International Standard 4978

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Flat rolled steel products for welded gas cylinders

Produits plats laminés en acier pour bouteilles à gaz soudées

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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 developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4978 was developed by Technical Committee ISO/TC 17, *Steel*, and was circulated to the member bodies in August 1978.

It has been approved by the member bodies of the following countries :

Austria	Germany, F. R.	Netherlands
Belgium	India	Poland
Bulgaria	Iran	Romania
Canada	Ireland	South Africa, Rep. of
Czechoslovakia	Italy	Spain
Denmark	Japan	Sweden
Egypt, Arab Rep. of	Korea, Dem. P. Rep. of	Switzerland
Finland	Korea, Rep. of	USSR
France	Mexico	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

United Kingdom
USA

Printed in Switzerland

Flat rolled steel products for welded gas cylinders

0 Introduction

This International Standard provides a specification for those non-ageing steels commonly used in several countries for welded gas cylinders. As well as these internationally recognized steels there are other steels used for the same application. Their use is not precluded by this specification provided that they comply with ISO 4706, and are acceptable to the user and inspection authorities. This International Standard has been reviewed by ISO/TC 58/SC 3, *Gas cylinders, Cylinder design*, to check the compliance with the requirements of ISO 4706.

1 Scope and field of application

This International Standard specifies the characteristics of flat rolled steel products with a thickness up to 6 mm of the unalloyed steels listed in table 1 which are intended for welded gas cylinders (see ISO 4706[1]) with a normalized structure.

2 References

ISO/R 377, *Selection and preparation of samples and test pieces for wrought steel.*

ISO 404, *Steel and steel products — General technical delivery requirements.*

ISO 4706, *Refillable welded steel gas cylinders.*[2]

ISO 6892, *Metallic materials — Tensile testing.*[3]

3 Information to be supplied by the purchaser

3.1 The purchaser shall state in his enquiry and order the following requirements :

a) the dimensions and tolerances of the product (see clause 9);

b) the steel type (see table 1);

c) the verification procedures and type of documents required (see clauses 10 and 16).

3.2 Certain alternatives are permitted by this International Standard and the purchaser may also state in his enquiry and order his requirements as follows, but if no such statement is made, supply will be at the option of the manufacturer :

d) heat treatment condition of supply (see clause 5);

e) if a product (check) analysis is required (see 6.2 and 12.2);

f) surface condition of supply (see clause 8).

4 Manufacture of the steel

4.1 Unless otherwise stated on the enquiry and order, the steelmaking process and the deoxidation practice within the provisions of 4.2, 4.3 and table 1 will be at the option of the steel manufacturer.

4.2 The steel shall be produced by the open hearth, electric or one of the basic oxygen processes. Other steelmaking processes may be used by agreement between the parties concerned.[4] If he so requests, the purchaser shall be informed of the steelmaking process used.

4.3 The deoxidation procedure shall ensure that the steel has acceptable non-ageing properties. The steel shall therefore be killed with aluminium so that Al_{met} is equal to or greater than 0,015 % (m/m). However, other elements which, by binding the nitrogen, have a similar effect may also be used instead of, or in addition to, aluminium (see also table 1).

If the manufacturer intends, however, to supply, steels with such additions in contents higher than 0,05 % (m/m), this shall be agreed with the purchaser, taking into account the restriction given in ISO 4706 for the niobium, titanium and vanadium content.

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1) ISO 4706 relates to welded steel cylinders of test pressure not greater than 75 bar (1 bar = 10^5 Pa = 10^5 N/m^2) and of water capacities from 1 litre up to and including 150 l for compressed, liquefied or dissolved gases exposed to ambient temperatures.

2) At present at the stage of draft.

3) At present at the stage of draft. (Revision of ISO 82, ISO 86, ISO 89, ISO/R 190, ISO 375, ISO 400, ISO/R 401, ISO/R 402, ISO/R 952, ISO/R 956 and ISO/R 1555.)

4) Such as the user, purchaser, and manufacturer of the equipment, the producer of the material supplied and the inspection and/or certifying authority.

5 Heat treatment

5.1 The delivery condition shall be agreed at the time of enquiry and order.

5.2 The most usual delivery condition is

"hot rolled and normalized".[1)]

The products can, however, also be delivered in other conditions such as

— hot rolled

— cold rolled and annealed

— cold rolled

6 Chemical composition

6.1 Cast analysis

The steel shall show on cast analysis the composition given in table 1 appropriate to the steel type specified.

6.2 Product analysis

If a check analysis on the product is required, the permissible deviations given in table 2 apply to the cast analysis specified in table 1 for samples taken from the standard position (see 12.2).

If a check analysis for acceptance purposes is required, this shall be stated in the enquiry and order.

7 Mechanical and technological properties

7.1 Tensile properties

The values to be obtained on test pieces selected, prepared and tested in accordance with 13.1 and clause 14 are given in table 1.

7.2 Weldability

The steels covered by this International Standard are weldable by the usual fusion welding processes.

8 Surface condition and soundness

8.1 The product can be supplied with an as-rolled surface or with a descaled surface. It shall have a workmanlike finish and shall be clean and free from surface and internal defects likely to have an adverse effect.

8.2 Any special requirements for freedom from defects shall be agreed between the parties concerned at the time of the enquiry and order.

8.3 The requirements for surface defects, rectification and internal defects given in ISO 404 apply.

9 Dimensions and tolerances

9.1 The dimensions of the products shall be stated in the enquiry and order.

9.2 Until the relevant International Standards are available, the tolerances on dimensions and mass shall be agreed between the parties concerned and stated on the enquiry and order.

9.3 The products may be rejected if the dimensional or shape tolerances are exceeded (see ISO 404).

10 Verification procedures

The purchaser shall indicate in his enquiry and order which of the verification procedures listed under the subclauses entitled "Documents" in clause 5 of ISO 404 shall be followed.

NOTE — The verification procedure selected shall, if appropriate, be compatible with the requirements of the International Standard covering the use of the product.

11 General rules for acceptance tests

The requirements of ISO 404 with respect to the following shall apply :

a) place of acceptance;

b) submission for inspection;

c) rights of the inspector;

d) acceptance.

12 Chemical analysis

12.1 In cases of dispute, the methods for chemical analysis shall be in accordance with the relevant International Standards. If no International Standard is available, the method to be used should be agreed between the parties concerned.

12.2 If a check analysis on the product is required, the number of samples to be taken shall be agreed between the parties concerned. The samples shall be taken either from the test pieces used for the verification of the mechanical properties, or from the whole thickness of the product at the same location as for the mechanical test samples.

1) The terms "hot rolled and normalized" or "normalized" refer also to material hot rolled under controlled conditions leading to a structure and to properties typical of those for material in the normalized condition.

13 Number, selection and preparation of samples and test pieces

13.1 Mechanical test at room temperature

13.1.1 The requirements of ISO/R 377, covering the identification and preparation of samples and test pieces, apply.

13.1.2 The test unit shall have a mass of not greater than 40 t and shall consist of material from the same cast and, if delivered in the normalized condition, from the same heat treatment batch.

13.1.3 One test sample shall be taken from each test unit.

13.1.4 The position from which the sample is to be taken shall lie halfway between the edge and the axis of the product and, in the case of coils, at the outer end of the coil. In cases of dispute, the distance between the outer end of the coil and the position from which the sample is taken shall be at least 1 m.

13.1.5 If the product is to be delivered in the normalized condition, the test samples shall be selected after the final heat treatment. If it is to be delivered in other than the normalized condition, the test samples shall be normalized at the temperatures specified in table 1.

13.1.6 From each test sample, one tensile test pieces shall be prepared with its axis at right angles to the direction of final rolling.

If the thickness is 3 mm or greater, this test piece shall be of rectangular section with dimensions in accordance with the requirements of ISO 6892. The width of the parallel portion shall not exceed 30 mm. The thickness shall be that of the product. If the thickness is less than 3 mm, the dimensions of the test pieces shall be those given in ISO 6892 for a gauge length of 80 mm.

13.2 Visual inspection

Every plate shall be inspected.

14 Tensile test

The tensile test shall, in cases of dispute, be carried out

a) for a thickness of 3 mm or greater, in accordance with annex D of ISO 6892;

b) for a thickness of less than 3 mm, in accordance with annex B of ISO 6892.

The tensile strength R_m, the yield strength R_e and the elongation A shall be determined, and the results obtained shall meet the requirements given in table 1.

For the yield strength, either the upper yield stress R_{eH} or the 0,5 % proof stress (total elongation) $R_{t0,5}$ may be determined.

15 Retests

The requirements of ISO 404 shall apply.

16 Documents

The purchaser shall state at the time of the enquiry and order which of the documents specified in ISO 404 are to be provided (see clause 10).

Table 1 — Chemical composition [applicable to cast (ladle) analysis], reference heat treatment and mechanical properties

Chemical composition, % (m/m)[1)2)]							Reference heat treatment[5)]			Mechanical properties[6)]			A, for plate thickness	
Steel	C max.	Si max.	Mn min.	P max.	S max.	Al_{met} min.[3)4)]	Symbol	Austenitizing temperature °C	Cooling	R_e min. N/mm²	R_m min. N/mm²	R_m max. N/mm²	<3 mm min. %	3 to 6 mm min. %
1	0,12	0,15	0,25	0,035	0,035	0,015	N	920 to 960	A	205	340	440	24	32
2	0,16	0,15	0,25	0,035	0,035	0,015	N	920 to 960	A	235	360	460	22	30
3	0,19	0,20	0,40	0,035	0,035	0,015	N	890 to 930	A	265	410	510	20	28
4	0,20	0,45	0,70	0,035	0,035	0,015	N	880 to 920	A	345	490	610	17	24

1) Elements not quoted in the table shall not be intentionally added without the agreement of the purchaser, other than for the purpose of finishing the heat (see 4.3). All reasonable precautions shall be taken to prevent the addition of such elements from scrap or other materials used in the manufacture, but residual elements may be present provided that the mechanical properties and applicability are not adversely affected.

2) For permissible deviations on product (check) analysis, see table 2.

3) If the total aluminium content is determined, a content of not less than 0,018 % (m/m) shall be deemed to fulfil the requirement of not less than 0,015 % (m/m) Al_{met}. However, in cases of dispute the metallic aluminium content shall be determined.

4) See also 4.3.

5) See 13.1.5.

N = normalized
A = air cooled

Time at austenitizing temperature : approximately 2 min per millimetre of plate thickness.

6) R_e is the yield strength

R_m is the tensile strength.

A is the percentage elongation after fracture. In cases of dispute, this shall be measured, for products of thickness 3 mm or greater, on test pieces with a gauge length of $L_o = 5{,}65\sqrt{S_o}$ (S_o is the initial cross-sectional area of the test piece), or for products less than 3 mm thick, on test pieces with a width of 20 mm and a gauge length of 80 mm.

Table 2 — Permissible deviations between specified and product analysis

Element	Specified value (see table 1) %	Permissible deviation[1)2)] %
C	≤ 0,20	+ 0,02
Si	≤ 0,45	+ 0,05
Mn	≤ 0,70	− 0,05
P	≤ 0,035	+ 0,005
S	≤ 0,035	+ 0,005

1) The values are valid only if the samples were selected according to 12.2.

2) These values should be considered as provisional until more reliable data are available.

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