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Welding consumables — Covered electrodes for manual metal arc welding of creep-resisting steels — Classification

Produits consommables pour le soudage — Électrodes enrobées pour le soudage manuel à l'arc des aciers résistant au fluage — Classification

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 3580 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

This third edition cancels and replaces the second edition (ISO 3580:2004).

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.

Introduction

This International Standard proposes a method for classification of covered electrodes, in terms of chemical composition of the all-weld metal (system A) and in terms of tensile strength and chemical composition (system B).

The mechanical properties of all-weld metal test specimens used to classify the electrodes vary from those obtained in production joints because of differences in welding procedure such as electrode diameter, width of weave, welding position and material composition.

The classification according to system A is mainly based on EN 1599:1997[1]. The classification according to system B is mainly based upon standards used around the Pacific Rim.

Welding consumables — Covered electrodes for manual metal arc welding of creep-resisting steels — Classification

1 Scope

This International Standard specifies requirements for classification of covered electrodes, based on the all-weld metal in the heat-treated condition, for manual metal arc welding of ferritic and martensitic creep-resisting and low alloy elevated temperature steels.

This International Standard is a combined specification for classification utilizing a system based upon the chemical composition of the all-weld metal, with requirements for the yield strength and impact energy of the all-weld metal, or utilizing a system based upon the tensile strength and the chemical composition of the all-weld metal.

a) Paragraphs and tables which carry the suffix letter “A” are applicable only to electrodes classified to the system based upon chemical composition, with requirements for the yield strength and impact energy of the all-weld metal under this International Standard.

b) Paragraphs and tables which carry the suffix letter “B” are applicable only to electrodes classified to the system based upon the tensile strength and the chemical composition of all-weld metal under this International Standard.

c) Paragraphs and tables which do not have either the suffix letter “A” or the suffix letter “B” are applicable to all covered electrodes classified under this International Standard.

For comparison purposes, some tables include requirements for electrodes classified according to both systems, placing individual electrodes from the two systems, which are similar in composition and properties, on adjacent lines in the particular table. In a particular line of the table that is mandatory in one system, the symbol for the similar electrode from the other system is indicated in parentheses. By appropriate restriction of the formulation of a particular electrode, it is often, but not always, possible to produce an electrode that can be classified in both systems, in which case the electrode, and/or its packaging, may be marked with the classification in either or both systems.

2 Normative references

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

ISO 2401, *Covered electrodes — Determination of the efficiency, metal recovery and deposition coefficient*

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

ISO 6847, *Welding consumables — Deposition of a weld metal pad for chemical analysis*

ISO 6947, *Welds — Working positions*

ISO 13916, *Welding — Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature*

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

ISO 15792-1:2000, *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 composition and 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. 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 covered electrode as given in 3A and 3B. The classification is based on the electrode size 4,0 mm with the exception of the symbol for welding position which is based on ISO 15792-3.

3A Classification by chemical composition

The classification is divided into six parts:

1) the first part gives a symbol indicating the product/process to be identified;

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

3) the third part gives a symbol indicating the type of electrode covering (see 4.4A);

4) the fourth part gives a symbol indicating the nominal electrode efficiency and type of current (see Table 4A);

5) the fifth part gives a symbol indicating the welding position (see Table 5A);

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

3B Classification by tensile strength and chemical composition

The classification is divided into five parts:

1) the first part gives a symbol indicating the product/process to be identified;

2) the second part gives a symbol indicating the strength of the all-weld metal (see Table 2);

3) the third part gives a symbol indicating the type of electrode covering, the type of current, and the welding position (see Table 3B);

4) the fourth part gives a symbol indicating the chemical composition of all-weld metal (see Table 1);

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

In order to facilitate the use of this International Standard, the classification is split into two sections:

a) Compulsory section

This section includes the symbols for the type of product, the chemical composition and the type of covering, i.e. the symbols defined in 4.1, 4.2 and 4.4A;

b) Optional section

This section includes the symbols for the nominal electrode efficiency, the type of current, the welding positions for which the electrode is suitable, and the symbol for hydrogen content, i.e. the symbols defined in 4.5A, 4.6A and 4.7.

In order to facilitate the use of this International Standard, the classification is split into two sections:

a) Compulsory section

This section includes the symbols for the type of product, the strength, the type of covering, the type of current, the welding position, and the chemical composition, i.e. the symbols defined in 4.1, 4.2, 4.3B, 4.4B and 4.6B.

b) Optional section

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

The full designation (see Clause 10) shall be used on packages and in the manufacturer's literature and data sheets. The designation system is shown in Annex A for both systems.

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol for the covered electrode used in the manual metal arc welding process shall be the letter E.

4.2 Symbol for the chemical composition of all-weld metal

The symbols in Table 1 indicate the chemical composition of all-weld metal determined in accordance with Clause 6. See Annexes B and C for descriptions of the symbols used for chemical composition in system A and in system B, respectively.

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 using the covered electrodes listed in Table 1 in accordance with 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 49 for 490 MPa minimum tensile strength, 52 for 520 MPa minimum tensile strength, 55 for 550 MPa minimum tensile strength or 62 for 620 MPa minimum 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 symbol[a] for classification according to		Chemical composition, % (by mass)[b]								
Chemical composition ISO 3580-A[c]	Tensile strength and chemical composition ISO 3580-B	C	Si	Mn	P	S	Cr	Mo	V	Other elements[d]
Mo	(1M3)	0,10	0,80	0,40 to 1,50	0,030	0,025	0,2	0,40 to 0,70	0,03	—
(Mo)	1M3	0,12	0,80	1,00	0,030	0,030	—	0,40 to 0,65	—	—
MoV	—	0,03 to 0,12	0,80	0,40 to 1,50	0,030	0,025	0,30 to 0,60	0,80 to 1,20	0,25 to 0,60	—
CrMo0,5	(CM)	0,05 to 0,12	0,80	0,40 to 1,50	0,030	0,025	0,40 to 0,65	0,40 to 0,65	—	—
(CrMo0,5)	CM	0,05 to 0,12	0,80	0,90	0,030	0,030	0,40 to 0,65	0,40 to 0,65	—	—
—	C1M	0,07 to 0,15	0,30 to 0,60	0,40 to 0,70	0,030	0,030	0,40 to 0,60	1,00 to 1,25	0,05	—
CrMo1	(1CM)	0,05 to 0,12	0,80	0,40 to 1,50	0,030	0,025	0,90 to 1,40	0,45 to 0,70	—	—
(CrMo1)	1CM	0,05 to 0,12	0,80	0,90	0,030	0,030	1,00 to 1,50	0,40 to 0,65	—	—
CrMo1L	(1CML)	0,05	0,80	0,40 to 1,50	0,030	0,025	0,90 to 1,40	0,45 to 0,70	—	—
(CrMo1L)	1CML	0,05	1,00	0,90	0,030	0,030	1,00 to 1,50	0,40 to 0,65	—	—
CrMoV1	—	0,05 to 0,15	0,80	0,70 to 1,50	0,030	0,025	0,90 to 1,30	0,90 to 1,30	0,10 to 0,35	—
CrMo2	(2C1M)	0,05 to 0,12	0,80	0,40 to 1,30	0,030	0,025	2,0 to 2,6	0,90 to 1,30	—	—
(CrMo2)	2C1M	0,05 to 0,12	1,00	0,90	0,030	0,030	2,00 to 2,50	0,90 to 1,20	—	—
CrMo2L	(2C1ML)	0,05	0,80	0,40 to 1,30	0,030	0,025	2,0 to 2,6	0,90 to 1,30	—	—
(CrMo2L)	2C1ML	0,05	1,00	0,90	0,030	0,030	2,00 to 2,50	0,90 to 1,20	—	—
—	2CML	0,05	1,00	0,90	0,030	0,030	1,75 to 2,25	0,40 to 0,65	—	—
—	2C1MV	0,05 to 0,15	0,60	0,40 to 1,50	0,030	0,030	2,00 to 2,60	0,90 to 1,20	0,20 to 0,40	Nb 0,010 to 0,050
—	3C1MV	0,05 to 0,15	0,60	0,40 to 1,50	0,030	0,030	2,60 to 3,40	0,90 to 1,20	0,20 to 0,40	Nb 0,010 to 0,050
CrMo5	(5CM)	0,03 to 0,12	0,80	0,40 to 1,50	0,025	0,025	4,0 to 6,0	0,40 to 0,70	—	—
(CrMo5)	5CM	0,05 to 0,10	0,90	1,00	0,030	0,030	4,0 to 6,0	0,45 to 0,65	—	Ni 0,40
—	5CML	0,05	0,90	1,00	0,030	0,030	4,0 to 6,0	0,45 to 0,65	—	Ni 0,40

Table 1 (*continued*)

Chemical composition symbol[a] for classification according to		Chemical composition, % (by mass)[b]								
Chemical composition ISO 3580-A[c]	Tensile strength and chemical composition ISO 3580-B	C	Si	Mn	P	S	Cr	Mo	V	Other elements[d]
CrMo9	(9C1M)	0,03 to 0,12	0,60	0,40 to 1,30	0,025	0,025	8,0 to 10,0	0,90 to 1,20	0,15	Ni 1,0
(CrMo9)	9C1M	0,05 to 0,10	0,90	1,00	0,030	0,030	8,0 to 10,5	0,85 to 1,20	—	Ni 0,40
—	9C1ML	0,05	0,90	1,00	0,030	0,030	8,0 to 10,5	0,85 to 1,20	—	Ni 0,40
CrMo91[e]	(9C1MV)	0,06 to 0,12	0,60	0,40 to 1,50	0,025	0,025	8,0 to 10,5	0,80 to 1,20	0,15 to 0,30	Ni 0,40 to 1,00 Nb 0,03 to 0,10 N 0,02 to 0,07
(CrMo91)	9C1MV	0,08 to 0,13	0,30	1,25	0,01	0,01	8,0 to 10,5	0,85 to 1,20	0,15 to 0,30	Ni 1,0 Mn + Ni = 1,50 max. Cu 0,25 Al 0,04 Nb 0,02 to 0,10 N 0,02 to 0,07
(CrMo91)	9C1MV1[e]	0,03 to 0,12	0,60	1,00 to 1,80	0,025	0,025	8,0 to 10,5	0,80 to 1,20	0,15 to 0,30	Ni 1,0 Cu 0,25 Al 0,04 Nb 0,02 to 0,10 N 0,02 to 0,07
CrMoWV12	—	0,15 to 0,22	0,80	0,40 to 1,30	0,025	0,025	10,0 to 12,0	0,80 to 1,20	0,20 to 0,40	Ni 0,8 W 0,40 to 0,60
Z	G	Any other agreed composition								

[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 may, 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] If not specified, contents are: Ni < 0,3 % (by mass), Cu < 0,3 % (by mass), Nb < 0,01 % (by mass).

[d] Elements listed without specified values shall be reported, if intentionally added. The total of these unspecified elements and all other elements found in the course of routine chemical analysis shall not exceed 0,50 % (by mass).

[e] The combination of Ni+Mn tends to lower the Ac1 temperature to the point where the PWHT temperature required for proper tempering may approach or exceed the Ac1 of the weld metal.

Table 2 — Mechanical properties of all-weld metal

Chemical composition symbol[a] for classification according to		Minimum yield strength[c]	Minimum tensile strength	Minimum[d] elongation	Impact energy J at +20 °C		Heat treatment of all-weld metal		
Chemical composition ISO 3580-A	Tensile strength and chemical composition ISO 3580-B[b]	MPa	MPa	%	Minimum average from three test specimens	Minimum single value[e]	Preheat and interpass temperature °C	Post-weld heat treatment of test assembly: Temperature[f] °C	Post-weld heat treatment of test assembly: Time min
Mo	(1M3)	355	510	22	47	38	< 200	570 to 620	60 ± 10
(Mo)	49XX-1M3	390	490	22	—	—	90 to 110	605 to 645	$60\,^{+10}_{0}$ g
(Mo)	49YY-1M3	390	490	20	—	—	90 to 110	605 to 645	$60\,^{+10}_{0}$ g
MoV		355	510	18	47	38	200 to 300	690 to 730	60 ± 10
CrMo0,5	(55XX-CM)	355	510	22	47	38	100 to 200	600 to 650	60 ± 10
(CrMo0,5)	55XX-CM	460	550	17	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
	55XX-C1M	460	550	17	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
CrMo1	(55XX-1CM) (5513-1CM)	355	510	20	47	38	150 to 250	660 to 700	60 ± 10
(CrMo1)	55XX-1CM	460	550	17	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
(CrMo1)	5513-1CM	460	550	14	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
CrMo1L	(52XX-1CML)	355	510	20	47	38	150 to 250	660 to 700	60 ± 10
(CrMo1L)	52XX-1CML	390	520	17	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
CrMoV1		435	590	15	24	19	200 to 300	680 to 730	60 ± 10
CrMo2	(62XX-2C1M) (6213-2C1M)	400	500	18	47	38	200 to 300	690 to 750	60 ± 10
(CrMo2)	62XX-2C1M	530	620	15	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
(CrMo2)	6213-2C1M	530	620	12	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
CrMo2L	(55XX-2C1ML)	400	500	18	47	38	200 to 300	690 to 750	60 ± 10
(CrMo2L)	55XX-2C1ML	460	550	15	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
	55XX-2CML	460	550	15	—	—	160 to 190	675 to 705	$60\,^{+10}_{0}$ g
	62XX-2C1MV	530	620	15	—	—	160 to 190	725 to 755	60 ± 10
	62XX-3C1MV	530	620	15	—	—	160 to 190	725 to 755	$60\,^{+10}_{0}$ g
CrMo5	(55XX-5CM)	400	590	17	47	38	200 to 300	730 to 760	60 ± 10
(CrMo5)	55XX-5CM	460	550	17	—	—	175 to 230	725 to 755	$60\,^{+10}_{0}$ g
	55XX-5CML	460	550	17	—	—	175 to 230	725 to 755	$60\,^{+10}_{0}$ g
CrMo9	(62XX-9C1M)	435	590	18	34	27	200 to 300	740 to 780	120 ± 10
(CrMo9)	62XX-9C1M	530	620	15	—	—	205 to 260	725 to 755	$60\,^{+10}_{0}$ g
	62XX-9C1ML	530	620	15	—	—	205 to 260	725 to 755	$60\,^{+10}_{0}$ g
CrMo91	(62XX-9C1MV)	415	585	17	47	38	200 to 315	745 to 775	120 to 180