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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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Printed in Switzerland

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard 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*.

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# Agricultural irrigation equipment — Water-driven chemical injector pumps

## 1 Scope

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

This International Standard is applicable to water-driven injector pumps which are intended to operate at water temperatures of up to 50 °C and with the types and concentrations of chemicals routinely applied in irrigation. It is not applicable to backflow prevention devices (which are not an integral part of a water-driven injector pump), nor to Venturi-principle water-driven devices for injecting chemicals into an irrigation system.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*.

ISO 2859-1:1999, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*.

ISO 7005-1:1992, *Metallic flanges — Part 1: Steel flanges*.

ISO 7005-2:1988, *Metallic flanges — Part 2: Cast iron flanges*.

ISO 7714:—<sup>1)</sup>, *Agricultural irrigation equipment — Volumetric valves — General requirements and test methods*.

## 3 Terms and definitions

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

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1) To be published. (Revision of ISO 7714:1995)

3.1

**water-driven injector pump**

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 nominal size of the device for connecting the water-driven injector pump to the irrigation system, by means of threads, flanges or other connecting devices

NOTE This designation is used to define the size of an in-line water-driven injector pump

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 pressure**

pressure range between the minimum working pressure  $p_{min}$  and the maximum working pressure  $p_{max}$

3.6

**drive water**

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

NOTE The drive water may be ejected from the water-driven injector pump or may be returned to the irrigation system.

3.7

**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

EXAMPLE 1:2 or 1:3

3.8

**irrigation water flow rate**

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

3.9

**injection rate**

**pumping rate**

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

3.10

**chemical**

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

**3.11****chemical solution**

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

**3.12****irrigation system water flow rate**

sum of the irrigation water flow rate and the injection rate

**3.13****mixing ratio**

ratio of the injection rate to the irrigation system water flow rate

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.

**3.14****pulse volume****stroke volume**

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

EXAMPLE One stroke in a piston or membrane activated water-driven injector pump.

**3.15****proportional water-driven injector pump**

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

**3.16****in-line water-driven injector pump**

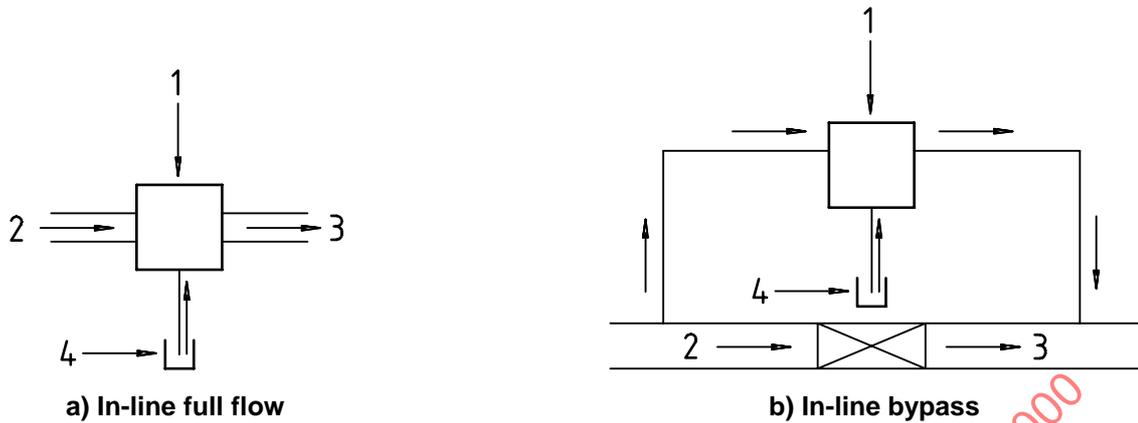
in-line water-driven chemical injector pump

water-driven injector pump installed in the main irrigation system piping or in bypass piping and featuring three ports including:

- one inlet for chemicals,
- one inlet for irrigation water,
- one outlet for irrigation water with chemicals injected

See Figure 1.

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



**Key**

- 1 Injector pump
- 2 Irrigation flow
- 3 Irrigation water with injected chemicals
- 4 Chemicals

**Figure 1 — In-line water-driven injector pump**

**3.17**

**on-line water-driven injector pump**

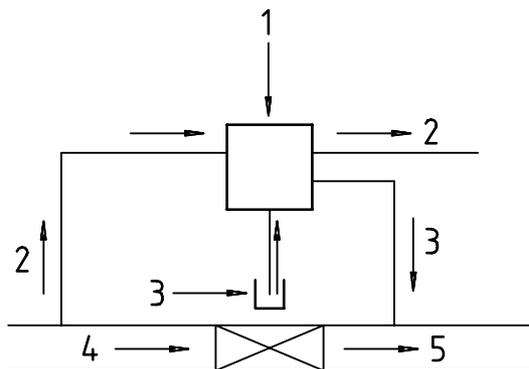
on-line water-driven chemical injector pump

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

- one inlet for chemicals,
- one outlet for chemicals,
- one inlet for drive water,
- one outlet for drive water

See Figure 2.

**NOTE** 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.



#### Key

- 1 Injector pump
- 2 Drive water
- 3 Chemicals
- 4 Irrigation flow
- 5 Irrigation water with injected chemicals

Figure 2 — On-line water-driven injector pump

### 3.18

#### chemical storage tank

container for storing chemicals and supplying them to a water-driven injector pump

## 4 Classification

### 4.1 Classification according to installation type

#### 4.1.1 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

### 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

## 5 Marking

The water-driven injector pump shall bear a clear, legible and durable marking which shall give the following particulars:

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

- b) nominal size;
- c) maximum and minimum working pressures;
- d) maximum and minimum irrigation water flow rates;
- e) injection rate;
- f) maximum injection rate;
- g) model number identical with that given in the manufacturer's catalogue;
- h) year of production or a mark which identifies the production series;
- i) 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 that passes 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 the debris in the irrigation water. These parts may be fitted with a suitable filtration device accessible for the purpose of cleaning.

For type 4.1.2 water-driven injector pumps in which drive water is ejected from the water-driven injector pump, the outlet for ejecting the drive water shall be fitted with suitable means, such as a thread or connector, to enable connection of a pipe for disposal of the drive water away from the vicinity of the water source.

### 6.2 Materials

Plastic parts of a water-driven injector pump that are exposed to ultra-violet (UV) radiation under normal field conditions in which the water-driven injector pump operates 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 or accessible 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) flanges in accordance with ISO 7005-2 if the flanges are made of cast-iron, or with ISO 7005-1 if the flanges are made of steel; flanges made of other materials shall 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 in place of a chemical solution as the injection liquid. 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 mesh filter body or a filter with equivalent filtration capacity, 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 true 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 Sampling and acceptance requirements

#### 7.2.1 Sampling test

Select test specimens for each test at random from a sample of at least 50 units supplied by a representative of the testing laboratory. The number of specimens selected for each test shall be as listed in Table 1.

#### 7.2.2 Acceptance test

When acceptance of manufacturing lots or shipments is required, ensure that the sampling is done according to ISO 2859-1, based on AQL 2.5 and special inspection level S-4.

Ensure that the test specimens are selected at random according to Table 2-A of ISO 2859-1:1999, and that they are tested according to 7.3.

The manufacturing lot or shipment shall be considered to be in accordance with this International Standard if the number of defective test specimens found in the test does not exceed the acceptance number specified in ISO 2859-1.

For tests other than the test set out in 7.3, select test specimens at random in accordance with the number specified in Table 1. Test the test specimens in accordance with 7.3 through 7.10 and clause 8.

Table 1

Clause or subclause	Subject of test	Number of test specimens	Acceptance number
7.3	Resistance to the pressure	5	0
7.4	Watertightness of check valves	5	0
7.5	Range of working pressure	5	0
7.6	Resistance to draining	5	0
7.7	Injection rate	5	0
7.8	Drive water ratio	5	0
7.9	Injection rate for proportional water-driven injector pump	5	0
7.10	Head loss for in line water-driven injector pumps	2	0
8	Durability	2	0
<p>If the number of defective test specimens in the sample is equal to the acceptance number given in this table, the sample shall be considered to be in accordance with the requirements of this International Standard.</p> <p>If the number of defective test specimens in the sample is greater than the acceptance number given in this table, the sample shall be considered to be not in accordance with the requirements of this International Standard.</p>			

The manufacturing lot or shipment shall be considered to be in accordance with this International Standard if the number of defective test specimens found in the other tests does not exceed the acceptance number specified in Table 1.

Notwithstanding the above, tests carried out according to clause 8 are not required for acceptance if the same water-driven injector pump model has previously passed the sampling test (7.2.1), provided the manufacturer has not introduced changes in the structure of the water-driven injector pump since the performance of the sampling test.

**7.3 Test of resistance to pressure**

With the water-driven injector pump not operating, apply a pressure equal to 1,6 times the maximum pressure ( $1,6 p_{max}$ ) 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, without leakage, and without the appearance of any permanent deformation.

**7.4 Test of watertightness of check valves**

**7.4.1** 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 pressure to the outlet of the water-driven injector pump equal to 25 %, 50 %, 75 % and 100 % of the maximum working pressure  $p_{max}$ . Apply the pressure at each stage for approximately 20 s.

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

**7.4.2** 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 described in 7.4.1 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.

## 7.5 Test of range of working pressure

**7.5.1** Install the water-driven injector pump in the test apparatus 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 one minute. Ensure that the water flow rate is approximately equal to the flow rate at the mid-point of the 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 approximately equal to the mid-point of the drive water flow declared by the manufacturer.

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

**7.5.2** Repeat the test described in 7.5.1, 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 the maximum working pressure  $P_{\max}$  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 approximately equal to the mid-point of the range of working pressure.

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

## 7.6 Test of resistance to draining

**7.6.1** Install the water-driven injector pump in the test apparatus 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.

For the purposes of this test, ensure that the chemical storage tank is situated so that one can observe and/or measure the upper level of the water throughout the test.

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

Ensure that the water flow rate is approximately equal to the flow rate at the mid-point of the 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 approximately equal to the mid-point of the drive water flow declared by the manufacturer.

Discontinue the operation of the water-driven injector pump. Immediately afterwards, apply a pressure (suction) equal to 5 kPa to 10 kPa lower than the atmospheric pressure at the outlet of the water-driven injector pump.

Apply this pressure (suction) for one minute 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.

**7.6.2** 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 this test 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.

## 7.7 Test of injection rate

Install the water-driven injector pump as described in 7.5.1. For a class 4.2.1.2 proportional water-driven injector pump with an adjustable mixing ratio, adjust the mixing ratio approximately to the mid-point of the adjustable range declared by the manufacturer.

Set the drive water flow rate to one approximately equal to the flow rate at the mid-point of the 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 pressure, including the minimum working pressure  $p_{\min}$  and the maximum working pressure  $p_{\max}$ .

At each pressure stage, operate the water-driven injector pump for at least two minutes 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  $\pm 10\%$ .

## 7.8 Drive water ratio test

For a class 4.1.2 water-driven injector pump in which the drive water is ejected, measure the volume of drive water during performance of the test described in 7.7.

Calculate the drive water ratio.

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

## 7.9 Test of injection rate for proportional water-driven injector pump

**7.9.1** Install the proportional water-driven injector pump as described in 7.5.1 and illustrated in Figure 1.

**7.9.2** For a class 4.2.1.1 proportional water-driven injector pump perform the test of 7.9.4 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  $\pm 10\%$ .

**7.9.3** For a class 4.2.1.2 proportional water-driven injector pump perform the test of 7.9.4 for three different mixing ratios:

- a) the minimum mixing ratio declared by the manufacturer,
- b) the maximum mixing ratio declared by the manufacturer, and
- c) some convenient mixing ratio between a) and b).

**7.9.4** 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 at some convenient 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 the 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 and