International Standard 8224/1

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Traveller irrigation machines — Part 1 : Laboratory and field test methods

Machines d'arrosage mobiles — Partie 1 : Méthodes d'essai en laboratoire et au champ

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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Traveller irrigation machines — Part 1 : Laboratory and field test methods

0 Introduction

ISO 8224 lays down the test methods for traveller irrigation machines; it includes the following parts:

Part 1: Laboratory and field test methods.

Part 2: Pipe and hose — Specific test methods. [1)]

Part 3: Distribution uniformity. [1)]

The basic requirement of an irrigation machine is the highest possible uniformity of water distribution. For reasons of reproducibility and repeatability, sprinkler performance and velocity of the traveller can be tested most appropriately in a laboratory.

However, many aspects of the performance of an irrigation machine may only be tested in the field. Hence this part of ISO 8224 comprises two sections:

Section one: Laboratory tests

Section two: Field tests

These sections may be used separately or in combination, as required.

This part of ISO 8224 has two annexes which do not form an integral part of the Standard.

1 Scope

This part of ISO 8224 specifies laboratory and field test methods for traveller irrigation machines intended for spreading of liquids, such as water, waste water, water with chemical solutions, liquid manure and sewage sludge.

2 Field of application

This part of ISO 8224 applies to stationary hose coiling machines, mobile hose laying machines and mobile hose dragging machines, each equipped with flexible hose or pipe and sprinkling devices used for agricultural and forestry areas. They may also be used for other purposes, including ground water recharge.

1) In preparation.

2) At present at the stage of draft.

3 Reference

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

4 Test liquid

Generally, clean cold irrigation water which has passed a 200 µm filter should be used. If the machine is designed for other liquids, the test may be extended to these liquids in agreement with the manufacturer.

5 Machine sampling

The sample irrigation machine used for testing shall be representative of the particular model and shall not be modified for the test.

6 Functional aspects

6.1 Manufacturer's instructions

The irrigation machine shall be tested in accordance with the manufacturer's instructions. These shall specify at least:

a) liquid or liquids to be applied, indicating maximum suspended particle size;

b) maximum percentage dry matter and/or maximum viscosity;

c) range of operating pressures at water inlet connection, in kilopascals;

d) maximum permissible pressure at water inlet connection, in kilopascals;

e) range of discharge and sprinkler characteristics, in cubic metres per hour;

f) maximum permissible road towing speed, in kilometres per hour;

g) maximum permissible land gradients when operating, in percentage;

h) maximum permissible coiling speed, in metres per hour;

j) range of operating speeds, in metres per hour;

k) maximum coiling speed using tractor power take-off, when applicable (rotational frequency of power take-off shaft), in metres per hour;

m) length, external diameter, wall thickness and material of flexible pipe or hose, all in metres;

n) description of safe operation and safety instructions.

6.2 Behaviour on cultivated land

This includes:

a) track width or range of adjustment of sprinkler carriage and irrigation machine;

b) ground clearance of irrigation machine, sprinkler carriage or sprinkler sledge;

c) width of crop-free passages required for the machine, if applicable;

d) possibility of depositing the flexible pipe or hose on cultivated land.

6.3 Handling

This includes:

a) setting up and dismantling times and labour requirements;

b) maintenance requirements;

c) power required for fast coiling;

d) necessary technical tractor data, including drawbar pull required, at a range of specified speeds, for transportation on grassland;

e) ease of adjustment and control, i.e. setting correct operating speed, changing nozzles, adjustment of sprinkler sector and sprinkler height, adjustment of the track width, turning the drum on the carriage, necessity or otherwise of disconnecting the sprinkler carriage during transport, operation of sprinkler without operation of driving element at the start and end of sprinkler track (manual or automatic).

Section one: Laboratory tests

7 Laboratory test equipment

7.1 Collectors, as specified in ISO 7749/2.

7.2 Pressure gauges, four, with a range of 2,5 MPa, capable of being read to an accuracy of ±10 kPa.

7.3 Stop-watch, accurate to ±0,1 s.

7.4 Flowmeter, with an accuracy of ±2 %.

7.5 Dynamometer, with an accuracy of ±0,25 kN.

7.6 Calibrated gauge tank, capable of being read to an accuracy of ±1 % of volume.

7.7 Tachometer, with an accuracy of ±1 %.

7.8 Cable, for reel or winch test.

7.9 Test bench, as illustrated in the figure.

NOTE — The variations in torque are due to

a) the variable tensile stress of the pipe on the ground;

b) the variation in reeling diameter due to the successive layers of pipe wound around the drum of a hose coiling irrigator, or of the cable around the winch of a mobile hose dragging machine.

The adjustment of the counterweight takes the above factors into account and is made by means of a tank filled with a volume of water corresponding to the desired stress.

This stress is given by the formula

$$F = 0{,}009\,8\,aml\,\frac{r + (n - 1/2)d}{r}$$

where

F is the tensile stress, in kilonewtons;

a is the coefficient depending on the slope and on the nature of the ground or crops (for comparative tests: $a = 0{,}8$);

m is the linear mass of the pipe full of water, in kilograms per metre;

l is the unreeled length of the pipe travelling on the ground, in metres;

r is the inside radius of the drum, in metres;

n is the number of layers of hose or pipe on the drum;

d is the outside diameter of the hose or pipe, in metres.

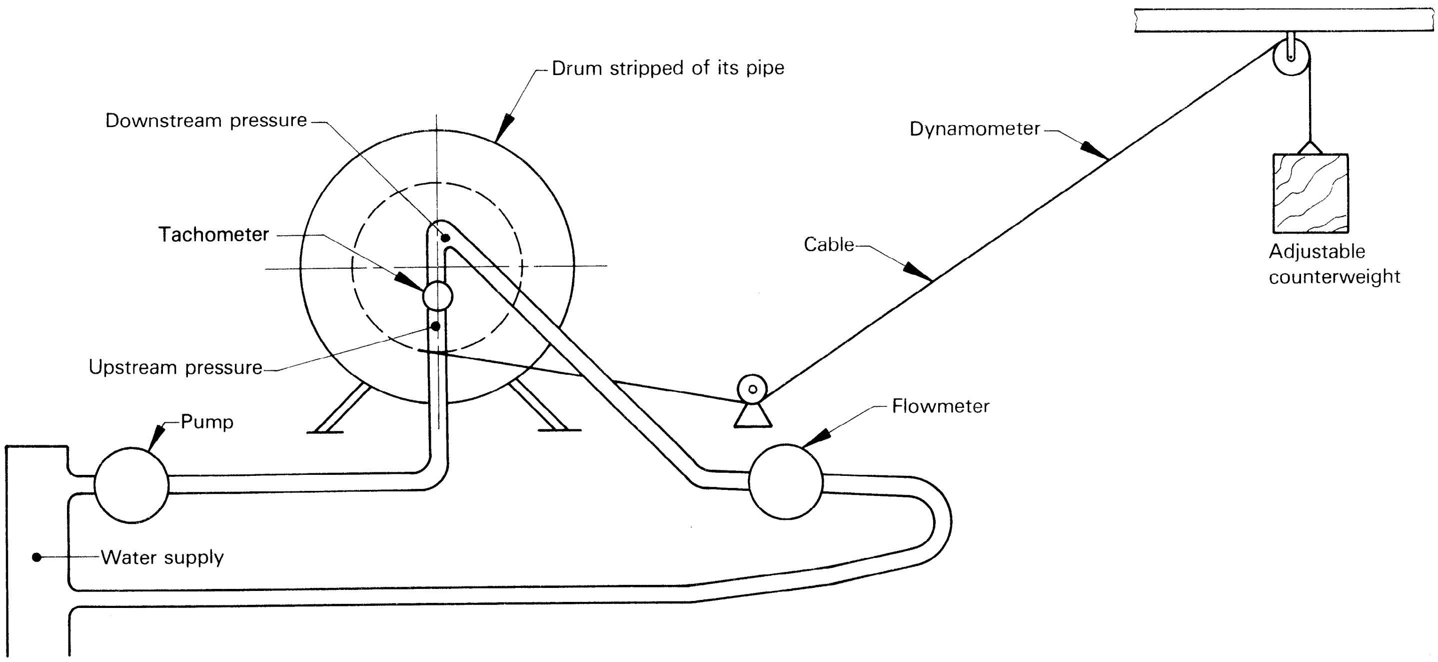

Figure — Test bench for testing travelling speed in laboratory

8 Water distribution

Sprinklers shall be tested in the laboratory according to ISO 7749/2 as concerns distribution uniformity. The results of computation shall be checked by field tests.

9 Travelling speed

9.1 Test procedure

9.1.1 General

Remove the pipe or cable from the machine. Attach one end of the cable to the drum or winch of the machine, and the other to the test bench.

Select a minimum of three cable reeling speeds of approximately 15, 30 and 45 m/h and continuously record the following measurements throughout the whole test period:

a) reeling speed of the cable (7.8), by measuring with the stop-watch (7.3) the time for 5 m of cable to pass over a fixed mark;

b) discharge of the machine, in cubic metres per hour, by means of the flowmeter (7.4);

c) the leakage rate of the drive mechanism, if any, by draining it into the calibrated gauge-tank (7.6);

d) the tensile stress exerted by the cable on the dynamometer (7.5);

e) pressure losses in the drive mechanism, using the pressure gauges (7.2), rotational frequency for hydrodynamic drive (e.g. turbine), using the tachometer (7.7), or number of strokes per hour for hydrostatic drive (e.g. piston).

9.1.2 Discharge or pressure for travelling speed

For each initial cable speed, proceed to the "speed-discharge" or "speed-pressure" tests with the discharge or pressure values recommended by the manufacturer.

In hydrodynamically driven machines: at the inlet of the machine, maintain the discharge successively at the following operating values; indicate nozzle sizes of the sprinkler and turbine:

— minimum discharge;

— discharge recommended by the manufacturer;

— maximum discharge.

In hydrostatically driven machines: at the inlet of the machine, maintain the pressure successively at the following operating values:

— minimum pressure;

— pressure recommended by the manufacturer;

— maximum pressure.

For each of the chosen relations "speed-discharge" or "speed-pressure", reproduce various operating conditions by varying the torque exerted by the cable on the drum or on the winch. For each relation "speed-discharge" or "speed-pressure", carry out four measurements for each layer of reeled hose corresponding to

— different positions of the sensor on one or several layers of reeled hose on the drum for the reel-type irrigators;

— different lengths of hose to be pulled by mobile hose dragging machines.

9.2 Results

Present the results in the form of graphs having the speed, in metres per hour, and pressure loss, in kilopascals, in the hydrodynamic drive mechanism, respectively, as ordinates, and the distance between the sprinkler and the machine, in metres, as abscissa. Tabular presentation is allowed.

Section two : Field tests

10 Field test equipment

10.1 Anemometer(s), with an accuracy of ± 5 %.

10.2 Collectors, as specified in ISO 7749/2.

10.3 Calibrated pressure gauges, four, with a range of 2,5 MPa, capable of being read to an accuracy of ± 10 kPa.

10.4 Stop-watch, with an accuracy of ± 0,1 s.

10.5 Flowmeter, with an accuracy of ± 2 %.

10.6 Dynamometer, with an accuracy of ± 0,25 kN (and, if required, wheels or rolling bridge to carry the stationary part).

11 Water distribution

11.1 General

The machine shall be operated on level ground (slope 1 % max.).

The wind velocity shall be less than 1,5 m/s and shall be measured throughout the test. The direction shall be indicated in relation to the travelling direction of the sprinkling device.

The pressure gauge shall be mounted near to the sprinkler on a straight section of pipe.

11.2 Test procedure

Arrange a line of collectors (10.2) 1 m apart, at right angles to the travelling direction. The number of collectors along the line shall be sufficient to cover the entire diameter of coverage of the sprinkler.

Operate the sprinkler to travel across the line of collectors at a speed to obtain at least 20 mm but not more than 50 mm of precipitation near the centreline of the irrigated strip.

Carry out the test for at least three different pressures in equal steps. The chosen pressures shall be related to the nozzle size used and be within the range of operating pressures.

Record the measured precipitation graphically, or optionally in tables.

Calculate the uniformity of water distribution according to ISO 7749/2.

12 Travelling speed uniformity

12.1 General

The test shall be carried out on level grassland (slope 1 % max.) (height of grass approx. 50 mm). The same track shall not be used more than once.

12.2 Test procedure

Mark reference points at intervals of 1 m on the pipe, hose or cable.

Operate the machine at such a speed that the pipe length full of water is coiled in 10 h or in 20 h, following the procedure specified in 11.2.

Measure the time for the passage of 1 m pipe or cable near the machine at the beginning and end of each layer on the reel, and, in addition, at least one measurement in between, using the stop-watch (10.4). For machines pulled by cables, the measurements shall be made at 25 m intervals, at the support level of irrigation machines.

Measure the leakage rate in hydrostatic drives, using the flow-meter (10.5), and the pressure in hydrodynamic drives, using the pressure gauges (10.3), for each observation period.

Measurements shall be taken at two different discharges, in cubic metres per hour, for hydrodynamically driven machines

and at two different pressures, in kilopascals, for hydrostatically driven machines.

Present the results in the form of graphs having the speed, in metres per hour, and pressure loss, in kilopascals, in the hydrodynamic drive mechanism, respectively, as ordinates, and the distance between the sprinkler and the machine, in metres, as abscissa. Tabular presentation is allowed.

13 Pressure losses

13.1 Test procedure

Mount four pressure gauges on straight pipe sections in the following positions:

— at the water inlet connection to the machine;

— at a point immediately upstream of the driving element;

— at a point immediately downstream of the driving element;

— at the sprinkler(s).

Mount a flowmeter in front of the first pressure gauge.

Measure the pressure loss through the machine and pipe for at least four different discharges equally spaced between minimum and maximum when in both fully coiled and fully uncoiled conditions.

The applied discharges (or pressures) shall correspond to the manufacturer's instructions.

If liquids other than water are tested, the test with water shall be carried out first.

14 Forces during uncoiling

14.1 General

The test conditions specified in 12.1 shall apply.

14.2 Test procedure

Measure the maximum force during laying or uncoiling of the pipe or hose, using the dynamometer (10.6). (Any additional forces necessary for proper operation of the equipment, e.g. braking, shall be included.)

Determine the minimum operation discharge for hydrodynamic drive, using the flowmeter (10.5), or minimum pressure for hydrostatic drive, using the pressure gauges (10.3), which is necessary to operate the machine at the condition of maximum resistance to uncoiling.

15 Operational reliability

Operate the machine according to manufacturer's instructions for at least 15 full work cycles and report the reliability of

— automatic stop of travelling and of discharge at the end of the track;

— automatic stop under abnormal conditions, i.e. incorrect coiling of pipe, hose, breakage of pipe or hose;

— drum brake equipment;

— creeping movement and stability of the stationary part of the machine during operation.

16 Test report

Examples of the test report and the data sheet for the laboratory test are given in annexes A and B respectively.