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Welding consumables — Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels — Classification

Produits consommables pour le soudage — Fils-électrodes fourrés pour le soudage à l'arc avec gaz de protection des aciers résistant au fluage — Classification

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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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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 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 3 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

This second edition cancels and replaces the first edition (ISO 17634:2004), which has been technically revised.

Introduction

This International Standard provides a classification system for tubular cored electrodes in terms of chemical composition of the all-weld metal, type of electrode core, type of shielding gas, and welding position or in terms of the tensile properties, chemical composition of the all-weld metal, usability characteristics of the electrodes, shielding gas, and welding position. The ratio of proof to tensile strength of weld metal is generally higher than that of parent metal. Matching weld metal proof strength to parent metal proof strength will not necessarily ensure that the weld metal tensile strength matches that of the parent metal. Where the application requires matching tensile strength, therefore, selection of consumables is made by reference to column 4 of Table 2.

Of note is that the mechanical properties of all-weld metal test specimens used to classify the tubular cored electrodes will vary from those obtained in production joints because of differences in welding procedure such as electrode size, width of weave, welding position, and parent metal composition.

The classification according to system A is mainly based on EN 12071:1999. The classification according to system B is mainly based upon standards used around the Pacific Rim.

Welding consumables — Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels — Classification

1 Scope

This International Standard specifies requirements for classification of tubular cored electrodes used in the post-weld heat-treated condition for gas shielded metal arc welding of creep-resisting and low alloy elevated temperature steels. One tubular cored electrode can be tested and classified with different shielding gases.

This International Standard is a combined specification providing for classification utilizing a system based upon the chemical composition of all-weld metal or utilizing a system based upon the tensile strength and the chemical composition of all-weld metal.

1) Paragraphs and tables which carry the suffix letter "A" are applicable only to tubular cored electrodes classified to the system based upon chemical composition with requirements for the yield strength and the average impact energy of 47 J of all-weld metal in accordance with this International Standard.

2) Paragraphs and tables which carry the suffix letter "B" are applicable only to tubular cored electrodes classified to the system based upon the tensile strength and chemical composition of all-weld metal in accordance with this International Standard.

3) Paragraphs and tables which have neither the suffix letter "A" nor the suffix letter "B" are applicable to all tubular cored electrodes classified in accordance with this International Standard.

It is recognized that the operating characteristics of tubular cored electrodes can be modified by the use of pulsed current, but for the purposes of this International Standard, pulsed current is not used for determining the electrode classification.

2 Normative references

The following referenced 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 544, *Welding consumables — Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings*

ISO 3690, *Welding and allied processes — Determination of hydrogen content in arc weld metal*

ISO 6947, *Welding and allied processes — Welding positions*

ISO 14175, *Welding consumables — Gases and gas mixtures for fusion welding and allied processes*

ISO 14344, *Welding consumables — Procurement of filler materials and fluxes*

ISO 15792-1:2000/Amd 1:2011, *Welding Consumables — Test methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*

ISO 15792-3, *Welding consumables — Test methods — Part 3: Classification testing of positional capacity and root penetration of welding consumables in a fillet weld*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

3 Classification

Classification designations are based upon two approaches to indicate the chemical composition, the tensile properties, and the impact properties of the all-weld metal obtained with a given electrode. The two designation approaches include additional designators for some other classification requirements, but not all as will be clear from the following sections. In most cases, a given commercial product can be classified in both systems. Then, either or both classification designations can be used for the product.

The classification includes all-weld metal properties obtained with a tubular cored electrode and appropriate shielding gas combination as given below. With the exception of the symbol for welding position which is based on ISO 15792-3, the classification is based on the tubular cored electrode size 1,2 mm or if this is not manufactured, the next larger diameter manufactured.

3.1A Classification by chemical composition

The classification is divided into six parts:

1) The first part (T) indicates a tubular cored electrode.

2) The second part gives a symbol indicating the chemical composition of all-weld metal (see Table 1).

3) The third part gives a symbol indicating the type of electrode core (see Table 3A).

4) The fourth part gives a symbol indicating the shielding gas (see 4.5).

5) The fifth part gives a symbol indicating the welding position (see Table 4A).

6) The sixth part gives a symbol indicating the hydrogen content of deposited metal (see Table 5).

3.1B Classification by tensile strength and chemical composition

The classification is divided into seven parts:

1) The first part (T) indicates a tubular cored electrode.

2) The second part gives a symbol indicating the strength and elongation of all-weld metal in the post-weld heat-treated condition (see Table 2).

3) The third part gives a symbol indicating the usability characteristics of the electrode. (see Table 3B);

4) The fourth part gives a symbol indicating the welding position (see Table 4B).

5) The fifth part gives a symbol indicating the shielding gas (see 4.5).

6) The sixth part gives a symbol indicating the chemical composition of all-weld metal (see Table 1);

7) The seventh part gives a symbol indicating the hydrogen content of deposited metal (see Table 5).

In both systems, the electrode classification shall include all compulsory sections and may include an optional section as outlined below.

3.2A Compulsory and optional section in the classification by chemical composition

a) Compulsory section

This section includes the symbols for the type of product, the chemical composition, the type of electrode core, and the shielding gas, i.e. the symbols defined in 4.1, 4.2, 4.4A, and 4.5.

b) Optional section

This section includes the symbols for the welding positions for which the electrode is suitable and the symbol for hydrogen content, i.e. the symbols defined in 4.6 and 4.7.

3.2B Compulsory and optional section in the classification by tensile strength and chemical composition

a) Compulsory section

This section includes the symbols for the type of product, the strength, and elongation in the post-weld heat-treated condition, the welding positions for which the electrode is suitable, the usability characteristics, the shielding gas, the impact properties, and the chemical composition, i.e. the symbols defined in 4.1, 4.2, 4.3B, 4.4B, 4.5, and 4.6.

b) Optional section

This section includes the symbol for hydrogen content, i.e. the symbol defined in 4.7.

The full designation shall comprise the compulsory symbols and may include optional symbols chosen by the manufacturer. The full designation (see Clause 10) shall be used on packages and in the manufacturer's literature and data sheets.

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol for the tubular cored electrode used in the gas shielded metal arc welding process is the letter T.

4.2 Symbol for the chemical composition of all-weld metal

The symbol in Table 1 indicates the chemical composition of all-weld metal determined in accordance with Clause 6.

4.3 Symbol for the mechanical properties of all-weld metal

4.3A Classification by chemical composition

No symbol shall be used for the mechanical properties of the all-weld metal. The all-weld metal obtained with the tubular cored electrodes in Table 1 under conditions given in Clause 5 shall also fulfil the mechanical property requirements specified in Table 2.

4.3B Classification by tensile strength and chemical composition

The symbol for tensile strength shall be the following:

— 49 for 490 MPa to 660 MPa tensile strength;

— 55 for 550 MPa to 690 MPa tensile strength;

— 62 for 620 MPa to 760 MPa tensile strength;

— 69 for 690 MPa to 830 MPa tensile strength.

The complete mechanical property requirements that shall be fulfilled by the various compositions are specified in Table 2.

Table 1 — Symbol for chemical composition of all-weld metal

Chemical composition[a] symbol for classification according to		**Chemical composition** (percentage mass fraction)[b]								
Chemical composition ISO 17634-A[c]	Tensile Strength and chemical composition ISO 17634-B[d]	**C**	**Mn**	**Si**	**P**	**S**	**Ni**	**Cr**	**Mo**	**V**
Mo	(2M3)	0,07 to 0,12	0,60 to 1,30	0,80	0,020	0,020	0,3	0,2	0,40 to 0,65	0,03
(Mo)	2M3	0,12	1,25	0,80	0,030	0,030	—	—	0,40 to 0,65	—
MoL		0,07	0,60 to 1,70	0,80	0,020	0,020	0,3	0,2	0,40 to 0,65	0,03
MoV		0,07 to 0,12	0,40 to 1,00	0,80	0,020	0,020	0,3	0,30 to 0,60	0,50 to 0,80	0,25 to 0,45
	CM	0,05 to 0,12	1,25	0,80	0,030	0,030	—	0,40 to 0,65	0,40 to 0,65	—
	CML	0,05	1,25	0,80	0,030	0,030	—	0,40 to 0,65	0,40 to 0,65	—
CrMo 1	(1CM)	0,05 to 0,12	0,40 to 1,30	0,80	0,020	0,020	0,3	0,90 to 1,40	0,40 to 0,65	0,03
(CrMo 1)	1CM	0,05 to 0,12	1,25	0,80	0,030	0,030	—	1,00 to 1,50	0,40 to 0,65	—
CrMo 1L	(1CML)	0,05	0,40 to 1,30	0,80	0,020	0,020	0,3	0,90 to 1,40	0,40 to 0,65	0,03
(CrMo 1L)	1CML	0,05	1,25	0,80	0,030	0,030	—	1,00 to 1,50	0,40 to 0,65	—
	1CMH	0,10 to 0,15	1,25	0,80	0,030	0,030	—	1,00 to 1,50	0,40 to 0,65	—
CrMo 2	(2C1M)	0,05 to 0,12	0,40 to 1,30	0,80	0,020	0,020	0,3	2,00 to 2,50	0,90 to 1,30	0,03
(CrMo 2)	2C1M	0,05 to 0,12	1,25	0,80	0,030	0,030	—	2,00 to 2,50	0,90 to 1,20	—

a A designation in parentheses [e.g. (CrMo1) or (1CM)] indicates a near match in the other designation system, but not an exact match. The correct designation for a given composition range is the one without parentheses. A given product can, by having a more restricted chemical composition which fulfils both sets of designation requirements, be assigned both designations independently provided that the mechanical property requirements of Table 2 are also satisfied.

b Single values shown in the table are maximum values.

c Cu ≤ 0,3; Nb ≤ 0,1.

d The weld metal shall be analysed for the specific elements for which values are shown in this table. Other elements listed without specified values shall be reported if intentionally added. The total of those latter unspecified elements and all other elements not intentionally added shall not exceed 0,50 %.

e Cu 0,50.

f Nb: 0,02 to 0,10; N: 0,02 to 0,07; Cu ≤ 0,25; Al ≤ 0,04, Mn + Ni = 1,40 max.

g Nb: 0,01 to 0,08; N: 0,02 to 0,07; Cu ≤ 0,25; Al ≤ 0,04.

h Consumables for which the chemical composition is not listed in this table shall be symbolized similarly and prefixed by the letter Z or G. The chemical composition ranges are not specified and therefore it is possible that two electrodes with the same Z classification are not interchangeable.

Table 1 *(continued)*

Chemical composition[a] symbol for classification according to		**Chemical composition** (percentage mass fraction)[b]								
Chemical composition ISO 17634-A[c]	Tensile Strength and chemical composition ISO 17634-B[d]	**C**	**Mn**	**Si**	**P**	**S**	**Ni**	**Cr**	**Mo**	**V**
CrMo 2L	(2C1ML)	0,05	0,40 to 1,30	0,80	0,020	0,020	0,3	2,00 to 2,50	0,90 to 1,30	0,03
(CrMo 2L)	2C1ML	0,05	1,25	0,80	0,030	0,030	—	2,00 to 2,50	0,90 to 1,20	—
	2C1MH	0,10 to 0,15	1,25	0,80	0,030	0,030	—	2,00 to 2,50	0,90 to 1,20	—
CrMo 5	(5CM)	0,03 to 0,12	0,40 to 1,30	0,80	0,020	0,025	0,3	4,0 to 6,0	0,40 to 0,70	0,03
(CrMo 5)	5CM	0,05 to 0,12	1,25	1,00	0,025	0,030	0,40	4,0 to 6,0	0,45 to 0,65	—
	5CML	0,05	1,25	1,00	0,025	0,030	0,40	4,0 to 6,0	0,45 to 0,65	—
	9C1M[e]	0,05 to 0,12	1,25	1,00	0,040	0,030	0,40	8,0 to 10,5	0,85 to 1,20	—
	9C1ML[e]	0,05	1,25	1,00	0,040	0,030	0,40	8,0 to 10,5	0,85 to 1,20	—
	9C1MV[f]	0,08 to 0,13	1,20	0,50	0,020	0,015	0,80	8,0 to 10,5	0,85 to 1,20	0,15 to 0,30
	9C1MV1[g]	0,05 to 0,12	1,25 to 2,00	0,50	0,020	0,015	1,00	8,0 to 10,5	0,85 to 1,20	0,15 to 0,30
Z	G	Any other agreed composition[h]								

a A designation in parentheses [e.g. (CrMo1) or (1CM)] indicates a near match in the other designation system, but not an exact match. The correct designation for a given composition range is the one without parentheses. A given product can, by having a more restricted chemical composition which fulfils both sets of designation requirements, be assigned both designations independently provided that the mechanical property requirements of Table 2 are also satisfied.

b Single values shown in the table are maximum values.

c Cu ≤ 0,3; Nb ≤ 0,1.

d The weld metal shall be analysed for the specific elements for which values are shown in this table. Other elements listed without specified values shall be reported if intentionally added. The total of those latter unspecified elements and all other elements not intentionally added shall not exceed 0,50 %.

e Cu 0,50.

f Nb: 0,02 to 0,10; N: 0,02 to 0,07; Cu ≤ 0,25; Al ≤ 0,04, Mn + Ni = 1,40 max.

g Nb: 0,01 to 0,08; N: 0,02 to 0,07; Cu ≤ 0,25; Al ≤ 0,04.

h Consumables for which the chemical composition is not listed in this table shall be symbolized similarly and prefixed by the letter Z or G. The chemical composition ranges are not specified and therefore it is possible that two electrodes with the same Z classification are not interchangeable.

Table 2 — Mechanical properties of all-weld metal

Chemical composition[a] symbol for classification according to		Minimum[b] proof strength	Tensile strength	Minimum[d] elongation	Impact energy J at +20 °C		Heat treatment of all-weld metal		
Chemical composition ISO 17634-A	Tensile strength and chemical composition ISO 17634-B	MPa	MPa	%	Minimum average from three test specimens	Minimum[e] single value	Preheat and interpass temperature °C	Post weld heat treatment of test assembly: Temperature °C	Post weld heat treatment of test assembly: Time min
Mo	(2M3)	355	510[c]	22	47	38	<200	570 to 620[f]	60[g]
(Mo)	T49TX-X-2M3	400	490 to 660	18	—	—	135–165	605 to 635[h]	60[i]
(Mo)	T55TX-X-2M3	470	550 to 690	17	—	—	135–165	605 to 635[h]	60[i]
MoL		355	510[c]	22	47	38	<200	570 to 620[f]	60[g]
MoV		355	510[c]	18	47	38	200 to 300	690 to 730[f]	60[g]
	T55TX-X-CM	470	550 to 690	17	—	—	160 to 190	675 to 705[h]	60[i]
	T55TX-X-CML	470	550 to 690	17	—	—	160 to 190	675 to 705[h]	60[i]
CrMo 1	(1CM)	355	510[c]	20	47	38	150 to 250	660 to 700[f]	60[g]

[a] A designation in parentheses [e.g. (CrMo1) or (1CM)] indicates a near match in the other designation system, but not an exact match. The correct designation for a given composition range is the one without parentheses. A given product can, by having a more restricted chemical composition which fulfils both sets of designation requirements, be assigned both designations independently provided that the mechanical property requirements of Table 2 are also satisfied.

[b] The 0,2 % proof strength, $R_{p0,2}$, is used.

[c] Minimum tensile strength.

[d] Gauge length is equal to five times the specimen diameter.

[e] Only one single value lower than minimum average is permitted.

[f] The test assembly shall be cooled in the furnace to 300 °C at a rate not exceeding 200 °C/h.

[g] Tolerance shall be $^{+10}_{-10}$ min.

[h] The furnace shall be at a temperature no higher than 315 °C when the test assembly is placed in it. The heating rate from that point to the holding temperature shall not exceed 280 °C/h. When the holding time has been completed, the assembly shall be allowed to cool in the furnace to a temperature below 315 °C at a rate not exceeding 195 °C/h. The assembly can be removed from the furnace at any temperature below 315 °C and allowed to cool in still air to room temperature.

[i] Tolerance shall be $^{+15}_{0}$ min.