INTERNATIONAL STANDARD

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Petroleum and natural gas industries — Aluminium alloy pipe for use as tubing for wells

Industries du pétrole et du gaz naturel — Tubes en alliage d'aluminium utilisés comme tubes de production dans les puits

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries.*

Introduction

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard is not intended to inhibit a manufacturer from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the manufacturer should identify any variations from this International Standard and provide details.

This International Standard includes requirements of various natures. These are identified by the use of certain verbal forms:

— “shall” is used to indicate that a provision is mandatory;

— “should” is used to indicate that a provision is not mandatory, but recommended as good practice;

— “may” is used to indicate that a provision is optional.

Petroleum and natural gas industries — Aluminium alloy pipe for use as tubing for wells

1 Scope

This International Standard specifies the technical delivery condition, manufacturing process, material requirements, configuration and dimensions, and verification and inspection procedures for aluminium alloy pipes for use as tubing for wells in petroleum and natural gas industries.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6892 (all parts), *Metallic materials — Tensile testing*

ISO 11961, *Petroleum and natural gas industries — Steel drill pipe*

ASTM G1, *Standard practice for preparing, cleaning, and evaluating corrosion test specimens*

ASTM G44, *Standard practice for exposure of metals and alloys by alternate immersion in neutral 3.5% sodium chloride solution*

NACE/TM 0177, *Laboratory testing of metals for resistance to sulfide stress cracking and stress corrosion cracking in hydrogen sulfide (H2S) environments*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
defect
imperfection of a size and/or population density greater than the acceptance criteria specified in this International Standard

3.1.2
heat
metal produced by a single cycle of a batch melting process

3.1.3
imperfection
discontinuity or irregularity in the product wall or on the product surface that is detectable by inspection methods outlined in this International Standard

Note 1 to entry: Imperfections are detected by methods outlined in this International Standard.

3.1.4
lot
those lengths of pipe with the same specified dimensions and grade which are heat treated as part of a continuous operation (or batch) and which are of a single heat or from different heats that are grouped according to a documented procedure which will ensure that the appropriate requirements of this International Standard are met

Note 1 to entry: The documented procedure will ensure that the requirements of this International Standard are met.

3.1.5
manufacturer
firm, company or corporation responsible for making and marking the product in accordance with the requirements of this International Standard

Note 1 to entry: Marking by the manufacturer warrants that the product conforms to this International Standard, and it is the manufacturer who is responsible for compliance with all of its applicable provisions.

3.1.6
pipe mill
firm, company or corporation that operates pipe-making facilities

3.1.7
seamless pipe
wrought tubular pipe product made without a welded seam, produced by a hot-forming process which can be followed by cold sizing or cold finishing to produce the desired shape, dimensions and properties

3.1.8
tubing
pipe placed within a well and serving to produce well fluids or to inject fluids

3.2 Symbols

D pipe body outside diameter

D_u outside diameter of upset end

d pipe body inside diameter

L_p pipe length (the distance between the pipe ends)

f test factor

m_1 mass of the specimen before the test

m_2 mass of the specimen after the test

p standard hydrostatic test pressure

S surface area of the specimen

t wall thickness of pipe body

b test time

t_u wall thickness of upset end

V_k corrosion rate

Y_{min} specified minimum yield strength for the pipe body

4 Information to be supplied by purchaser

4.1 In placing orders for aluminium alloy tubing, the purchaser shall specify the following on the purchase order:

a) reference to this International Standard (i.e. ISO 13085);

b) quantity;

c) tubing delivery condition (see 5.4);

d) outside diameter (see Table 3);

e) wall thickness (see Table 3);

f) material group (see Table 1);

g) length (see Table 2);

h) delivery date and shipping instruction;

i) inspection by purchaser (see Annex A).

4.2 The purchaser should also state on the purchase order requirements concerning the following stipulations, which are optional with the purchaser:

a) pipe coatings (see 7.9);

b) non-destructive inspection (see 10.4);

c) leak-proof test (see 8.4);

d) aluminium alloy name (see Table 1).

5 Process of manufacture and delivery condition

5.1 General

Tubing furnished to this International Standard shall be made by the seamless process.

5.2 Heat treatment

Tubing shall be heat treated by solution heat treatment followed by artificial or natural aging. The aluminium pipe shall not be subjected to cold working after the final heat treatment process, except for that which is incidental to normal straightening or threading operations.

The temperature and time requirements for the solution and aging heat treatment cycles shall be determined in accordance with the manufacturer's documented practice. Actual furnace temperatures and transfer timing shall be documented in order to verify that each heat treatment lot meets the manufacturer's documented requirements.

5.3 Traceability

The manufacturer shall establish and follow procedures for maintaining heat and/or lot identity until all required heat and/or lot tests have been performed and conformance with specification requirements has been verified.

5.4 Delivery condition

Aluminium alloy tubing shall be supplied as plain end pipe (with external or internal upsets but without threads).

6 Material requirements

6.1 Material groups

Aluminium alloy tubing after heat treatment shall conform to the requirements specified in Table 1. They are divided into four material groups:

a) **Group I**, without additional requirements for high strength or corrosion resistance;

b) **Group II**, with improved strength;

c) **Group III**, with high temperature mechanical properties;

d) **Group IV**, with improved corrosion resistance.

Table 1 — Material requirements for aluminium alloy tubing

Characteristic	Unit	Material group			
		I	II	III	IV
Alloy name		D16T	1953T1	AK4–1T1	1980T1
Yield strength, min (0,2 % offset method)	MPa	325	480	340	350
Tensile strength, min	MPa	460	530	410	400
Elongation, min	%	12	7	8	9
Operational temperature, max	°C	160	120	220	160
Corrosion rate in 3,5 % sodium chloride solution, max	g/(m²h)	—	—	—	0,08
Corrosion in accordance with NACE (method B) solution (NACE/TM 0177)		—	No EC cracking	—	—
Mechanical testing shall be in accordance with ISO 6892. The NACE test requirement shall be stated on the purchase agreement. The NACE test is for quality control purposes only and does not qualify the material for any specific sour service application. It is the product user's responsibility to ensure that the product is suitable for the intended application.					
NOTE 1 It is permitted to use an alternative aluminium alloy system, as long as there is purchaser agreement and it conforms to the requirements of one of the four material group categories. NOTE 2 The mechanical properties of the alloys given in this table are for a test temperature of (20 ± 3) °C. NOTE 3 Maximum operational temperature is a material temperature that results in the minimum room temperature yield strength reduction by no more than 30 % at the exposure time of 500 h. See ISO 20312 for material yield strength reduction at other operating temperatures.					

6.2 Metallographic examination

Each heat treatment lot sample shall undergo metallographic examination. The macrostructure shall be homogeneous, without cracks, pits, laminations, shrinkage cavities, surface tears or sponginess. The microstructure shall not contain porosities or grain boundary eutectic melting resulting from solution heat treatment.

For terminology relating to microstructure examination, see ASTM B 917.

6.3 Chemical composition

Chemical analysis shall be undertaken on each heat. The manufacturer shall establish limits for chemical composition and shall confirm to the established limits.

6.4 Tensile properties

Product shall conform to the tensile requirements specified in Table 1.

The tensile properties of upset tubing, except elongation of the upset ends, shall comply with the requirements given for the pipe body. In case of dispute, the properties (except elongation) of the upset shall be determined from a tensile test specimen cut from the upset. A record of such tests shall be available to the purchaser.

7 Configuration and dimensions of pipes

7.1 Configuration

The configuration of the aluminium alloy tubing billet shall correspond to Figure 1.

Dimensions in millimetres

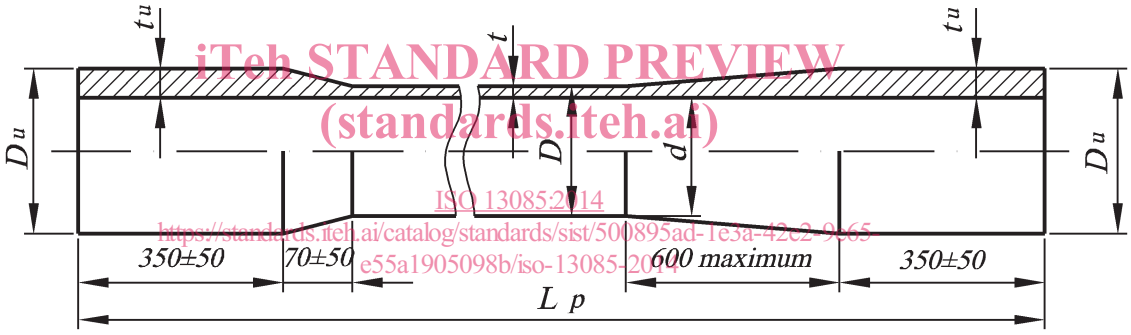

Figure 1 — Tubing billet (see Tables 2 and 3)

7.2 Length

Tubing length ranges shall comply with the requirements specified in Table 2 and Figure 1.

Table 2 — Tubing length

Dimensions in metres

Pipe condition at delivery	Range		
	1	2	3
L_p, tol. ± 0,25	5,50 to 7,92	8,50 to 10,36	11,58 to 13,72
NOTE Other pipe lengths can be ordered by agreement between the manufacturer and purchaser.			

7.3 Dimensions of pipes

The dimensions of the pipe body and upset ends, together with the tolerances, are given in Table 3. By agreement between the purchaser and manufacturer, this International Standard can also be applied to other pipe body and upset ends dimensions.