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Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of creep-resisting steels — Classification

Produits consommables pour le soudage — Fils-électrodes pleins, fils-électrodes fourrés et couples fil-flux pour le soudage à l'arc sous flux des aciers résistant au fluage — Classification

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Foreword

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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 24598 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

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Introduction

This International Standard provides a classification in order to designate solid wire electrodes in terms of their chemical composition, solid wire electrodes and tubular cored electrodes in terms of the deposit composition obtained with a particular submerged arc flux and, where required, electrode-flux combinations in terms of the yield strength, tensile strength and elongation of the all-weld metal deposit. The ratio of yield to tensile strength of weld metal is generally higher than that of parent metal. Users should note that matching weld metal yield strength to parent metal yield strength will not necessarily ensure that the weld metal tensile strength matches that of the parent material. Where the application requires matching tensile strength, therefore, selection of the consumable should be made by reference to column 3 of Table 1A or Table 1B, as appropriate.

Although combinations of wire electrodes and fluxes supplied by individual companies may have the same grading, the individual wire electrodes and fluxes from different companies are not interchangeable unless verified in accordance with this International Standard.

It should be noted that the mechanical properties of all-weld metal test pieces used to classify the wire electrodes will vary from those obtained in production joints because of differences in welding procedure such as electrode size, welding position and material composition.

This International Standard recognizes that there are two somewhat different approaches in the global market to classifying a given wire electrode, tubular cored electrode or electrode/flux combination, and allows for either or both to be used to suit a particular market need. Application of either type of classification designation (or of both where suitable) identifies a product as classified in accordance with this International Standard. The classification in accordance with system A is mainly based on EN 12070:1999. The classification in accordance with system B is mainly based upon standards used around the Pacific Rim. Future revisions will aim to merge the two approaches into a single classification system.

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Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of creep-resisting steels — Classification

1 Scope

This International Standard specifies requirements for classification of solid wire electrodes, tubular cored electrodes and electrode/flux combinations (all-weld metal deposits) for submerged arc welding of creep-resisting and low-alloy elevated-temperature steels. One flux can be tested and classified with different electrodes. One electrode can be tested and classified with different fluxes. The solid wire electrode is also classified separately based on its chemical composition.

This International Standard is a combined specification providing for classification utilizing a system based upon the chemical composition of the solid wire electrode and all-weld metal deposit, or utilizing a system based upon the tensile strength of the all-weld metal deposit and the chemical composition of the solid wire electrode and all-weld metal deposit obtained with the electrode/flux combination.

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1) Clauses, subclauses and tables which carry the suffix letter "A" are applicable only to solid wire electrodes, tubular cored electrodes and all-weld metal deposits classified in accordance with the system based upon chemical composition.

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2) Clauses, subclauses and tables which carry the suffix letter "B" are applicable only to solid wire electrodes, tubular cored electrodes and all-weld metal deposits classified in accordance with the system based upon the tensile strength of all-weld metal deposits and the chemical composition of solid wire electrodes and all-weld metal deposits.

3) Clauses, subclauses and tables which do not have either the suffix letter "A" or the suffix letter "B" are applicable to all solid wire electrodes, tubular cored electrodes and electrode/flux combinations classified under this International Standard.

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 31-0:1992, *Quantities and units — Part 0: General principles*

ISO 544, *Welding consumables — Technical delivery conditions for welding filler materials — Type of product, dimensions, tolerances and marking*

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

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

ISO 14174, *Welding consumables — Fluxes for submerged arc welding — Classification*

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ISO 14344, *Welding and allied processes — Flux and gas shielded electrical welding processes — Procurement guidelines for consumables*

ISO 15792-1, *Welding consumables — Test methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*

3 Classification

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

A solid wire electrode shall be classified in accordance with its chemical composition as given in Table 4.

An all-weld metal deposit from a solid wire electrode or tubular cored electrode shall be classified in accordance with the all-weld metal deposit composition, as given in Table 5, obtained with a particular flux.

When the solid wire electrode or tubular cored electrode is classified in combination with a flux for submerged arc welding, the classification shall be prefixed with a symbol in accordance with Clause 4 as appropriate.

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3A Classification by chemical composition

The classification is divided into three 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 solid wire electrode (see Table 4) and all-weld metal deposit (see Table 5);

3) the third part gives a symbol indicating the type of flux used (see Table 3).

3B Classification by tensile strength and chemical composition

The classification is divided into five parts:

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

2) the second part gives a symbol indicating the strength and elongation of the all-weld metal deposit in the post-weld heat-treated condition (see Table 1B);

3) the third part gives a symbol indicating the impact properties of all-weld metal deposits in the same condition as specified for the tensile strength (see Table 2B);

4) the fourth part gives a symbol indicating the type of flux used (see Table 3);

5) the fifth part gives a symbol indicating the chemical composition of the solid wire electrode, if used (see Table 4), and of the all-weld metal deposited by an electrode/flux combination (see Table 5).

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4 Symbols and requirements

A solid wire electrode can be classified separately based upon its chemical composition, as specified in Table 4. The all-weld metal deposit composition and mechanical properties obtained with a particular solid wire electrode or tubular cored electrode will vary somewhat depending upon the flux used. Accordingly, the classification of the all-weld metal deposit obtained with a particular solid wire electrode or tubular cored electrode may be different for different fluxes.

4.1 Symbol for the product/process

The symbol for the weld deposit produced by a solid or tubular electrode using the submerged arc welding process with a particular flux, shall be the letter “S” placed at the beginning of the designation.

4.1A Classification by chemical composition

The symbol for the solid wire electrode for use in the submerged arc welding process shall be the letter “S” placed at the beginning of the wire electrode designation.

4.1B Classification by tensile strength and chemical composition

The symbol for the solid wire electrode for use in the submerged arc welding process shall be the letters “SU” placed at the beginning of the solid wire electrode designation.

The symbol for the tubular wire electrode for use in the submerged arc welding process shall be the letters “TU” placed at the beginning of the tubular wire electrode designation.

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4.2 Symbols for the tensile properties of the all-weld metal deposit

4.2A Classification by chemical composition

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No symbol shall be used for the mechanical properties of the all-weld metal deposit. The all-weld metal deposit produced in combination with a particular flux shall fulfil the tensile-property requirements specified in Table 1A.

4.2B Classification by tensile strength and chemical composition

The symbols in Table 1B indicate the tensile strength, yield strength and elongation of the all-weld metal deposit in the post-weld heat-treated condition determined, in accordance with 5.1, with a particular flux.

4.3 Symbols for impact properties of all-weld metal deposits

4.3A Classification by chemical composition

No symbol shall be used for the impact properties of the all-weld metal deposits. The all-weld metal deposits produced in combination with a particular flux shall fulfil the impact property requirements specified in Table 1A.

4.3B Classification by tensile strength and chemical composition

The symbols in Table 2B indicate the temperature at which an impact energy of 27 J is achieved in the post-weld heat-treated condition under the conditions given in Clause 5. Five test pieces shall be tested. The lowest and highest values obtained shall be disregarded. Two of the three remaining values shall be greater than the specified 27 J level; one of the three may be lower but shall be no less than 20 J. The average of the three remaining values shall be at least 27 J.

When an all-weld metal deposit has been classified for a certain temperature, it automatically covers any higher temperature listed in Table 2B.

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Table 1A — Mechanical properties of all-weld metal deposits (classification by chemical composition)

Alloy symbol	Minimum proof strength $R_{p0,2}$ MPa	Minimum tensile strength R_m MPa	Minimum [a] elongation A %	Impact energy at + 20° C J		Heat treatment		
				Minimum average from three test pieces	Minimum single value [b]	Preheat and interpass temperature °C	Post-weld heat treatment of test piece	
							Temperature [c] °C	Time [d] min
Mo MnMo	355	510	22	47	38	< 200	—	—
MoV	355	510	18	47	38	200 to 300	690 to 730	60
CrMo1	355	510	20	47	38	150 to 250	660 to 700	60
CrMoV1	435	590	15	24	21	200 to 300	680 to 730	60
CrMo2 CrMo2Mn	400	500	18	47	38	200 to 300	690 to 750	60
CrMo2L	400	500	18	47	38	200 to 300	690 to 750	60
CrMo5	400	590	17	47	38	200 to 300	730 to 760	60
CrMo9	435	590	18	34	27	200 to 300	740 to 780	120
CrMo91	415	585	17	47	38	250 to 350	750 to 760	180
CrMoWV12	550	690	15	34	27	250 to 350 [e] or 400 to 500 [e]	740 to 780	120
Z	Any other agreed mechanical properties							

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[a] The gauge length is equal to five times the test piece diameter.

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

[c] The test piece shall be cooled in the furnace to 300 °C at a rate not exceeding 200 °C/h. The test piece may be removed from the furnace at any temperature below 300 °C and allowed to cool in still air to room temperature.

[d] Tolerance ± 10 min.

[e] Immediately after welding the test piece shall be cooled down to 120 °C to 100 °C and kept at this temperature for at least 1 h.

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Table 1B — Symbols for tensile properties (classification by tensile strength and chemical composition)

Symbol	Minimum yield strength [a] MPa	Tensile strength MPa	Minimum elongation [b] %
49	400	490 to 660	20
55	470	550 to 700	18
62	540	620 to 760	15
69	610	690 to 830	14

[a] 0,2 % offset ($R_{p0,2}$).

[b] The gauge length is equal to five times the test piece diameter.

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Table 2B — Symbols for impact properties of all-weld metal deposits (classification by tensile strength and chemical composition)

Symbol	Temperature for minimum average impact energy of 27 J °C
Z	No requirements
Y	+ 20
0	0
2	− 20
3	− 30
4	− 40

4.4 Symbol for types of welding flux

The symbols for welding flux in accordance with ISO 14174 are given in Table 3.

Table 3 — Symbols for types of welding flux

Type of flux	Symbol
Manganese-silicate	MS
Calcium-silicate	CS
Calcium-magnesium	CG
Calcium-magnesium-basic	CB
Calcium-magnesium-iron	CI
Calcium-magnesium-iron-basic	IB
Zirconium-silicate	ZS
Rutile-silicate	RS
Aluminate-rutile	AR
Aluminate-basic	AB
Aluminate-silicate	AS
Aluminate-fluoride-basic	AF
Fluoride-basic	FB
Any other type	Z

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4.5 Symbol for the chemical composition of solid wire electrodes and of all-weld metal deposits

The symbols in Table 4 indicate the chemical composition of the solid wire electrode, determined under the conditions given in Clause 6.

The symbols in Table 5 indicate the chemical composition of the all-weld metal deposit obtained with the solid wire electrode, or with the tubular cored electrode, and a particular flux.

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