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Agricultural irrigation equipment — Water-driven chemical injector pumps

Matériel agricole d'irrigation — Pompes doseuses à moteur hydraulique pour l'injection de produits chimiques

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13457 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 18, *Irrigation and drainage equipment and systems*.

This second edition cancels and replaces the first edition (ISO 13457:2000), which has been technically revised.

Agricultural irrigation equipment — Water-driven chemical injector pumps

1 Scope

This International Standard specifies the construction, operational requirements and test methods for water-driven chemical injector pumps (hereinafter, water-driven injector pumps). These water-driven injector pumps are used to inject chemicals into irrigation systems. The chemicals include liquid fertilizers and solutions of fertilizers and other soluble agricultural chemicals such as acids and pesticides.

This International Standard is applicable to water-driven injector pumps intended to operate at water temperatures of up to 50 °C and with the types and concentrations of chemicals routinely applied in irrigation.

It does not cover the function of backflow prevention devices, nor is it applicable to water-driven devices for injecting chemicals into an irrigation system operating on the basis of the Venturi principle.

2 Normative references

The following referenced documents are indispensable for the application 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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 7005-1, *Metallic flanges — Part 1: Steel flanges* [1)]

ISO 7005-2, *Metallic flanges — Part 2: Cast iron flanges*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
water-driven chemical injector pump
hydraulic pump intended to inject chemicals into an irrigation system, operated exclusively by the energy of irrigation water driving a hydraulic device such as a piston or turbine

3.2
nominal size
conventional numerical designation used to define the size of an in-line water-driven injector pump

NOTE This size is equal to the size of the connection to the irrigation system, by means of threads, flanges or other connecting devices.

1) Under revision.

3.3
minimum working pressure
p_{min}
lowest pressure declared by the manufacturer at the inlet of a water-driven injector pump at which the water-driven injector pump functions properly

3.4
maximum working pressure
p_{max}
highest pressure declared by the manufacturer at the inlet of a water-driven injector pump at which the water-driven injector pump functions properly

3.5
range of working pressures
pressure range between the minimum working pressure and the maximum working pressure

3.6
drive water
irrigation water used to operate an on-line water-driven injector pump

3.7
drive water flow rate
rate of flow of drive water used to operate an on-line water-driven injector pump

3.8
drive water ratio
ratio of one unit volume of injected chemicals to the volume of drive water required to inject the same unit volume of chemical solution

3.9
drive water flow range
range of flow between minimum and maximum flows stated by the manufacturer to be appropriate for operating the pump

3.10
irrigation water flow rate
rate of flow of irrigation water through the irrigation pipeline serviced by the water-driven injector pump

3.11
injection rate, pumping rate
rate of flow of chemical solution injected into an irrigation system during operation of a water-driven injector pump

3.12
chemical
liquid fertilizers and solutions of fertilizers and other soluble agricultural chemicals such as acids and pesticides used in agriculture in liquid, solution or water soluble form, normally applied through, or otherwise injected into, irrigation systems

3.13
chemical solution
water in which one or several types of chemicals have been dissolved or diluted

3.14
irrigation system water flow rate
sum of the irrigation water flow rate and the injection rate

3.15
mixing ratio
ratio of the injection rate to the total irrigation system flow rate

3.16
stroke volume
pulse volume
volume of chemical solution injected into an irrigation system in one water-driven injector pump cycle

3.17
proportional water-driven chemical injector pump
water-driven injector pump intended to maintain a relatively constant mixing ratio throughout the period of its operation at the irrigation water flow rates declared by the manufacturer

3.18
in-line water-driven injector pump
water-driven injector pump installed in the main irrigation system piping or in bypass piping

See Figure 1.

3.19
on-line water-driven injector pump
water-driven injector pump installed off the main irrigation system piping and featuring four ports

See Figure 2.

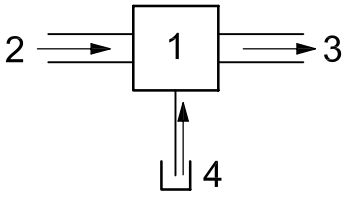
3.20
chemical storage tank
container for storing chemicals and supplying them to a water-driven injector pump

3.21
maximum suction head
maximal distance between the centreline of the outlet of the water-driven injector pump and the lowest level of the chemical in the storage tank

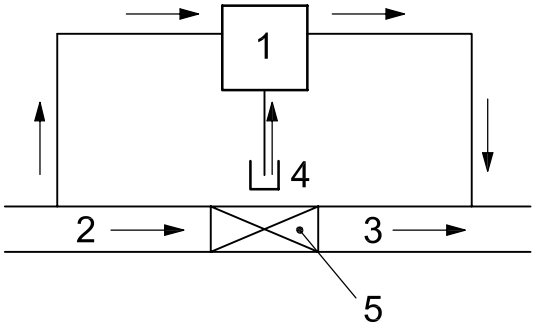
4 Classification

4.1 Classification according to installation type

4.1.1 In-line water-driven injector pump (Figure 1)



In-line full flow



In-line bypass

Key

1 injector pump
2 inlet for irrigation water
3 outlet for irrigation water with injected chemicals
4 inlet for chemicals
5 valve

NOTE 1 The arrows denote the flow direction.

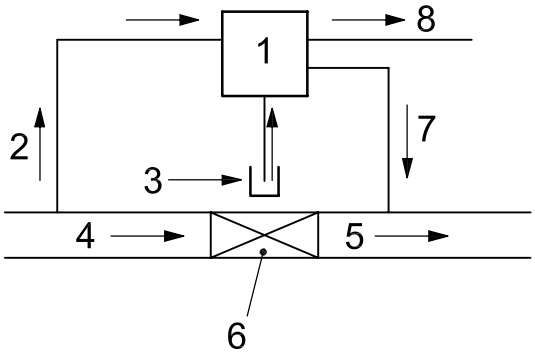
NOTE 2 The injection of a chemical occurs inside the water-driven injector pump.

Figure 1 — In-line water-driven injector pump

4.1.1.1 Full flow installation

4.1.1.2 Bypass flow installation

4.1.2 On-line water-driven injector pump (Figure 2)



Key

1 injector pump
2 inlet for drive water
3 inlet for chemicals
4 irrigation flow
5 irrigation water with injected chemicals
6 valve
7 outlet for chemicals
8 outlet for drive water

NOTE 1 The arrows denote the flow direction.

NOTE 2 The injection of a chemical into the irrigation water occurs outside the water-driven injector pump. The outlet for the chemical is intended to be connected to the main irrigation system piping. The drive water from the drive water outlet cannot be returned to the main irrigation system piping.

NOTE 3 The drive water can be ejected from the water-driven injector pump as shown or returned to the irrigation system (see Figure 1).

Figure 2 — On-line water-driven injector pump

4.2 Classification according to mixing ratio

4.2.1 Proportional water-driven injector pump

4.2.1.1 Fixed mixing ratio

4.2.1.2 Adjustable mixing ratio

4.2.2 Non-proportional water-driven injector pump

EXAMPLE An injection rate of 1 l/h into an irrigation water flow rate of 199 l/h gives an irrigation system water flow rate of 200 l/h, and a mixing ratio of 1:200.

5 Marking

The water-driven injector pump shall bear a clear, legible and durable marking giving the following information:

a) name of manufacturer or manufacturer's trade mark;

b) nominal size;

c) maximum working pressure (p_{max});

d) model number identical with that given in the manufacturer's catalogue;

e) year of production or a mark identifying the production series;

f) arrows indicating the direction of flow of water and chemicals into and out of the water-driven injector pump.

6 Technical characteristics

6.1 General

The water-driven injector pump shall employ means, such as a vacuum breaker valve, to prevent emptying of the chemical storage tank to the irrigation system through the water-driven injector pump in the event that the pressure in the water-driven injector pump falls below the pressure in the chemical storage tank.

The water-driven injector pump shall employ means, such as a check valve, to prevent irrigation water passing through the water-driven injector pump from entering the chemical storage tank.

It shall be possible to disassemble and clean those parts of the water-driven injector pump subject to clogging by the chemicals or by debris in the irrigation water. These parts may be fitted with a suitable filtration device accessible for the purpose of cleaning.

For on-line water-driven injector pumps (4.1.2), in which there is water loss due to the ejection of drive water out of the pump, the outlet through which the drive water is ejected shall be fitted with suitable means, e.g. a thread or a connector, to enable connection of a pipe for draining the outflow of drive water away from the pump.

NOTE For backflow prevention, refer to the specific requirements of each country.

6.2 Materials

Plastic parts of a water-driven injector pump that are exposed to ultra-violet (UV) radiation under normal field operating conditions shall include additives to improve their resistance to UV radiation.

Plastic parts that enclose waterways shall be opaque or shall be provided with an opaque cover designed to block all light from reaching clear waterway enclosures.

Plastic pipes conveying chemicals may be transparent and may be exposed to light.

All parts of a water-driven injector pump shall be resistant to, or protected from, those chemicals in concentrations approved or recommended for injection into irrigation systems, except as indicated in the manufacturer's literature.

6.3 Connection of a water-driven injector pump to an irrigation system

A water-driven injector pump shall be connected to an irrigation system by one of the following means:

a) threads in accordance with ISO 7-1, except that other threads shall be allowed, provided that a suitable adapter is supplied with each threaded connection;

b) cast-iron flanges in accordance with ISO 7005-2 or steel flanges in accordance with ISO 7005-1, with flanges made of other materials required to comply with the assembly dimensions (diameter of the distributing circle, number of holes) specified in ISO 7005-2;

c) compression, grooved-end or other special fittings.

7 Mechanical and function tests

7.1 General

Unless otherwise specified, perform all tests using water instead of a chemical solution as the injection liquid. Ensure that both irrigation and injection water are at a temperature between 15 °C and 35 °C and that they are filtered with a 120 µm filter element or a filter with equivalent filtration capacity or test with water containing less than a mass fraction of 0,002 % (20 ppm) [2)] of contaminant particles of 120 µm or bigger, or corresponding to the maximum limit specified by the manufacturer in product literature.

Ensure that measuring instruments used during the tests are accurate to within $\pm$ 2 % of the actual value.

Ensure that the chemical storage tank used for the test is equipped for measurement of volumetric changes in its contents, or is fitted with a sight tube (manometer), or is translucent so that water levels can be monitored. Markings on the side are helpful.

7.2 Test of resistance to pressure

With the water-driven injector pump not operating, apply a pressure equal to 1,6 times the maximum working pressure (p_{max}) to all parts of the water-driven injector pump that would come under pressure during normal operation. Hold this pressure for 5 min.

The water-driven injector pump and all its parts shall withstand this test pressure without sustaining any damage and without the appearance of any permanent deformation.

7.3 Test of watertightness of check valves

7.3.1 Seal the water inlet of the water-driven injector pump and leave the chemical inlet orifice of the water-driven injector pump open to the atmosphere. Apply a series of pressures to the outlet of the water-driven injector pump equal to 25 %, 50 %, 75 % and 100 % of p_{max}. Apply each pressure for 20 s.

There shall be no backflow leakage through the chemical pathway of the water-driven injector pump.

2) Parts per million (ppm) is a unit deprecated by the SI system.

7.3.2 For water-driven injector pumps with an integral check valve intended to prevent the flow of water in the opposite direction to the intended direction of flow, repeat the test according to 7.3.1 with the inlet of the water-driven injector pump open to the atmosphere.

There shall be no backflow leakage through the water inlet of the water-driven injector pump.

7.4 Test of range of working pressure

7.4.1 Install the water-driven injector pump in the test bench according to the manufacturer's instructions so that the top level of the water in the chemical storage tank is 0,5 m lower than the centreline of the outlet of the water-driven injector pump.

Apply a pressure equal to the minimum working pressure (p_{min}) at the inlet of the water-driven injector pump for 1 min. Ensure that the water flow rate is at the mid-range of irrigation water flow rates declared by the manufacturer and, for an on-line water-driven injector pump, ensure that the drive water flow rate is at the mid-range of the drive water flow rates declared by the manufacturer.

The water-driven injector pump shall inject chemicals as required for normal operation.

7.4.2 Repeat the test according to 7.4.1: once with the pressure at the inlet of an in-line water-driven injector pump or at the outlet of an on-line water-driven injector pump equal to p_{max}, and once with the pressure at the inlet of an in-line water-driven injector pump or at the outlet of an on-line water-driven injector pump equal to the mid-point of the working pressure range.

The water-driven injector pump shall inject chemicals as required for normal operation in the field.

7.5 Test of resistance to draining

7.5.1 Install the water-driven injector pump in the test bench according to the manufacturer's instructions so that the upper level of the water in the chemical storage tank is 0,5 m lower than the centreline of the outlet of the water-driven injector pump.

Ensure that the chemical storage tank is situated so the water surface level can be observed and/or measured throughout the test.

Operate the water-driven injector pump for 2 min with the pressure at the inlet of the water-driven injector pump equal to the mid-point of the working pressure range.

Ensure that the water flow rate is equal to the flow rate at the mid-range of irrigation water flow rates declared by the manufacturer and, for an on-line water-driven injector pump, ensure that the drive water flow rate is at mid-range of the drive water flow rates declared by the manufacturer.

Discontinue the operation of the water-driven injector pump. Immediately afterwards, apply a vacuum equal to 10 kPa lower than the atmospheric pressure at the outlet of the water-driven injector pump.

Apply this vacuum for 1 min and, during this period, observe the level of the water in the chemical storage tank.

The level of the water in the chemical storage tank shall not vary during the time interval from the shut-off of the water-driven injector pump until the conclusion of the test.

7.5.2 For water-driven injector pumps intended to operate with the level of the chemical solution in the chemical storage tank higher than the centreline of the outlet of the water-driven injector pump, repeat the test according to 7.5.1 with the water-driven injector pump installed according to the manufacturer's instructions and the level of the water in the chemical storage tank at the maximum level above the centreline of the water-driven injector pump as declared by the manufacturer.

The level of the water in the chemical storage tank shall not vary during the time interval from the shut-off of the water-driven injector pump until the conclusion of the test.

7.6 Test of injection rate as a function of inlet pressure

Install the water-driven injector pump according to 7.4.1. For a proportional water-driven injector pump with adjustable mixing ratio (4.2.1.2), adjust the mixing ratio to the mid-point of the adjustable range declared by the manufacturer.

Set the drive water flow rate to the mid-range of flow rates declared by the manufacturer and maintain this flow rate throughout the test.

Apply five different pressures at the inlet of the water-driven injector pump at approximately equal intervals to cover the range of working pressures, including p_{min} and p_{max}.

At each test point, operate the water-driven injector pump for 2 min and measure the injection rate of the water-driven injector pump volumetrically.

The injection rate at any inlet pressure shall not deviate from that declared by the manufacturer by more than ± 10 %.

7.7 Drive water ratio test

For a water-driven injector pump in which the drive water is ejected (4.1.2), measure the volume of drive water during performance of the test according to 7.6.

Calculate the drive water ratio.

The drive water ratio shall comply with the ratio declared by the manufacturer within an allowable deviation of ± 10%.

7.8 Test of injection rate for proportional water-driven injector pump

7.8.1 Install the proportional water-driven injector pump in accordance with 7.4.1 and as shown in Figure 1.

7.8.2 For a proportional water-driven injector pump with fixed mixing ratio (4.2.1.1), perform the test according to 7.8.4 at the fixed mixing ratio for the proportional water-driven injector pump. Present the injection rate in tabular or graphical format as a function of the drive water flow rate.

In no case shall the measured mixing ratio deviate from the fixed mixing ratio declared by the manufacturer by more than ± 10%.

7.8.3 For a proportional water-driven injector pump with adjustable mixing ratio (4.2.1.2), perform the test according to 7.8.4 for

a) the minimum mixing ratio declared by the manufacturer,

b) the maximum mixing ratio declared by the manufacturer, and

c) the mid-point of these mixing ratios.

7.8.4 Operate the in-line water-driven injector pump at the upper and the lower limits of the range of irrigation water flow rates, as specified by the manufacturer, and at four or more other irrigation water flow rates within this range. Select a test pressure near the mid-point of the range of working pressure. For each irrigation water flow rate measure the injection rate and calculate the actual mixing ratio achieved by the water-driven injector pump.

Operate the on-line water-driven injector pump at the upper and lower limits of the range of drive water flow rates, as specified by the manufacturer, and at four or more other drive water flow rates within this range, ensuring that the irrigation water flow rate is at the mid-point of the range of the irrigation water flow rate declared by the manufacturer. Select a test pressure near the mid-point of the range of working pressure. For

each irrigation water flow rate, measure the injection rate and calculate the actual mixing ratio achieved by the water-driven injector pump.

7.9 Test of head loss for in-line water-driven injector pump

With the water-driven injector pump installed in the test bench according to 7.4.1, measure the head loss through the water-driven injector pump at the mid-range of working pressure. Measure the head loss for five different irrigation water flow rates equally spaced within the range of irrigation water flow rates declared by the manufacturer.

The head loss for any irrigation flow rate shall not exceed the head loss declared by the manufacturer by more than 10 %.

8 Durability

8.1 Connect the water-driven injector pump to the test bench according to the manufacturer's instructions so that the water surface in the chemical storage tank is about 0,5 m lower than the centre line of the outlet of water-driven injector pump. Perform all tests using water instead of a chemical solution as the injection fluid.

Ensure that both irrigation and injection water are at a temperature between 5 °C and 50 °C and that they are filtered with a 120 µm filter element, or a filter with an equivalent capacity or a capacity equal to the maximum limit specified by the manufacturer in product literature.

Ensure that the water flow rate is at the mid-range of irrigation water flow rates declared by the manufacturer and, for an on-line water-driven injector pump, ensure that the drive water flow rate is mid-range of the drive water flow rates declared by the manufacturer.

Operate the water-driven injector pump for four periods of 250 h each, followed by intervals of approximately 50 h of non-operation. The total operation time and non-operation time for all four periods shall be 1 150 h. Perform the test after the last operation period.

Ensure that the following operating conditions are satisfied.

— The operating pressure shall be at the mid-range of working pressure declared by the manufacturer.

— Drive water flow rate:

  1) for in-line water-driven injector pumps, the irrigation water flow rate at the mid-range of irrigation water flow rates shall be that declared by the manufacturer;

  2) for on-line water-driven injector pumps, the drive water flow rate shall be at the mid-range of drive water flow rates declared by the manufacturer.

— For water-driven injector pumps with an adjustable injection rate, the injection rate shall be at the mid-range of injection rates declared by the manufacturer.

8.2 After operating the water-driven injector pump for 1 150 h in total according to 8.1, repeat the following tests:

— resistance to pressure (see 7.2);

— watertightness of check valves (see 7.3);

— range of working pressure (see 7.4) with the inlet pressure at the mid-range of working pressures;

— injection rate as a function of pressure at the inlet of a water-driven injector pump (see 7.6); the injection rate shall not deviate from the injection rate declared by the manufacturer by more than ± 15 %;

— drive water ratio (see 7.7); the drive water ratio shall not deviate from the drive water ratio declared by the manufacturer by more than ± 20 %;

— injection rate for proportional water-driven injector pump (see 7.8).

Perform the tests with the mixing ratio set at the mid-range of mixing ratios declared by the manufacturer and with the drive water flow rate set at mid-range of the drive water flow rates declared by the manufacturer. The mixing ratio shall not vary from that declared by the manufacturer by more than ± 15 %.

9 Information to be supplied by the manufacturer

The manufacturer shall provide the following information for the water-driven injector pump in the catalogue or information sheets. The date of publication shall be noted on all published information.

a) General information

1) catalogue number;

2) type and size of connections to the irrigation system;

3) general dimensions and weight;

4) operating principle;

5) list of spare parts and a drawing showing a cross-section or exploded view and the parts that can be replaced;

6) type and size of flow regulator, if an integral part;

7) head loss;

8) for on-line water-driven injector pumps, the volume of drive water discharged.

b) Operating instructions

1) installation instructions;

2) calibration instructions;

3) maintenance and storage instructions;

4) performance table showing the injection rates resulting from operation of the range of operating parameters;

5) precision of the injection rate as a function of pressure at the inlet of the water-driven injector pump;

6) instructions for filtration of the chemicals and of the irrigation water;

7) stroke volume of piston-type water-driven injector pumps with adjustable mixing ratio (4.2.1.2);

8) drive water ratio;

9) drive water flow range;

10) maximum suction head;

11) range of mixing ratios and method of setting mixing ratio (manual, hydraulic or electronic);

12) data on digital and analogue output, flow volume and timing and relevant graphical description and tables for operating data;

13) influence on pump operation of head loss in drive water ejection pipe, if applicable;

14) range of working pressure (minimum and maximum working pressure);

15) range of irrigation water flow rates;

16) injection rate;

17) reference to backflow prevention.

Bibliography

[1] ISO 7714, *Agricultural irrigation equipment — Volumetric valves — General requirements and test methods* [3)]

3) To be published (revision of ISO 7714:2000).

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