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Agricultural irrigation equipment — Emitting-pipe systems — Specification and test methods

Matériel agricole d'irrigation — Gaines de micro-irrigation — Spécifications et méthodes d'essai

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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.

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.

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Agricultural irrigation equipment — Emitting-pipe systems — Specification and test methods

1 Scope

This International Standard specifies mechanical and functional requirements of agricultural irrigation emitting-pipes and their fittings, test methods and the data to be supplied by the manufacturer to permit correct installation and operation in the field.

It applies to dripping and trickling pipes, hoses and tubing intended for irrigation, of which the emitting units form an integral part. It also applies to the fittings used for connecting these emitting-pipes, hoses and tubing: it does not apply to porous pipe (porous along its entire length).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3501:1976, *Assembled joints between fittings and polyethylene (PE) pressure pipes — Test of resistance to pull out.*

ISO 8796:1989, *Polyethylene (PE) 25 pipes for irrigation laterals — Susceptibility to environmental stress-cracking induced by insert-type fittings — Test method and specification.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 emitting-pipe: Continuous pipe, hose or tubing with perforations or other hydraulic devices formed in the pipe during production and intended to emit water in the form of drops or continuous flow, at emission rates not exceeding 15 l/h per emitting unit.

3.2 regulated [pressure-compensating] emitting-pipe: Emitting-pipe of relatively constant emission rate at varying water pressures at the emitting-pipe inlet within the limits specified by the manufacturer.

3.3 unregulated emitting-pipe: Emitting-pipe whose emission rate varies at different water pressures.

3.4 non-reusable emitting-pipe: Light-weight emitting-pipe not intended for removal and reinstallation.

3.5 reusable emitting-pipe: Heavy-weight emitting-pipe which is designed for removal and reinstallation with proper handling from one season to another or under other circumstances.

3.6 emitting unit: Section of the emitting-pipe, repeated at intervals, from which water is emitted to one clearly distinguishable location.

3.7 unit emitting-pipe: Length of emitting-pipe containing one emitting unit.

3.8 clamping band: Ring- or band-like device used for obtaining a water-tight joint between emitting-pipe and fitting.

3.9 fitting: Any connecting device suitable for attachment to the emitting-pipe with or without a clamping band.

3.10 inlet fitting: Fitting having one end suitable for connection to a standard irrigation pipe or appliance and the other end or ends suitable for connection to an emitting-pipe.

3.11 in-line fitting: Fitting with both ends suitable for connection to an emitting-pipe.

3.12 nominal diameter: Conventional numerical designation used to indicate the size of the emitting-pipe and approximately equal to the outside diameter, in millimetres, of the pipe.

3.13 nominal test pressure, p_n: Reference pressure of 100 kPa at the inlet of an unregulated emitting unit; or any other pressure so designated in manufacturer publications.

3.14 nominal emission rate, q_n:

(1) Unregulated [non-compensating] emitting-pipe: Emission rate, in litres per hour, of the emitting unit at nominal test pressure and at a water temperature of 23 °C, as specified by the manufacturer.

(2) Regulated [pressure-compensating] emitting-pipe: Emission rate, in litres per hour, of the emitting unit at a water temperature of 23 °C, as specified by the manufacturer.

3.15 range of working pressures: Range of water pressures at the inlet of the emitting unit, between and including the minimum working pressure, p_{min}, and the maximum working pressure, p_{max}, recommended by the emitting-pipe manufacturer to ensure proper operation.

3.16 range of regulation: Range of water pressures at the inlet of the regulated emitting unit, in which each emitting unit of the emitting-pipe discharges water within the range of emission rates specified by the manufacturer.

4 Classification

Emitting-pipes are classified according to three criteria (see 4.1 to 4.3).

4.1 Uniformity of emission rate and regulation

Two categories of uniformity are classified:

a) Uniformity category A: Emitting-pipes having higher uniformity of emission rates and smaller deviations from the specified nominal emission rate.

b) Uniformity category B: Emitting-pipes having lower uniformity of emission rates and greater deviations from the specified nominal emission rate.

NOTE 1 The requirements for each category are defined in 9.1 and 9.2.

4.2 Duration of use

Two categories of duration of use are classified:

a) non-reusable emitting-pipes;

b) reusable emitting-pipes.

4.3 Type of operation

Two categories of type of operation are classified:

a) unregulated emitting-pipes;

b) regulated emitting-pipes.

5 Designation

Emitting-pipes shall be designated by

a) the words "emitting-pipe";

b) reference to this International Standard;

c) the nominal diameter;

d) nominal emission rate, in litres per hour;

e) maximum working pressure, in multiples of 100 kPa units;

f) the uniformity category.

EXAMPLE

An emitting-pipe complying with this International Standard, of 16 mm nominal diameter, 2 l/h emission rate, intended for operation at working pressures up to a maximum of 120 kPa and conforming to uniformity category A is designated as follows:

Emitting-pipe ISO 9261 16 - 2 - 1,2 - A

6 Marking

6.1 Emitting-pipe

Each emitting-pipe shall bear clear and permanent markings including the following details:

a) name of manufacturer or his registered trademark;

b) mark for identification of year of manufacture;

c) designation according to clause 5;

d) arrow indicating direction of flow (if it affects operation of the emitting-pipe).

These details shall be marked at intervals not exceeding 5 m.

6.2 Fittings

Emitting-pipe fittings shall bear clear and permanent markings including the following details:

Name of manufacturer or his registered trademark.

6.3 Packaging of emitting pipes

When the emitting-pipes are supplied in coils, each coil shall carry an attached tag bearing the following clear, legible and permanent information:

a) name and address of manufacturer;

b) designation and catalogue number of emitting-pipe;

c) nominal diameter of emitting-pipe;

d) classification according to 4.1, 4.2 and 4.3;

e) length of emitting-pipe in coil;

f) year of production and manufacturing lot;

g) nominal emission rate of unit emitting-pipe and nominal pressure;

h) spacing of emitting units.

6.4 Packaging of fittings

Fittings shall be supplied in package form, each bearing the following clear, legible and permanent information:

a) name and address of manufacturer;

b) catalogue number of fitting;

c) nominal diameter of emitting-pipe and, if applicable, nominal diameter of the irrigation lateral or the nominal size of the thread;

d) year of production and manufacturing lot.

7 Construction and materials

7.1 General

The emitting-pipe, its parts and fittings shall have no manufacturing defects that may impair performance.

The construction of the emitting-pipe and its fittings shall permit their easy connection, with or without clamping bands, whether the connection is made manually or by means of suitable tools supplied by the manufacturer.

7.2 Dimensions

7.2.1 The manufacturer shall specify the inside diameter and wall thickness of the product, and the actual dimensions of the product shall comply with those declared by the manufacturer as stipulated in 9.3.

7.2.2 The dimensions of the connecting fittings shall fit the dimensions of the emitting-pipe, to ensure easy and reliable connection.

7.2.3 Emitting-pipes of the same class but of different inside diameter, made by the same manufacturer, with differences of diameter greater than 2 mm, shall be designated as different sizes.

7.3 Materials

The material used in the manufacture of emitting-pipes and their fittings shall be resistant to fertilizers and chemicals commonly employed in irrigation, and shall be suitable for use with water at temperatures up to 60 °C and at pressures designated for the emitting-pipe.

The materials shall, insofar as possible, not support the growth of algae and bacteria. The parts of the emitting-pipe that are exposed to light shall be opaque and protected against UV degradation.

7.4 Fittings

The manufacturer shall supply, for each type and size of emitting-pipe, fittings suitable in size and shape to make good connections to the emitting-pipe.

The jointing, made with or without the use of clamping bands, shall be of sufficient strength to withstand the full range of working pressures.

Clamping means, such as bands and screws, shall be of non-corroding materials or of materials protected against corrosion.

8 Test specimens and conditions

8.1 Test specimens

The sample shall be taken at random by a representative of the test laboratory from a lot of at least 500 emitting units. The test specimen shall not be taken from adjacent sections of the pipe. The test specimen shall include a minimum of five adjacent emitting units and the total number of test specimens shall contain at least 25 emitting units. The

number of emitting units required for each test is indicated in the relevant clause.

8.2 Order of tests

The tests shall be conducted in the order listed in clause 9. All tests, beginning with 9.2, shall be conducted on specimens which were taken according to 9.1.

8.3 Test conditions

Unless otherwise specified in the relevant clause, all tests shall be carried out at ambient air temperature and at a water temperature of 23 °C ± 1 °C. The water used shall be filtered through a filter with nominal aperture of 75 µm to 100 µm (160 mesh to 200 mesh), or as recommended by the manufacturer.

8.4 Accuracy of measuring devices

The water pressure shall be measured with an error not exceeding 2 % of the actual values.

During the test, the pressure shall not vary by more than 2 %.

The emission rate of the emitting-pipe shall be measured with an error not exceeding ± 2 % of the actual values.

9 Test methods and requirements

9.1 Uniformity of emission rate

9.1.1 General

This test applies to regulated and unregulated emitting-pipes. The test sample shall include at least 25 emitting units in accordance with the requirement in 8.1.

9.1.2 Unregulated emitting-pipes

Measure the emission rates of the emitting units in the emitting-pipe when the water pressure at the inlets of the emitting units equals the nominal test pressure. Record separately the measured emission rate of each emitting outlet.

Calculate the coefficient of variation, C_v, from the following formula:

$$C_v = \frac{s_q}{\bar{q}} \times 100$$

where

s_q is the standard deviation of the emission rates for the sample;

$\bar{q}$ is the mean emission rate of the sample.

The following requirements shall be met:

a) The mean emission rate of the test sample shall not deviate from the nominal emission rate, q_n, by more than 5 % for category A, nor more than 10 % for category B.

b) The coefficient of variation, C_v, of the emission rate of the test sample shall not exceed 5 % for category A, nor 10 % for category B.

9.1.3 Regulated emitting-pipes

Condition the emitting units in the test sample by operating them for 1 h minimum at an emitting unit inlet pressure equal to the pressure at the middle of the working pressure range. At the beginning of conditioning, the emitting units shall be operated three times at about p_{max} and three times at about p_{min}, each operation to be maintained for at least 3 min. During the last 10 min of conditioning, the pressure shall be maintained at the midpoint of the range of regulation.

Immediately after, and without altering the inlet pressure, test the emitting units according to 9.1.2, but at the mid-point of the range of regulation.

The emitting units shall comply with the requirements of 9.1.2.

9.2 Emission rate of emitting unit as function of inlet pressure

The tests to be performed to determine emission rate as a function of pressure shall be made in continuation of the tests performed in accordance with 9.1.2.

9.2.1 Selection of test samples

Number the emitting units tested according to 9.1, in ascending order according to the measured emission rate, No. 1 being the emitting unit of lowest emission rate, No. 25 the highest.

Take four emitting units from the series obtained — Nos. 3, 12, 13, 23 — and measure their change in emission rate as a function of the inlet pressure.

Test each emitting unit in steps not greater than 50 kPa, from zero pressure up to 1,2 p_{max}. Regulated emitting units shall be tested at three or more different pressures within the range of regulation, at rising and falling inlet pressures. The reading of the results shall be taken at least 3 min after reaching the test pressure.

If the inlet pressure exceeds the desired pressure by more than 10 kPa during its rise and fall, return to zero pressure and repeat the test.

9.2.2 Unregulated emitting-pipe

Calculate, for each pressure level, the average emission rate, $\bar{q}$, obtained by measuring the emission rates of the four emitting units at rising pressure.

Plot the curve $\bar{q}$ as a function of inlet pressure.

The curve of $\bar{q}$ shall conform to the curve presented in manufacturer publications within an allowable deviation of not more than ± 5 % for category A, not more than ± 10 % for category B.

9.2.3 Regulated emitting-pipe

Calculate, for each inlet pressure level, p, the average emission rate, $\bar{q}$, obtained by measuring the emission rates of the four emitting units at rising and falling pressure (the average of eight emission rate measurements).

The value of $\bar{q}$ shall not deviate from the nominal emission rate by more than 5 % for category A, nor more than 10 % for category B.

9.3 Dimensions

9.3.1 Wall thickness of emitting-pipe

Measure the wall thickness of the emitting-pipe at four points equally spaced on the periphery of the pipe. Repeat the test at two cross-sections. In the event of a part of the pipe wall being thicker by design (e.g. flap in emitting-pipe), such increase in thickness is disregarded.

The wall thickness of the emitting-pipe, when measured at each of the four points, shall not be less than 90 % of the declared wall thickness.

9.3.2 Inside diameter of emitting-pipe

To measure the inside diameter of the emitting-pipe, insert a conical part (apex angle not greater than 10°) into the end of the emitting-pipe, taking care not to enlarge the pipe diameter. Mark on the cone the circle made by the end of the pipe and measure its diameter.

The measured inside diameter shall not deviate by more than $\pm 0{,}3$ mm from the declared diameter.

9.3.3 Flow paths in emitting unit

Measure, in at least three emitting units, acurately to the nearest 0,02 mm and under no pressure, the smallest dimension of the flow-path. (This does not apply to a dimension that varies with pressure.)

The smallest measured flow-path dimension shall not be smaller than the dimension declared by the manufacturer.

9.3.4 Spacing of emitting units

Measure three spacings of emitting units accurately to the nearest 1,0 mm.

The spacings of the emitting units shall not deviate by more than 5 % from the spacings declared by the manufacturer.

9.4 Resistance to hydrostatic pressure

9.4.1 Resistance to hydrostatic pressure at ambient temperature

Carry out the test on a length of emitting-pipe consisting of five unit emitting-pipes joined by means of in-line fittings.

Carry out the test in two stages (9.4.1.1 and 9.4.1.2).

9.4.1.1 Connect the emitting-pipe assembly to a source of water, by means of an inlet fitting, and close its outlet end. Fill the emitting-pipe assembly with water and check that no air remains trapped in the pipe. Increase the water pressure gradually (10 s minimum) to the maximum working pressure multiplied by 1,2 for non-reusable emitting-pipes, or to the maximum working pressure multiplied by 1,8 for reusable emitting-pipes, and maintain the test pressure for 1 h.

The emitting-pipe assembly shall withstand the test pressure without showing signs of damage to the emitting-pipe, the emitting units or the connecting fittings. The unit emitting-pipes shall not pull apart, and no leakage shall occur at the inlet fitting. Leakages not exceeding the emission rate on one emitting unit are permissible at in-line fittings.

9.4.1.2 Reduce the test pressure to nominal pressure and maintain for at least 3 min. Measure the flow-rate of each emitting unit.

The flow-rate of each emitting unit shall not deviate by more than 10 % from its original flow-rate as measured in 9.1.

9.4.2 Resistance to hydrostatic pressure at elevated temperature

Carry out the test on a length of emitting-pipe consisting of three unit emitting-pipes joined by means of in-line fittings.

9.4.2.1 Connect the emitting-pipe assembly to a source of water by means of an inlet fitting, and close its outlet end. Fill the emitting-pipe assembly with water and check that no air remains trapped in the pipe. Raise the water pressure gradually (10 s minimum) to maximum pressure and maintain the pressure for 24 h for non-reusable emitting-pipes or

48 h for reusable emitting-pipes, while the emitting-pipe test assembly is immersed in water at 60 °C ± 2 °C temperature.

The emitting-pipe shall withstand the test pressure without showing signs of damage.

9.4.2.2 Remove the test assembly from the water and leave it for 30 min at ambient temperature. Apply a hydrostatic pressure, p_n, for at least 3 min at ambient temperature and measure the flow-rate of each emitting unit.

The flow-rate of each emitting unit shall not deviate by more than 10 % from its original flow-rate, as measured in 9.1.

9.5 Resistance to tension at elevated temperature

Carry out the test on five unit emitting-pipes at a temperature of 50 °C ± 2 °C.

If the emitting-pipe is reusable, mark two lines, about 150 mm apart, on the unit emitting-pipe.

Fasten each unit emitting-pipe in the grips of a tension-testing machine and uniformly increase (within 20 s to 30 s) the pull on the unit emitting-pipe to

— 160 N for non-reusable emitting-pipes [see 4.1 a)];

— 180 N for reusable emitting-pipes [see 4.1 b)].

Maintain the pull for 15 min, then release the pull and allow the unit pipe to cool to ambient temperature.

Non-reusable emitting-pipes shall withstand the test pull without breaking or tearing.

Reusable emitting-pipes shall withstand the test pull without breaking or tearing, the nominal flow-rate in the test specimen shall not vary by more than ± 5 % from the flow-rate measured before testing, and the distance between the two marked lines shall not vary by more than 5 % from the distance measured according to 9.1.

9.6 Resistance to pull-out of joints between fittings and reusable emitting-pipes

The test method and the test equipment used shall be as specified in ISO 3501, but the test pull shall be 180 N, applied for 1 h.

The fitting shall not pull out from the emitting-pipe.

9.7 Resistance of polyethylene (PE) emitting-pipe to environmental stress-cracking

The test and requirements shall be as specified in ISO 8796.

9.8 Determination of emitting unit exponent

This determination applies only to regulated emitting units.

The relation between the emission rate, q, in litres per hour, and the inlet pressure in an emitting unit, p, in kilopascals, is given by the formula:

$$q \simeq k \times p^m$$

where

k is a constant;

m is the emitting unit exponent.

Using all the $\bar{q}$ and p values obtained in 9.2.3, calculate the emitting exponent, m, from the following formula:

$$m = \frac{\sum (\lg p_i)(\lg \bar{q}_i) - \frac{1}{n}\left(\sum \lg p_i\right)\left(\sum \lg \bar{q}_i\right)}{\sum (\lg p_i)^2 - \frac{1}{n}\left(\sum \lg p_i\right)^2}$$

where

i is 1, 2, 3, ..., n;

n is the number of pressure values used in 9.2.3;

$\bar{q}$ is the mean emission rate, in litres per hour;

p is the inlet pressure, in kilopascals.

The value of the emitting unit exponent, m, shall not exceed 0,2.

10 Data supplied by manufacturer

The manufacturer shall make available to the user, together with the pipe end fittings, catalogues or information sheets that include the following data:

a) catalogue number of emitting-pipe and fitting;

b) type of fittings for connecting emitting-pipe to supply network or appliances;

c) instruction sheets for proper operation of emitting-pipe. The instruction sheets shall be dated;

d) the words "Uniformity category A" or "Uniformity category B", as applicable, including the relevant values given in table 1;

e) details of suitable fittings (including code number as marked on the fitting) for different applications;

f) installation instructions for the emitting-pipe and fittings;

g) nominal emission rate of unit emitting-pipe;

h) inside diameter of emitting-pipe;

i) wall thickness of emitting-pipe;

j) range of working pressures of emitting-pipe;

k) classification of emitting-pipe;

l) operating characteristics of emitting-pipe (see 9.2);

m) limitations of emitting-pipe use (fertilizers, chemicals, etc.);

n) range of regulation (if any);

o) filtration requirements;

p) spacing of emitting units in emitting-pipe;

q) minimum recommended radius for coiling emitting-pipe;

r) maintenance and storage requirements;

s) nominal test pressure;

t) dimension of smallest flow path in emitting unit.

Table 1 — Uniformity values (according to 9.1)

Category	Parameter	
	Deviation of $\bar{q}$ from q_n max. %	Coefficient of variation, C_v max. %
A	±5	±5
B	±10	±10