	Yes	Yes	Yes
Air shear nozzle	Yes	Yes – both air and liquid pressure	Yes	Yes	Yes
Pneumatic nozzle	Yes	Yes	Yes	No	Yes
Fog nozzle	Yes	Yes	No	No	No
Impinging stream nozzle	Yes	Yes	Yes	Yes	Yes
Ultra-sonic nozzle	Yes	No	Yes	Yes	No
Vibratory nozzle	Yes	No	Yes	Yes	No
Vibrating needle atomiser	Yes	No	No	Yes	No
Piezoelectric vibratory nozzle	Yes	No	Yes	Yes	No
Electromagnetic vibratory nozzle	Yes	No	Yes	Yes	Yes
Pulse width modulation (PWM) nozzle	Yes	Yes	Yes	Yes	Yes
Vibrating reed nozzle	Yes	No	Yes	No	No

Table A.1 *(continued)*

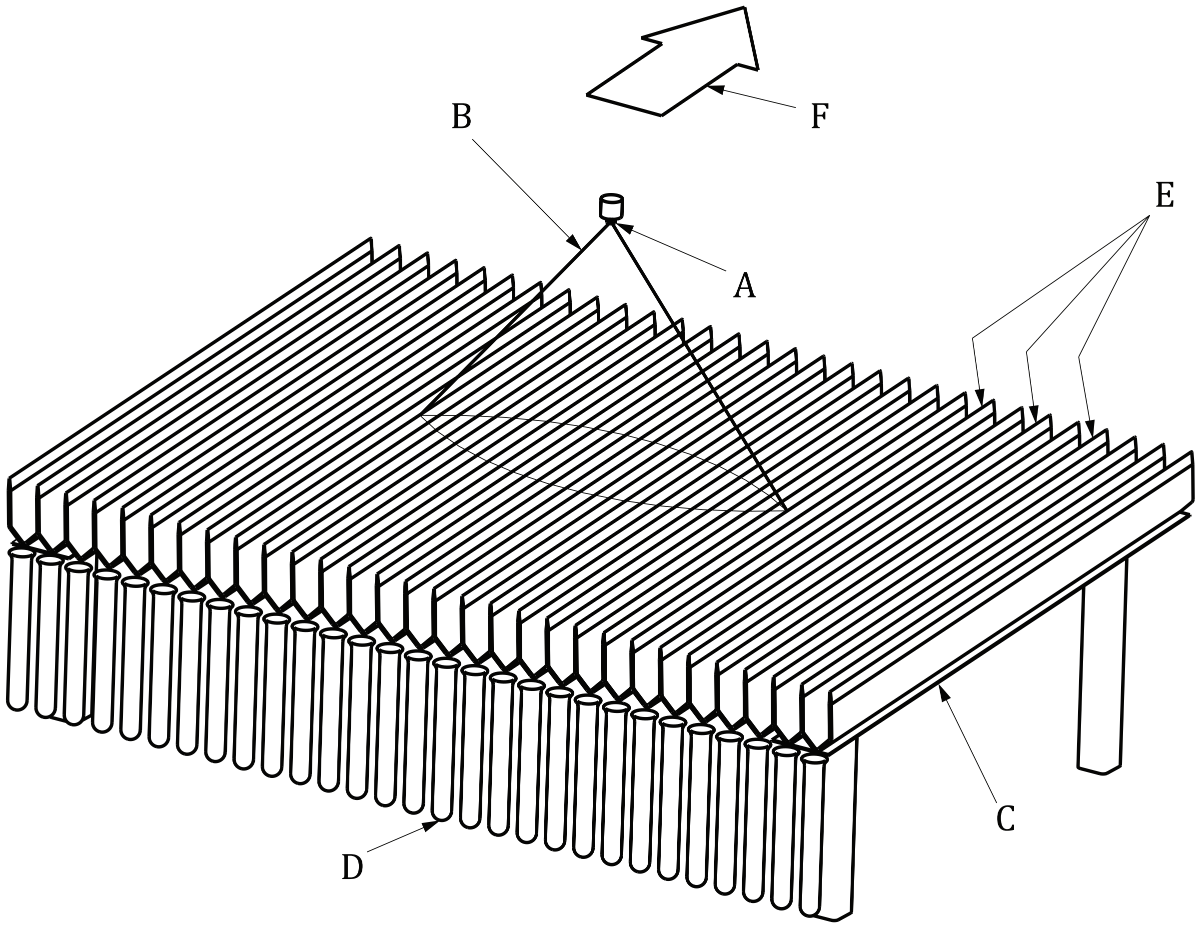
Nozzle type	6.2 Uniformity of flow	6.3 Variations in flow rate as pressure varies	6.4 Distribution	6.5 Wear test	6.6 Spray angle
Centrifugal energy nozzle	Yes	No	Yes	No	Yes
Twin fluid nozzle	Yes	Yes – both air and liquid pressure	Yes Yes	Yes	Yes
Electrostatic nozzle	Yes	Yes	No	Yes	Yes

Annex B
(informative)

Horizontal patternator

B.1 General

The horizontal patternator device is equipped with a number of equally spaced grooves which divide the spray and collect the volume or mass of spray deposited (Figure B.1). This provides a stationary means of testing spray distribution of a nozzle or multiple overlapping nozzles over a given amount of time.



Key

A nozzle

B spray

C horizontal patternator

D collection tubes

E grooves

F intended travel direction

Figure B.1 — Example of a horizontal patternator

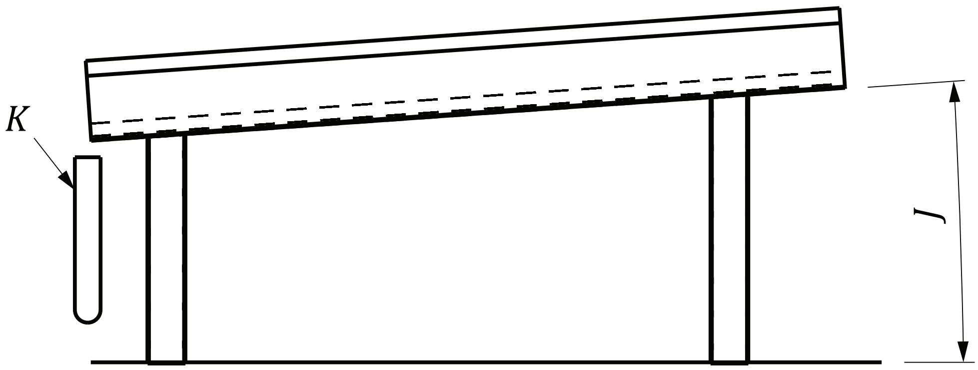
The nozzle(s) are arranged above the horizontal patternator in a static position with the intended direction of travel parallel to the groove walls (Figure B.1). Thus the distribution of the volume or mass of spray in the grooves is a measurement of the transverse distribution of the spray patterns from a single nozzle or multiple overlapping nozzles.

B.2 Groove characteristics

Good practice for the groove characteristics is as follows:

a) The walls of the grooves should preferably be vertical to minimize the potential redistribution due to splashing.

b) The inclination of the troughs of each groove (*J* in Figure B.2) should be a minimum of 1° towards the collection tubes.



Key

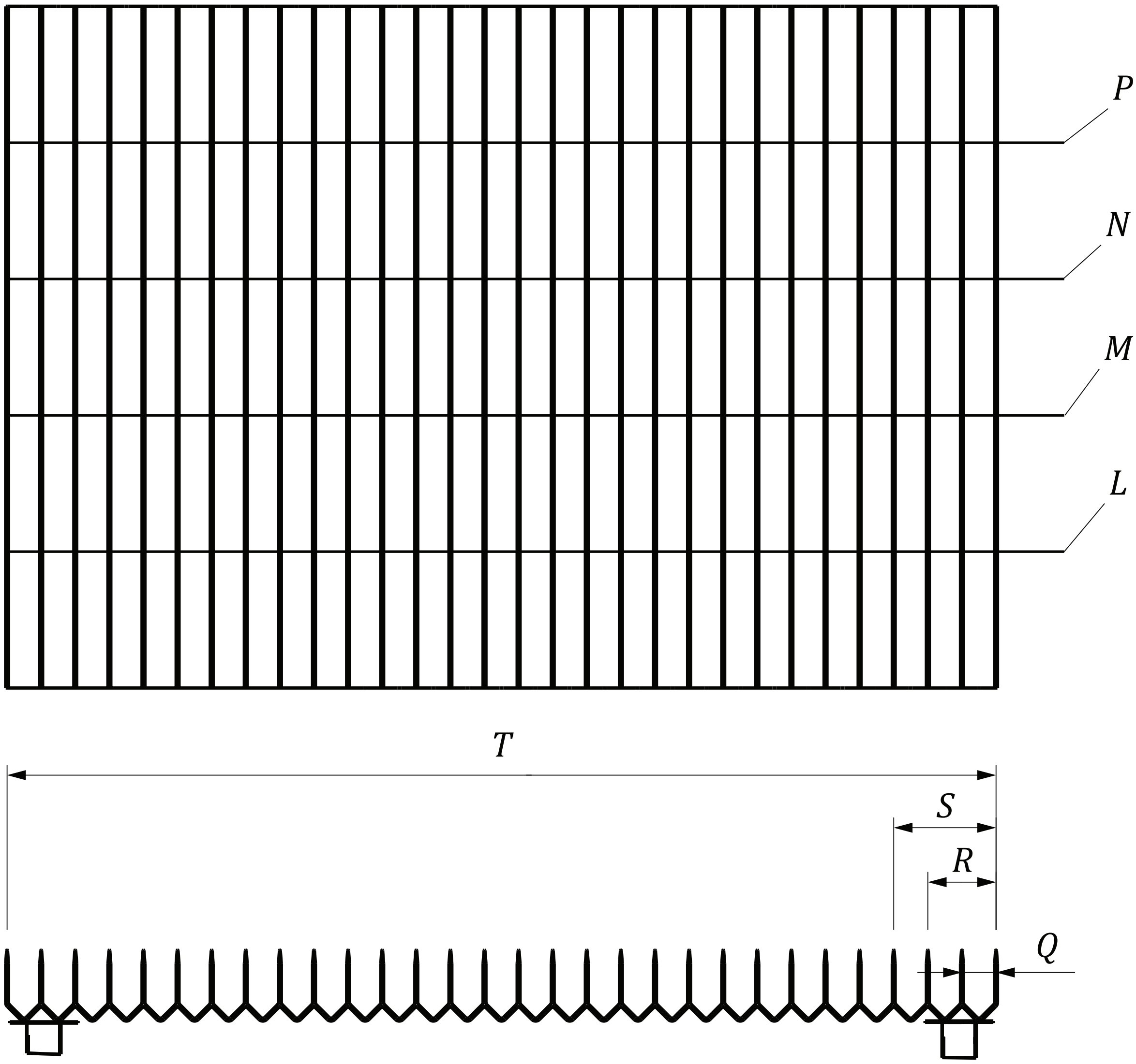
J inclination of the bottom of the trough from horizontal

K collection tubes

Figure B.2 — Angle of grooves

c) The maximum thickness of the lower portion of the groove walls (*U* in Figure B.4) should be 4 mm.

d) The distance between two groove walls can be measured using a ruler or tape measure, verifying each groove wall position relative to a reference wall on the end. Figure B.3 shows an example of the top and front view, where the horizontal lines of the top view represent locations where the tape measure is placed across the top of the grooves to verify the position of each groove.



Key

L	lower measurement
M	lower middle measurement
N	upper middle measurement
P	upper measurement
Q	first groove wall
R	second groove wall
S	third groove wall
T	overall width

Figure B.3 — Groove section

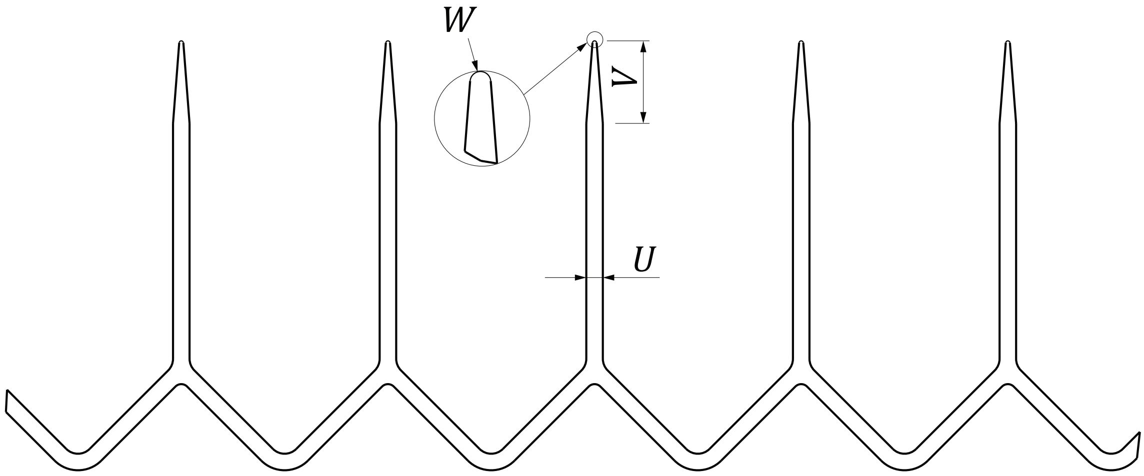
B.3 Upper part of the groove walls

Good practice for the upper part of the groove wall is as follows. The upper part of the walls are formed by symmetrical chamfered edges which may be rounded off and should have the following characteristics:

a) The height of the chamfered edge (*V* in Figure B.4) should be equal to at least three times the thickness of the wall.

b) The rounding-off radius (*W* in Figure B.4) should not be greater than 0,8 m.

NOTE Wide-angle spray can bounce off the upper groove walls if the included angle is too large.



Key

U lower groove wall thickness

V height of chamfered edge

W rounding off radius

Figure B.4 — Groove section

Annex C
(informative)

Nozzle spray angle, spacing and height relationships for horizontal patternator testing

Table C.1 — Nominal testing height in relation to nozzle angle and nozzle spacing

Nominal nozzle spray angle	Nominal testing height cm		
	Nozzle spacing 25 cm	Nozzle spacing 33,3 cm	Nozzle spacing 50 cm
60°	70	60	90
80°/90°	35	50	75
110°/120°	25	35	50

Annex D
(normative)

Specification of the aluminium oxide

a) Average analysis:

— Al_2O_3: = 99,5 %;

— SiO_2: from 0,01 % to 0,03 %;

— Fe_2O_3: from 0,01 % to 0,03 %;

— Na_2O: from 0,2 % to 0,4 %;

— α-Al_2O_3: over 90 %.

b) Grain distribution: F320 microgrits in accordance with ISO 8486-2:2007, Table 1.

Annex E
(informative)

Model test report for nozzles in accordance with ISO 5682-1

E.1 General

a)	Name and address of the nozzle manufacturer	
b)	Trademark	
c)	Type of nozzle(s)	
d)	Catalogue reference	
e)	Material(s)	
f)	Batch number	
g)	Date of batch	

E.2 Results of nozzle characteristic tests

NOTE During tests E.2.2 to E.2.6 the pressure or flow control setting was kept stable, at least to within 2,5 % of the target setting.

E.2.1 Nozzle sampling

E.2.1.1 Nozzle sample

Nozzle designation	
Number of samples	
Lot size	
Place of sampling	
Date of sampling	

E.2.2 Nozzle flow rate uniformity

E.2.2.1 Ambient conditions

Temperature of the test liquid	°C
Temperature of the ambient air	°C
Relative humidity of the air	%

E.2.2.2 Equipment

Pressure (model number, accuracy, range)	
Flow rate (model number, accuracy, range)	
Temperature (model number, accuracy, range)	
Humidity (model number, accuracy, range)	

E.2.2.3 Test liquid

Clean water, free from solids in suspension. Additives such as adjuvants should be noted.

E.2.2.4 Nozzle pressure

Maximum	
Intermediate or rated	If none, assume 0,3 MPa (3 bar).
Minimum	

E.2.2.5 Measurements

The error of the measurement of the flow rate is less than ± 1 %, as stated in 4.6.

E.2.2.6 Results for the flow rates of all the nozzles

Provide a table in which the flow rate of each nozzle is expressed as a percentage of the nozzle manufacturer's nominal flow rate and of the mean flow rate of the sample size.

Table E.1 — Flow rate of all of the nozzles

Nozzle number	Flow rate	% of nominal flow rate	% of mean rate
	(l/min)	(l/min)	(l/min)
1			
2			
...			
20			
Mean flow rate			
Nominal flow rate			

E.2.3 Nozzle flow rate as a function of nozzle flow control setting adjustments

E.2.3.1 Ambient conditions

Temperature of the test liquid	°C
Temperature of the ambient air	°C
Relative humidity of the air	%

E.2.3.2 Equipment

Pressure (model number, accuracy, range)	
Flow rate (model number, accuracy, range)	
Temperature (model number, accuracy, range)	
Humidity (model number, accuracy, range)	

E.2.3.3 Test liquid

Clean water, free from solids in suspension. Additives such as adjuvants should be noted.

E.2.3.4 Nozzle pressure

Maximum	
Rated	If none, assume 0,3 MPa (3 bar).
Minimum	

E.2.3.5 Measurement of the variation in flow rate as a function of the pressure

The measurements were carried out on nozzle sample no. ____ for which the flow rate is closest to the mean value determined in 6.2.

Duration of flow rate measurement	s

E.2.3.6 Results for the flow rate as a function of pressure

Graph with the flow rate on the x-axis and the nozzle flow control setting on the y-axis, or table.

E.2.4 Spray distribution on a horizontal patternator

E.2.4.1 Ambient conditions

Temperature of the test liquid	°C
Temperature of the ambient air	°C
Relative humidity of the air	%

E.2.4.2 Equipment

Pressure (model number, accuracy, range)	
Flow rate (model number, accuracy, range)	
Temperature (model number, accuracy, range)	
Humidity (model number, accuracy, range)	
Horizontal patternator (model number, accuracy, range)	

E.2.4.3 Test liquid

Clean water, free from solids in suspension. Additives such as adjuvants should be noted.

E.2.4.4 Nozzle pressure

Maximum	
Intermediate or rated	If none, assume 0,3 MPa (3 bar) for hydraulic nozzles.
Minimum	

E.2.4.5 Flow rate

Maximum	l/min
Intermediate or rated	l/min
Minimum	l/min

E.2.4.6 Nozzle height

Optimum height indicated by the nozzle manufacturer:

h	mm
h × 0,80 =	mm
h × 1,20 =	mm

E.2.4.7 Measurement time

Measurement time:

s

E.2.4.8 Results for the distribution of the spray

Show results in a graph or table indicating the values like in the table below.

Table E.2 — Horizontal patternator distribution measurements

	Groove location					Mean volume
	g1	g2	g3	g4	g...	
Volume						
% of mean volume						

E.2.5 Nozzle flow rate changes due to abrasion (accelerated wear test)

E.2.5.1 Ambient conditions

Temperature of the test liquid	°C
Temperature of the ambient air	°C
Relative humidity of the air	%

E.2.5.2 Equipment

Pressure (model number, accuracy, range)	
Flow rate (model number, accuracy, range)	
Temperature (model number, accuracy, range)	
Humidity (model number, accuracy, range)	

Horizontal patternator (Model number, accuracy, range, groove width [*E* of Figure 4], overall width [Figure B.3], and overall depth [Y in Figure 10])

E.2.5.3 Test liquid

Clean water with the addition of 20 g/l of oxide aluminium.

The test liquid is kept at a constant concentration in the tank during the test.

Volume of liquid placed in the tank at the beginning of the test	
Type of stirring system	
The liquid has been renewed after	h

E.2.5.4 Nozzle pressure

Nozzle pressure	bar

E.2.5.5 Measurements

The measurements have been carried out for nozzles nos. _____ and _____ for which the flow rates are closest to the mean flow rate determined in 6.2.

E.2.5.6 Results for the variations in the flow rate and the distribution due to abrasion

E.2.5.6.1 Nozzle flow rate variation

Table E.3 — Flow rate variation

	Nozzle					Mean
	n_1	n_2	n_3	n_4	n_5	
Flow rate (initial) l/min						
Flow rate (end) l/min						
Flow rate variation % = (end - initial) / initial × 100						

Table E.4 — Mean flow rate variation as a function of time

Time	t_1	t_2	t_3	t_4	t…
Mean flow rate variation %					

E.2.5.6.2 Distribution of the spray observed at the start and end of test

Present the results as in E.2.4.8.

E.2.6 Spray angle

E.2.6.1 Ambient conditions

Temperature of the test liquid	°C
Temperature of the ambient air	°C
Relative humidity of the air	%

E.2.6.2 Equipment

Pressure (model number, accuracy, range)	
Flow rate (model number, accuracy, range)	
Temperature (model number, accuracy, range)	
Humidity (model number, accuracy, range)	
Horizontal patternator (model number, accuracy, range)	if applicable
Angle meter (model number, accuracy)	if applicable

E.2.6.3 Test liquid

Clean water, free from solids in suspension. Additives such as adjuvants should be noted.

E.2.6.4 Nozzle pressure

Nozzle pressure	MPa (bar)

E.2.6.5 Results

Mean of angles measured	°

E.3 General disposition

The tests for which the results are given above were carried out in accordance with ISO 5682-1.

Place	Date

Annex F
(informative)

Reporting results for cone nozzles

In order to compare the spray patterns obtained in 6.4.5, calculate a symmetry index U_i defined as follows:

$U_i = (\Sigma_{max} - \Sigma_{min}) / \Sigma_{min}$

where

Σ_{min} is the sum of minimum values of each groove for the complete set of nozzle samples;

Σ_{max} is the sum of maximum values of each groove for the complete set of nozzles.

Annex G
(informative)

Standard spray boom for testing multiple nozzles

G.1 General

The standard spray boom consists of a structure to support multiple nozzles for assessment in defined conditions of the evenness of transverse distribution from overlapping spray patterns.

The spray boom should provide defined nozzle spacing, nozzle height and a uniform liquid supply.

The standard spray boom setup may not be applicable to all nozzle types.

G.2 Nozzle spacing

The standard spray boom should be equipped with fittings to enable the mounting of nozzle bodies. The fittings should allow the positioning of the nozzles under test with distances of 25 cm; 33,3 cm; or 50 cm with a maximum error of ± 5 mm.

G.3 Nozzle height

The standard spray boom should enable positioning each nozzle mounted at a uniform height above the horizontal patternator with a maximum deviation of ± 5 mm. The spray boom should be supported by a suspension allowing adjustment of the distance between nozzle orifice and leading edges of the patternator grooves in a range of 20 cm to 100 cm.

G.4 Liquid supply

The liquid supply of the standard spray boom should be able to provide a flow rate of at least 10 l/min per meter of working width at a spray pressure of 1 MPa (10 bar).

Bibliography

[1] EN 837-1, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

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