International Standard ISO 7749/1

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Irrigation equipment — Rotating sprinklers — Part 1: Design and operational requirements

Matériel d'irrigation — Asperseurs rotatifs — Partie 1 : Exigences de conception et de fonctionnement

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Foreword

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Irrigation equipment — Rotating sprinklers — Part 1 : Design and operational requirements

0 Introduction

ISO 7749 lays down requirements for rotating sprinklers for agricultural and horticultural irrigation.

ISO 7749/2 specifies the conditions and methods used for testing the distribution uniformity of rotating sprinklers.

1 Scope and field of application

This part of ISO 7749 specifies the design and operational requirements of rotating sprinklers and sprinkler nozzles for irrigation equipment and their methods of test. It applies to sprinklers intended for assembly in pipeline networks for irrigation and for operation at the pressures recommended by the manufacturer.

2 References

ISO 7/1, *Pipe threads where pressure-tight joints are made on the threads — Part 1 : Designation, dimensions and tolerances.*

ISO 228/1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1 : Designation, dimensions and tolerances.*

ISO 3951, *Sampling procedures and charts for inspection by variables for percent defective.*

ISO 7749/2, *Irrigation equipment — Rotating sprinklers — Part 2 : Distribution uniformity — Test methods.*[1)]

3 Definitions

For the purposes of ISO 7749, the following definitions apply.

3.1 rotating sprinkler: A device which revolves around its vertical axis and distributes water over an area.

3.2 nozzle: Aperture or adjutage of the sprinkler through which the water is discharged. The sprinkler may contain one or several interchangeable cylindrical or other shaped nozzles.

3.3 equivalent nozzle diameter: The theoretical nozzle outlet diameter, computed on the basis of rate of flow (neglecting shape of nozzle outlet). (See the annex.)

3.4 range of effective working pressure: The pressure range between the minimum effective pressure, p_1, and the maximum effective pressure, p_2, recommended by the manufacturer as the pressure range in which the sprinklers operate effectively. (See the figure.)

3.5 minimum working pressure, p_{min}: The lowest working pressure declared by the manufacturer.

3.6 maximum working pressure, p_{max}: The highest working pressure declared by the manufacturer.

3.7 nominal rate of flow: The quantity of water discharged by a sprinkler with a specific nozzle per unit of time, at the nominal test pressure.

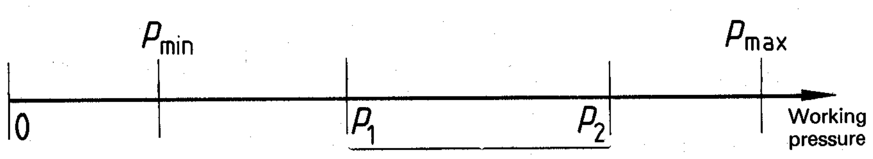

Figure — Range of effective working pressure

1) At present at the stage of draft.

3.8 nominal test pressure: The water pressure within the range of the effective working pressure that is determined by the nozzle size and nozzle angle, and used for testing the sprinkler (see 5.3).

3.9 diameter of coverage: The diameter of the area wetted by the sprinkler.

3.10 trajectory height: The maximum height of the trajectory above the sprinkler nozzle, when operating at the nominal test pressure.

3.11 nozzle angle: The angle of the water stream above a horizontal plane, as discharged from the sprinkler nozzle at the nominal test pressure.

3.12 normal nozzle angle: A nozzle angle of 20° and greater.

3.13 low nozzle angle: A nozzle angle smaller than 20°.

3.14 sprinkler spacings: The distance between sprinklers along irrigation laterals and the distance between laterals.

3.15 coefficient of distribution uniformity; CDU: The uniformity of water application rate at a given pressure and spacing, expressed as a percentage, by the Christiansen method. (See ISO 7749/2.)

3.16 wind velocity: The average wind velocity in the test field during the test of distribution uniformity of the sprinkler. (See ISO 7749/2.)

3.17 irrigation lateral: A branch supply line on which water distribution devices (sprinklers, emitters, drippers) are mounted directly or by means of fittings, risers or tubes.

4 Specifications

4.1 Materials

The sprinkler and its nozzles shall be made of copper alloy, plastics or other suitable corrosion-resistant materials.

4.2 Construction and workmanship

Sprinkler parts, including nozzles, of the same type and manufacture shall be interchangeable.

The construction of the sprinkler shall permit replacement of parts with standard tools. Should special tools be required, the manufacturer shall supply them.

The sprinkler shall be connected to the riser by means of threads or any other means that ensure proper strength of the connection and compliance with the requirements of this part of ISO 7749.

Sprinklers having a metal part for connection to risers shall be equipped with a hexagon suitable for gripping with a standard open wrench.

Sprinklers having a plastics part for connection to risers shall be equipped with at least two parallel surfaces suitable for gripping and other configurations (projections, slots, etc.) to facilitate manual assembly and removal.

Nozzles shall be attached to the sprinkler by threading, push-in or any other method that permits rapid and effective replacement under service conditions.

4.3 Threaded connections

4.3.1 Threaded connections to riser

The threads shall comply with ISO 7/1.

4.3.2 Nozzle threads

The threads of the nozzles (if any) shall comply with ISO 7/1 or ISO 228/1.

4.4 Performance requirements

The following performance requirements apply to sprinklers complete with one or more specific nozzles.

4.4.1 Working pressures

The sprinkler shall rotate continuously and regularly in its designed direction within its entire range of pressures from minimum working pressure, p_{min}, up to maximum working pressure, p_{max}.

The minimum working pressure, p_{min}, shall be at least 10 % lower than the lower limit of the effective pressures, p_1; the maximum working pressure, p_{max}, shall be at least 10 % above the upper limit of the effective pressures, p_2 (see the figure).

$$p_{min} < 0,9\ p_1$$

$$p_{max} > 1,1\ p_2$$

Sprinklers with low nozzle angle and flow rate up to 250 l/h shall have a rotation speed not less than 1 min^{-1}.

4.4.2 Actuating mechanism

The actuating mechanism of the sprinkler shall operate in accordance with 7.6 at any inclination of the riser up to 10° from the vertical.

5 General test conditions

5.1 Number of test specimens

The number of test specimens required for each of the tests specified in this part of ISO 7749 shall be as given in table 1.

Table 1

Clause	Subject of test	Number of test specimens
4	Materials, construction and threaded connections	3
4.4	Performance requirements	3
6	Endurance tests	3
7.1	Uniformity of rotation time	3
7.2	Uniformity of flow rate	—1)
7.3	Distribution characteristics	3
7.4	Diameter of coverage	2
7.5	Height of sprinkler water stream trajectory	2
7.6	Range of working pressures	2
8	Durability	2

1) Number of test specimens and acceptance conditions according to ISO 3951.

5.2 Accuracy of measuring devices

The allowable deviation in measuring accuracy of the pressure shall be ±2 %.

The pressure shall not vary by more than 4 % during the test.

The flow rate of the sprinkler shall be measured with an accuracy of ±1 %.

The rotation speed shall be measured with a stop-watch, graduated in divisions of 0,1 s.

5.3 Nominal test pressure

The nominal test pressure of the sprinkler shall be determined by the size of the nozzle, as given in table 2.

Table 2

Equivalent nozzle diameter1) mm	< 2	2 to 7,0	7,1 to 20	> 20
Nominal test pressure kPa	200	300	400	500

1) The equivalent nozzle diameter shall be computed according to the annex.

5.4 Test liquid

Specifications of the test liquid shall be as defined in ISO 7749/2.

5.5 Acceptance

The acceptance number for all tests except that in 7.2 is zero, as the total number of test specimens is small.

6 Strength tests

6.1 Test of construction and parts

Dismantle the sprinkler and check its parts visually.

To comply with this part of ISO 7749, the parts shall show no manufacturing defects, such as bubbles, cracks or projections.

6.2 Test of resistance of threaded connections

6.2.1 Threaded connections to riser

For sprinklers made of metal, the threaded connection shall withstand a torque of 50 N·m for threads up to 1 according to ISO 7/1 and ISO 228/1, and a torque of 100 N·m for threads greater than 1, without showing signs of damage.

6.2.2 Nozzle threads

The nozzle threads shall withstand a torque of 5 N·m, without showing any signs of damage to the nozzle or sprinkler.

6.3 Test of resistance to hydrostatic pressure

Connect the sprinkler to the test rig and plug up the outlet of the nozzles. The connection of the sprinkler to the supply line shall be made according to recommendations of the manufacturer for field assembly. The sprinkler nozzles shall be plugged in such a manner that no leakage occurs at the connection during the test.

Check that no air remains in the system, then gradually increase the water pressure, beginning with one quarter of the nominal working pressure.

6.3.1 Metal sprinklers

Raise the water pressure to the maximum working pressure, p_{max}, multiplied by 1,6, and maintain it at that level for 10 min at room temperature.

6.3.2 Plastics sprinklers

Raise the water pressure to the maximum working pressure, p_{max}, multiplied by 2,4, and maintain it at that level for 1 h at room temperature.

6.3.3 Requirements

To comply with this part of ISO 7749, no defects in the sprinkler body shall appear during the test, and no leakage shall occur through the sprinkler body or its gaskets.

6.4 Test of watertightness

6.4.1 Watertightness of sprinkler

Connect the sprinkler with its nozzles to the supply pipeline as commonly used at the service conditions recommended by the manufacturer.

Increase the water pressure from p_{min} to p_{max} in steps of 100 kPa and maintain the pressure at each step for 1 min. Throughout the test, leakage through the sliding bearing of the sprinkler shall be collected by suitable means.

The tightness test shall be performed after 24 h of sprinkler operation at the maximum test pressure ± 10 %.

To comply with this part of ISO 7749:

a) the rate of leakage through the rotary journal bearing shall not exceed 2 % of sprinkler flow rate at the nominal test pressure;

b) in sprinklers with flow rates up to 250 l/h, the leakage rate shall not exceed 5 l/h;

c) there shall be no leakage through the threaded connection to the supply line.

6.4.2 Watertightness of nozzle connection

Plug up the outlets of the sprinkler nozzles and install the sprinkler in the test assembly. Tighten threaded nozzles to the torque, expressed in newton metres, which is numerically equal to the equivalent nozzle diameter, in millimetres. Do not use additional sealing materials.

Check that no air remains in the system, then increase the water pressure gradually from the minimum working pressure, p_{min}, to 1,6 times the maximum working pressure, p_{max}. Maintain this pressure for 10 min at room temperature.

To comply with this part of ISO 7749, leakage through the connection of the nozzle to the sprinkler shall not exceed 0,25 % of the sprinkler nominal flow rate.

7 Operating tests

Separate tests shall be conducted for each sprinkler nozzle or combination of nozzles.

7.1 Test of uniformity of rotation time

This test applies to sprinklers with flow rates greater than 250 l/h and rotation speeds of less than one rotation per 8 s.

While mounted on a vertical riser, operate the sprinkler at its nominal test pressure and measure the time required for each quarter revolution separately. Repeat the measurement five times.

Compute the average time required for a quarter revolution and the greatest deviations, expressed as a percentage, from the average.

To comply with this part of ISO 7749, the extreme deviations from the average shall not exceed ± 12 %.

7.2 Test of uniformity of flow rate

The sprinklers of one test sample are tested for uniformity of flow rate at nominal test pressure, while mounted on risers.

The sample shall comply with the requirements of ISO 3951, shall have an acceptable quality level (AQL) of 2,5 %, and upper and lower specification limits as follows:

a) 7 % for sprinklers with flow rates up to 250 l/h;

b) 5 % for sprinklers with flow rates exceeding 250 l/h.

7.3 Test of distribution characteristics

The test of distribution characteristics shall be performed as described in ISO 7749/2.

7.3.1 Sprinklers with low nozzle angle and low flow rate

This test applies to sprinklers with low nozzle angle and flow rates up to 250 l/h, of the same model and manufacture. The test is performed along one radius and at no wind (see ISO 7749/2). Draw the distribution curve of three sprinklers and compute the average distribution curve.

To comply with this part of ISO 7749:

a) the distribution curve of each of the sprinklers tested, at any point, shall not deviate by more than ± 5 % from the average distribution curve;

b) the average distribution curve shall not deviate by more than ± 10 % from the distribution curve supplied by the manufacturer.

7.3.2 Sprinklers with flow rates greater than 250 l/h

The distribution uniformity of sprinklers is tested by the full field method or by the radius method (see ISO 7749/2).

The tests are performed according to the conditions specified in table 3.

Table 3

Wind velocity	Pressure	Sprinkler placement
0,9 m/s max.[1)]	Three different pressures (in multiples of 50 kPa), at the beginning, middle and end of the range of the effective working pressures declared by the manufacturer	Three consecutive collector placements by agreement with the manufacturer

1) Sprinklers with high water trajectory may be tested by the full field method at a wind velocity of 2 m/s maximum (but the manufacturer shall specify in his catalogue the wind velocity at which the test was conducted).

Compute the coefficient of distribution uniformity (CDU) of the sprinkler by the Christiansen method.

7.4 Test of diameter of coverage

Measure the diameter of coverage at the middle of the range of effective working pressures declared by the manufacturer. The test may be performed, as specified in 7.3, either by the full field method or by the radius method.

When testing by the full field method, compute the diameter of coverage from the average of the measurements along the four wind directions at which the collectors were placed (two rows in each direction).

When testing by the radius method, compute the diameter of coverage as the average of four measurements made when the sprinkler base is rotated a quarter revolution (90°) about its axis for each measurement.

Measure the diameter of coverage up to the point at which the height of the collected water in the collector is at least 0,3 mm per hour (volume of collected water divided by the area of the collector opening).

To comply with this part of ISO 7749, the diameter of coverage shall be at least 6 m, but shall not vary from the diameter of coverage declared by the manufacturer by more than ±5 %.

7.5 Test of trajectory height of sprinkler
(for sprinklers with low nozzle angle)

Measure the height of the sprinkler water stream trajectory at the ends and the middle of the range of effective pressures, while the sprinkler is in operation. The trajectory height of the sprinkler is measured at the highest point reached by the water.

To comply with this part of ISO 7749, the trajectory height of the water stream above the sprinkler nozzle, for sprinklers with flow rates up to 250 l/h, shall not exceed 90 cm.

7.6 Test of range of working pressures

Before performing this test, keep the sprinkler immersed in water, maintained at 60 °C, for 1 h. Mount the sprinkler on the riser as recommended by the manufacturer for field service. Increase the water pressure from zero to the pressure at which the sprinkler begins to rotate steadily in one direction. Operate the sprinkler at this pressure for 2 min. Raise the water pressure gradually to the maximum working pressure, p_{max}. Then operate the sprinkler at this pressure for 1 min.

Repeat the test with the sprinkler inclined 10° from the vertical.

To comply with this part of ISO 7749, the sprinklers shall rotate consistently in one direction throughout the entire range between the minimum and the maximum working pressures.

8 Durability tests

Operate the sprinkler for 2 000 h at the highest effective working pressure. The sprinkler shall be operated continuously for 4 to 5 days, then stopped for 1 to 2 days, in alternating sequence, until a total of 2 000 h of operation is reached.

No water discharged from the sprinkler nozzles shall reach the sprinkler body during the test.

After operating the sprinkler for 2 000 h, the sprinkler shall be checked and tested as described in 8.1 to 8.6.

8.1 Test of construction and parts

See 6.1.

8.2 Test of resistance to hydrostatic pressure

See 6.3.

8.3 Test of watertightness

As 6.4.1, except that the allowable leakage is doubled.

8.4 Flow rate of the sprinkler at nominal test pressure

This shall not vary by more than 8 % from the flow rate of the sprinkler before carrying out the durability test.

8.5 Test of uniformity of rotation time

As 7.1, except that the extreme deviation from the average shall not exceed ±20 %.

8.6 Test of distribution characteristics

Carry out the test (see 7.3) under the same conditions as before the durability test. The following changes are permissible:

a) for sprinklers with flow rates up to 250 l/h, the allowable deviation from the distribution curve supplied by the manufacturer is 20 %;

b) for other sprinklers, the coefficient of distribution uniformity (CDU) shall not differ by more than −10 % from the coefficient of distribution uniformity declared by the manufacturer.

9 Marking

9.1 Sprinklers

Each sprinkler shall bear a clear and permanent marking including the following particulars:

a) name of manufacturer or his registered trademark;

b) catalogue identification symbol;

c) nozzle angle;

d) mark to designate position of nozzle (when position of nozzle affects sprinkler operation).

9.2 Nozzles

Each nozzle shall bear a clear and permanent marking including the following particulars:

a) equivalent nozzle diameter, to the nearest 0,1 mm, as computed from the equation given in the annex;

b) mark indicating correct position of nozzle, if this affects sprinkler operation.

An explanation of the mark shall be given in the catalogue of the manufacturer.

NOTE — One of the listed marks may be an identifying mark, such as colour, provided it is described in the manufacturer's catalogue.

10 Data supplied by the manufacturer

The manufacturer shall supply suitable information on rotating sprinklers to the user, in the form of catalogues, instructions, data sheets, all bearing marks of identification and date of issue.

Technical data on the sprinklers shall be based on the results of tests performed according to this part of ISO 7749.

10.1 General data

- catalogue number of sprinkler;
- size of sprinkler threads and specification for connection to supply piping;
- limitations of sprinkler use (fertilizers, chemicals, water quality, etc.);
- protection against abrasion by sand (if any);
- instructions for assembly of nozzle in correct position, if this affects sprinkler operation;
- list of spare parts;
- if any marking is in code, the coding shall be understandable.

10.2 Operating data

The manufacturer shall supply, for each nozzle or assembly of nozzles, the following data:

- for sprinklers with flow rates above 250 l/h, the values of the coefficient of distribution uniformity (CDU) for the recommended combinations of sprinkler spacings, nozzles and working pressures, at specific wind conditions;
- distribution curve for sprinklers with low nozzle angle and flow rates up to 250 l/h;
- rates of flow at effective working pressures;
- diameter of coverage at the effective working pressures;
- minimum and maximum working pressures;
- nozzle angle;
- heights of sprinkler water stream for sprinklers with low nozzle angle, at all effective working pressures;
- instructions for assembly, operation, maintenance and storage.

Annex

Rates of flow and their equivalent nozzle diameters

The equivalent nozzle outlet diameter is computed on the basis of measured rate of flow at the nominal working pressures specified in table 2. The diameter is determined by the average rate of flow obtained from the measured rates of flow of five nozzles.

Table 4 shows a number of rates of flow and their equivalent nozzle diameters.

Equivalent nozzle outlet diameters greater than 10,0 mm are given by the equation

$$d = 2\sqrt{\frac{q}{\pi c\sqrt{0,2gp}} \times \frac{1\,000}{60}}$$

where

d is the equivalent diameter, in millimetres;

q is the rate of flow, expressed in cubic metres per hour, of the sprinkler (with nozzle);

c is the flow coefficient of nozzle (c = 0,9 for the purpose of computing equivalent diameter);

g is the acceleration due to gravity, 9,81 m/s^2;

p is the water pressure, in kilopascals.

Table 4

Nominal working pressure							
200 kPa		300 kPa				400 kPa	
Rate of flow m^3/h	Equivalent diameter of nozzle outlet mm	Rate of flow m^3/h	Equivalent diameter of nozzle outlet mm	Rate of flow m^3/h	Equivalent diameter of nozzle outlet mm	Rate of flow m^3/h	Equivalent diameter of nozzle outlet mm
0,050	1,0	0,25	2,0	1,31	4,6	4,01	7,5
0,061	1,1	0,30	2,2	1,42	4,8	4,56	8,0
0,073	1,2	0,36	2,4	1,54	5,0	5,15	8,5
0,085	1,3	0,39	2,5	1,67	5,2	5,77	9,0
0,100	1,4	0,42	2,6	1,80	5,4	6,43	9,5
0,113	1,5	0,48	2,8	1,94	5,6	7,13	10,0
0,129	1,6	0,56	3,0	2,08	5,8		
0,146	1,7	0,63	3,2	2,22	6,0		
0,163	1,8	0,71	3,4	2,37	6,2		
0,182	1,9	0,80	3,6	2,53	6,4		
		0,89	3,8	2,69	6,6		
		0,99	4,0	2,85	6,8		
		1,09	4,2	3,02	7,0		
		1,20	4,4				