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Titanium and titanium alloys — Strip for welded tubes — Technical delivery conditions

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Contents

Page

Foreword

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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).

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 11, *Titanium*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document was developed in response to worldwide demand for stabilizing the quality assurance for the strip for welded tubes by common regulations worldwide.

Determining condition concerning such technical delivery conditions for strips of titanium and titanium alloys used for welded tubes as chemical composition, mechanical properties and dimensional tolerance is extremely important to promote commerce of titanium and titanium alloys products in the global market.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning the titanium alloys given in Tables 1 and 2.

ISO takes no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured ISO that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights is registered with ISO. Information may be obtained from the patent database available at www.iso.org/patents.

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Titanium and titanium alloys — Strip for welded tubes — Technical delivery conditions

1 Scope

This document specifies general requirements for the manufacture and technical delivery conditions of strips made from titanium and titanium alloys for welded tubes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 7438, *Metallic materials — Bend test*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 28401, *Light metals and their alloys — Titanium and titanium alloys — Classification and terminology*

ASTM E8/E8M, *Standard Test Methods for Tension Testing of Metallic Materials*

ASTM E539, *Standard Test Method for Analysis of Titanium Alloys by Wavelength Dispersive X-Ray Fluorescence Spectrometry*

ASTM E1409, *Standard Test Method for Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion*

ASTM E1447, *Standard Test Method for Determination of Hydrogen in Titanium and Titanium Alloys by Inert Gas Fusion Thermal Conductivity/Infrared Detection Method*

ASTM E1941, *Standard Test Method for Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis*

ASTM E2371, *Standard Test Method for Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based Test Methodology)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 28401 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
strip
flat rolled product of rectangular cross-section with uniform thickness of 0,30 mm or more and less than 4,5 mm supplied in coils usually with slit edges with width of 20 to 610 mm

Note 1 to entry: The thickness does not exceed one-tenth of the width.

3.2
burr height
deformation height raised by slitting at the edges of the strip

3.3
wave
ratio of the wave height (H) for the suitable length (L) of the length of the strip in the longitudinal direction

Note 1 to entry: H is the maximum height difference between the peak and valley of the wave in the longitudinal direction of the strip.

Note 2 to entry: L is the arbitrary length of periodic distortion or arbitrary length of localized distortion.

3.4
camber
maximum horizontal curve between a reference line of 2 000 mm long placed between any two points on the cut edge of the strip

3.5
lot
set of products with the same nominal size produced with the same ingot, processing, heat treatment and chemical treatment

4 Information to be supplied by the purchaser

4.1 General information

The purchase order shall include the following information:

a) quantity (e.g. total mass or total length of the strip);

b) designation;

c) thickness and width;

d) packaging;

e) inspection;

f) certification.

4.2 Options

A number of options are specified in this document:

a) restrictive chemistry (see 6.2);

b) product analysis (see 6.2);

c) special mechanical properties (see 6.3 and 6.4);

d) special tolerance (see 6.5);

e) method of manufacture and finish (see Clause 5 and 6.6).

In the event that the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the strip shall be supplied in accordance with the basic specification.

5 Manufacturing

The strip shall be manufactured by cold-rolling of the hot-stripped mill product followed by the appropriate surface conditioning and heat treatment. The strip shall be edge-cut by slitting in the requested width.

6 Requirements

6.1 General

When supplied in the delivery condition indicated in 4.1 and inspected in accordance with Clause 6, the strip shall conform to the requirements of this document.

6.2 Chemical composition

The titanium and titanium alloys strip shall conform to the chemical requirements given in Table 1.

The elements listed in Table 1 are either intentional alloy additions or elements that are inherent to the manufacture of titanium sponge, ingot or mill product.

The content of any element intentionally added to the formulation of heat shall be reported.

Other elements are those not specified in the relevant designated material, such as Cr and Mo of Ti1-0,18Pd, and those not originally specified in Table 1, such as Co and Hf. The choice of element taken as the other element shall be agreed between the purchaser and the manufacturer.

Other elements need not be reported unless the concentration is greater than 0,1 % for each, or 0,4 % for the total.

When agreed upon between the manufacturer and the purchaser and specified in the purchase order, other specific residual elements not listed in Table 1 may be added, and their content shall be reported.

The chemical analysis shall be conducted by the standard techniques normally utilized by the manufacturer and the purchaser. In case of disagreement, the test methods given in ASTM E2371 or ASTM E539 shall be used as the referee method, except for carbon, oxygen and hydrogen, which are not covered in those standards. The test methods given in ISO 22960, ISO 22961 or ISO 22962 may be used as the referee method for iron instead of those given in ASTM E2371 or ASTM E539. The test method given in ASTM E1409 shall be used as the referee method for oxygen and nitrogen. ISO 22963 may be used as the referee method for oxygen. The test method given in ASTM E1447 shall be used as a referee method for hydrogen. The test method given in ASTM E1941 shall be used as the referee method for carbon.

Table 1 — Chemical composition (% mass fraction)

Designation	C max.	O max.	N max.	H max.	Fe max. range	Al	V	Ru	Pd	Mo	Ni	Cr	Co	Si	Other elements max.	
															each	total
Ti1	0,08	0,18	0,03	0,015	0,20										0,1	0,4
Ti1H	0,08	0,18	0,03	0,015	0,20										0,1	0,4
Ti2L	0,08	0,20	0,03	0,015	0,25										0,1	0,4
Ti2	0,08	0,25	0,03	0,015	0,30										0,1	0,4
Ti3	0,08	0,35	0,05	0,015	0,30										0,1	0,4
Ti3H	0,08	0,35	0,05	0,015	0,30										0,1	0,4
Ti2L-0,18Pd	0,08	0,20	0,03	0,015	0,25				0,12 to 0,25						0,1	0,4
Ti2-0,18Pd	0,08	0,25	0,03	0,015	0,30				0,12 to 0,25						0,1	0,4
Ti-3Al-2,5V	0,08	0,15	0,03	0,015	0,25	2,5 to 3,5	2,0 to 3,0								0,1	0,4
Ti3-0,3Mo-0,75Ni	0,08	0,25	0,03	0,015	0,30					0,2 to 0,4	0,6 to 0,9				0,1	0,4
Ti-0,06Pd	0,08	0,25	0,03	0,015	0,30				0,04 to 0,08						0,1	0,4
Ti2-0,06Pd	0,08	0,25	0,03	0,015	0,30				0,04 to 0,08						0,1	0,4
Ti2-0,11Ru	0,08	0,25	0,03	0,015	0,30			0,08 to 0,14							0,1	0,4
Ti-0,5Co-0,06Pd	0,08	0,25	0,03	0,015	0,30				0,04 to 0,08				0,20 to 0,80		0,1	0,4
Ti2-0,45Ni-0,15Cr-0,015Pd-0,03Ru	0,08	0,25	0,03	0,015	0,30			0,02 to 0,04	0,01 to 0,02		0,35 to 0,55	0,10 to 0,20			0,1	0,4
Ti-1,5Al	0,08	0,25	0,03	0,015	0,30	1,0 to 2,0									0,1	0,4
Ti-0,25Fe-0,4Si	0,08	0,15	0,03	0,015	0,15 to 0,40									0,30 to 0,50	0,1	0,4

6.3 Tensile properties

The room temperature tensile properties of the strip in both longitudinal and transverse directions of final rolling shall conform to the requirements given in Table 2.

The tensile test shall be carried out in accordance with ISO 6892-1 or ASTM E8/E8M.

For measurement of the 0,2 % proof strength or yield strength, the strain increase rate on the gauge length shall be 0,3 %/min to 0,7 %/min. For measurement of the tensile strength after that of 0,2 % proof strength or yield strength, the strain increase rate estimated from the crosshead displacement rate shall be approximately 10 %/min to 40 %/min.

Mechanical properties for conditions other than those given in Table 2 may be agreed between the manufacturer and the purchaser.

Table 2 — Tensile properties at room temperature

Designation	Tensile strength (R_m) MPa		0,2 % Proof strength ($R_{p0,2}$)[a] MPa		Elongation in 50 mm[b] %
	min.	max.	min.	max.	min.
Ti1	240	—	138	310	24
Ti1H	270	410	165	—	24
Ti2L	340	510	215	—	23
Ti2	345	—	275	450	20
Ti3	450	—	380	550	18
Ti3H	480	620	345	—	18
Ti2L-0,18Pd	340	510	215	—	23
Ti2-0,18Pd	345	—	275	450	20
Ti-3Al-2,5V	620	—	483	—	12
Ti3-0,3Mo-0,75Ni	483	—	345	—	12
Ti-0,06Pd	345	515	275	—	20
Ti2-0,06Pd	345	—	275	450	20
Ti2-0,11Ru	345	—	275	450	20
Ti-0,5Co-0,06Pd	345	515	275	—	20
Ti2-0,45Ni-0,15Cr-0,015Pd-0,03Ru	345	—	275	450	20
Ti-1,5Al	345	—	215	450	20
Ti-0,25Fe-0,4Si	515	—	410	620	20

[a] 0,2 % proof strength is specified. When specific yielding point is exhibited, the yield strength (R_e) shall satisfy the specified strength.

[b] Elongation value when using a test piece with a gauge length different from 50 mm shall be agreed between the manufacturer and the purchaser.

6.4 Bend test

The room temperature bend test of the strip in the longitudinal direction of the final rolling shall be carried out in accordance with ISO 7438.

The strip, when subjected to the bending test under the conditions specified in Table 3, shall not generate any cracks outside the bent portion.