INTERNATIONAL STANDARD

ISO 11678

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Agricultural irrigation equipment — Aluminium irrigation tubes

Matériel agricole d'irrigation — Tubes d'irrigation en aluminium

Reference number
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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.

International Standard ISO 11678 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 — Aluminium irrigation tubes

1 Scope

This International Standard specifies minimum required properties and test methods for aluminium tubes intended for use in agricultural irrigation systems for the transport of water, at temperatures not exceeding 50 °C, for irrigation purposes.

It applies to hand-moved and towed tubes, and to tubes intended for stationary or temporary installation.

It does not apply to tubes with integrated couplings, which will be the subject of a future International Standard.

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 209-1:1989, *Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition.*

ISO 2859-1:1989, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.*

3 Definitions

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

3.1 alclad tube; cladded tube: Tube having on both inside and outside surfaces a metallurgically bonded aluminium or aluminium alloy coating which is anodic to the core material and which, therefore, protects the core from corrosion.

3.2 average outside diameter of aluminium tube: Arithmetic mean of two mutually perpendicular outside diameters, measured at one cross-section.

3.3 average wall thickness of tube: Arithmetic mean of eight measurements of wall thickness, equally spaced around the circumference of one cross-section, but not on the weld line in the case of welded tubes.

3.4 denting factor: Parameter calculated as the product of the minimum tensile yield strength, in megapascals, and the square of the wall thickness of the tube, in millimetres, divided by the nominal diameter, in millimetres, in evaluating the ability of an aluminium tube to withstand external mechanical loading without permanent local deformation.

3.5 nominal diameter of tube, D_{nom}: Conventional numerical designation approximately equal to the outside diameter of an aluminium tube.

3.6 nominal pressure, PN: Maximum working pressure at which a piping component is stated to operate under normal service conditions.

4 Classification

The tubes are classified as follows.

4.1 According to nominal pressure

4.1.1 Tubes of a nominal pressure of up to 400 kPa (4 bar).

4.1.2 Tubes of a nominal pressure of up to 1 000 kPa (10 bar).

4.1.3 Tubes of a nominal pressure of up to 1 600 kPa (16 bar).

4.2 According to method of manufacture

4.2.1 Welded tubes, designated by letter code "W".

4.2.2 Extruded tubes, designated by letter code "E".

4.3 According to the type (see table 6)

4.3.1 Type A tubes.

4.3.2 Type B tubes.

5 Marking

All tubes shall bear a readily visible, clear and durable impressed marking, including the following details:

a) manufacturer's name and/or trademark;

b) year of manufacture;

c) nominal pressure, as specified in 4.1;

d) a marking to identify chemical composition, as specified in the manufacturer's catalogue;

e) marking to indicate method of manufacture;

f) marking to indicate whether the tube is type A or type B.

The marking shall be impressed near the end of the tubes at a distance of at least 0,2 m from the end and not more than 0,5 m from the end. The depth of the impression shall be at least 0,05 mm and shall not exceed 0,15 mm.

6 Technical characteristics

6.1 General

The walls of the tube at its ends shall be parallel to its axis, and the ends of the tube shall be perpendicular to its axis. For tubes reinforced with a sleeve, the tube lip shall overlap the sleeve lip. Insertion of the reinforced sleeve shall not increase the outside diameter of the tube. For a distance of 200 mm from the ends of the tube, weld seams (if these exist) shall not protrude from the inner and outer surfaces of the tube by more than 0,3 mm.

6.2 Material

6.2.1 Welded tubes

Welded tubes shall be of aluminium alloy, the chemical composition of which is specified in table 1, or of any other material which has been verified as suitable for the purpose.

6.2.2 Extruded tubes

Extruded tubes shall be of aluminium alloy, the chemical composition of which is specified in table 2, or of any other material which has been verified as suitable for this purpose.

6.3 Dimensions

6.3.1 Tube diameter

The outside diameter of the tube and its allowable deviations shall be as specified in table 3. To determine the average outside diameter of an aluminium tube, two measurements shall be made of two mutually perpendicular outside diameters measured at one cross-section.

6.3.2 Tube length

The length of the tube shall not be shorter than the manufacturer's declared length by more than 20 mm, measured with an instrument having an accuracy of 5 mm.

Table 1 — Required chemical composition of alloys for welded tubes

Alloy		Wall section	Chemical composition[1] %							
ISO Designation[2]	International registration record[3]		Cr	Ti	Zn	Mg	Mn	Si	Fe	Cu
Al Mn1Cu	3003		—	—	0,10 max.	—	1,0 to 1,5	0,6 max.	0,7 max.	0,05 to 0,20
Al Mn1Mg1	3004	Core	—	—	0,25 max.	0,8 to 1,3	1,0 to 1,5	0,30 max.	0,7 max.	0,25 max.
		Cladding[4]	—	—	0,8 to 1,3	0,1 max.	0,1 max.	—	0,7 max.	0,1 max.
Al Mg1,5(C)	5050		0,10 max.	—	0,25 max.	1,1 to 1,8	0,10 max.	0,40 max.	0,7 max.	0,20 max.
Al Mg2,5	5052	Core	0,15 to 0,35	—	0,10 max.	2,2 to 2,8	0,10 max.	0,25 max.	0,40 max.	0,10 max.
		Cladding[4]	—	—	0,8 to 1,3	0,1 max.	0,1 max.	0,7 max.	—	0,1 max.
Al Mg1SiCu	6061		0,04 to 0,35	0,15 max.	0,25 max.	0,8 to 1,2	0,15 max.	0,40 to 0,8	0,7 max.	0,15 to 0,40

1) The percentage of any other alloy component shall not exceed 0,05 % and the total of all other alloy components shall not exceed 0,15 %. Aluminium shall make up the remainder of the alloy.

2) Conforming to ISO 209-1.

3) The four-digit designation listed is taken from the *Registration Record of International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys*, published by the Aluminum Association, Washington, DC, USA.

4) The thickness of the cladding shall be at least 10 % of the total wall thickness of the tube.

Table 2 — Required chemical composition of alloys for extruded tubes

Alloy		Chemical composition[1] %							
ISO Designation	International registration record	Cr	Ti	Zn	Mg	Mn	Si	Fe	Cu
Al Mg1SiCu	6061	0,04 to 0,35	0,15 max.	0,25 max.	0,8 to 1,2	0,15 max.	0,40 to 0,8	0,7 max.	0,15 to 0,40
Al Mg0,7Si	6063	0,10 max.	0,10 max.	0,10 max.	0,45 to 0,9	0,10 max.	0,20 to 0,6	0,35 max.	0,10 max.

1) The percentage of any other alloy component shall not exceed 0,05 % and the total of all other alloy components shall not exceed 0,15 %. Aluminium shall make up the remainder of the alloy.

6.3.3 Wall thickness of tube

The wall thickness shall be measured at eight points, equally spaced around the circumference of one cross-section, but not on the weld in the case of welded tubes.

At any point, the wall thickness shall not exceed the value declared by the manufacturer by more than the values specified in table 4.

In addition, for extruded tubes, the average wall thickness shall not exceed the value declared by the manufacturer by more than the values specified in table 4.

Table 3 — Outside diameter and allowable tolerance for aluminium irrigation tubes

Nominal diameter D_{nom}		Outside diameter	Allowable deviation of outside diameter from:			
			average diameter mm		any diameter mm	
mm	(inches)	mm	Type A	Type B	Type A	Type B
25	(1)	25,4	—	± 0,2	—	± 0,45
32	(1,25)	31,75	± 0,2	—	± 0,2	—
40	(1,5)	38,1		± 0,3	± 0,4	± 0,65
50	(2)	50,8	± 0,25	± 0,4	± 0,5	± 0,8
75	(3)	76,2				
100	(4)	101,6	± 0,3	± 0,65	± 0,6	± 1,3
125	(5)	127	± 0,4	± 0,8	± 0,8	± 1,65
150	(6)	152,4		± 0,9		± 1,95
200	(8)	203,2		± 1,3		—
250	(10)	254	—	± 2	—	—

Table 4 — Wall thickness for aluminium irrigation tubes

Nominal diameter D_{nom}		Tolerance in wall thickness mm					
		Welded tubes		Extruded tubes			
		At any point		Average		At any point	
mm	(inches)	Type A	Type B	Type A	Type B	Type A	Type B
⩽ 75	(⩽ 3)	$^{+0,1}_{0}$	$^{+0,16}_{0}$	$^{+0,4}_{0}$	± 0,2	$^{+0,6}_{0}$	± 0,3
100	(4)						
125	(5)			$^{+0,5}_{0}$	± 0,25	$^{+0,7}_{0}$	± 0,35
150	(6)						
200	(8)			$^{+0,6}_{0}$	± 0,31	$^{+0,8}_{0}$	± 0,41
250	(10)			$^{+0,8}_{0}$	± 0,4	$^{+1}_{0}$	± 0,5

6.3.4 Denting factor

The denting factor DF, in newtons per millimetre, of a tube is calculated from the equation:

$$DF = \frac{R_p t^2}{D_{nom}}$$

where

R_p is the required tensile yield strength of the tube material, in megapascals (see table 5);

t is the specified wall thickness, in millimetres;

D_{nom} is the nominal diameter, in millimetres.

To prevent excessive denting in handling or field use, the tube shall have a denting factor equal to, or greater than, the minimum denting factor specified in table 6 for the tube size under consideration.

Table 6 — Minimum denting factors for aluminium irrigation tubes

Nominal diameter D_{nom}		Minimum denting factor N/mm	
mm	(inches)	Type A tubes	Type B tubes
⩽ 40	(⩽ 1,5)	1,6	6
50	(2)		4,5
75	(3)		3
100	(4)		2,2
125	(5)		2
150	(6)		
200	(8)		1,9
250	(10)	—	1,5

Table 5 — Required yield strength for different alloys

Alloy		Yield strength, R_p
ISO designation	International registration record	MPa
Al Mn1Cu	3003	147
Al Mn1Mg1	3004	168
Al Mg1,5(C)	5050	140
Al Mg2,5	5052	182
	Alclad 5052	172
Al Mg1SiCu	6061	112
Al Mg0,7Si	6063	176

7 Mechanical tests

7.1 Sampling and acceptance requirements

7.1.1 Type tests

The sample of test specimens shall be taken at random by a representative of the test laboratory from a lot of 20 to 50 tubes of the same nominal diameter. The number of test specimens required for each test shall be as specified in table 7.

If the number of defective test specimens is equal to or less than the acceptance number in table 7, the lot shall be accepted. If the number is greater than the acceptance number in table 7, the lot shall be rejected.

7.1.2 Acceptance tests

When acceptance of manufacturing lots or of shipments of aluminium tubes is required, the sampling shall be conducted according to ISO 2859-1:1989, based on AQL 2,5 and Inspection Level S-4.

All test specimens in the sample selected at random according to table II-A of ISO 2859-1:1989 shall be tested for tightness according to 7.2. The shipment or manufacturing lot complies with this International Standard and is acceptable if the number of defective specimens found in the test does not exceed the acceptance number specified in ISO 2859-1:1989.

For the other tests, that is, for burst pressure and straightness tests, the number of test specimens shall be selected at random from the sample according to table 7. The shipment or manufacturing lot complies with this International Standard and is acceptable if the number of defective specimens found in these tests does not exceed the acceptance number specified in table 7.

Table 7 — Required number of test specimens and acceptance number

Sub-clause	Name of test	Number of test specimens	Acceptance number
6.3	Dimensions	5	1
7.2	Tightness		0
7.3	Burst pressure		0
7.4	Straightness of tube		1

7.2 Tightness

Test a complete tube. Close the ends of the tube by means of suitable seals. Connect the tube through one of the seals to a source of hydraulic pressure. Fill the tube with water and check to ensure that no air remains trapped in the tube.

Increase the pressure gradually to a pressure equal to 1,6 times the nominal pressure of the tube declared by the manufacturer (see 4.1). Maintain this pressure for 2 min.

No sign of leakage, sweating, water emission or damage shall be noted.

7.3 Burst pressure

Calculate the theoretical burst pressure, p_t, in megapascals, for the tube from the following formulae:

— for type A tubes

$$p_t = 1{,}6PN + 0{,}2$$

— for type B tubes

$$p_t = 3PN$$

where PN is the nominal pressure of the tube, in megapascals.

Take a length of aluminium tube such that, after closing off the ends with suitable seals, the test section has a free length of 0,6 m. Connect the tube through one of the seals to a source of hydraulic pressure. Fill the tube with water and check to ensure that no air remains trapped in the tube. Increase the pressure in four equal steps up to the theoretical burst pressure.

The tube shall not burst before the theoretical burst pressure is reached.

7.4 Straightness of tube

Place the tube on a straight plane and check its straightness by rotating the tube 360°: this may be done by laying the tube on the floor, positioning it against a flat wall, and manipulating the tube until the position of maximum h is obtained (see figure 1). Calculate the maximum allowable deviation, e, as a percentage, as follows:

$$e = \frac{h}{l} \times 100$$

where

h is the maximum distance between the outer surface of the pipe and the wall;

l is the length of pipe.

The tube shall have a maximum allowable deviation, e, not exceeding 0,2 %.

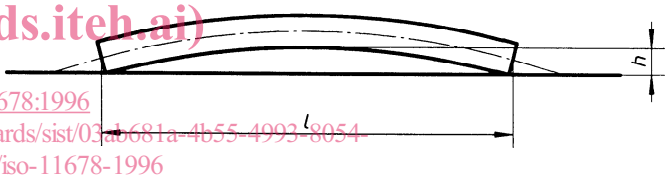

Figure 1 — Measurement of h and l

8 Information to be supplied by manufacturer

The following minimum information shall be supplied by the manufacturer.

a) name and address of manufacturer or supplier;

b) nominal pressure, in kilopascals;

c) classification of tube according to method of manufacture (E or W);

d) classification of tube according to type (type A or type B);

e) tube dimensions: nominal diameter, wall thickness, length;

f) designation of tube by chemical composition;

g) other technical information.

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