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Welding consumables – Fluxes for submerged arc welding and electroslag welding – Classification (ISO 14174:2019)

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European foreword

This document (EN ISO 14174:2019) has been prepared by Technical Committee ISO/TC 44 "Welding and allied processes" in collaboration with Technical Committee CEN/TC 121 "Welding and allied processes" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2019, and conflicting national standards shall be withdrawn at the latest by November 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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Endorsement notice

The text of ISO 14174:2019 has been approved by CEN as EN ISO 14174:2019 without any modification.

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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.

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 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 the following URL: www.iso.org/iso/foreword.html.

This document 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 14174:2012), which has been technically revised. The main changes compared to the previous edition are as follows:

— Subclause 5.4.3 now clarifies burn-out;

— ISO 18724 has been added to Clause 2;

— Table 3 has been expanded;

— Table 5 for flux class 2, welding current and voltage have been revised;

— an example of a Z option has been added;

— information on IIW Round robin testing of fluxes has been added to Annex B and as a bibliographical reference;

— Clause B.16 has been corrected to include CaF_2 (to align with EN 760).

Any feedback, question or request for official interpretation related to any aspect of this document 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/members.html. Official interpretations, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

Welding consumables — Fluxes for submerged arc welding and electroslag welding — Classification

1 Scope

This document specifies requirements for classification of fluxes for submerged arc welding and electroslag welding for joining and overlay welding using wire electrodes, tubular cored electrodes, and strip electrodes.

NOTE This document was based on EN 760:1996.

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

ISO 14171, *Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels — Classification*

ISO 14343, *Welding consumables — Wire electrodes, strip electrodes, wires and rods for arc welding of stainless and heat resisting steels — Classification*

ISO 18274, *Welding consumables — Solid wire electrodes, solid strip electrodes, solid wires and solid rods for fusion welding of nickel and nickel alloys — Classification*

ISO 80000-1:2009, *Quantities and units — Part 1: General* Corrected by ISO 80000-1:2009/Cor 1:2011

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Classification

Fluxes for submerged arc welding and electroslag welding for joining and overlay welding are granular, fusible products of mainly mineral origin, which are manufactured by various methods. Fluxes influence the chemical composition and the mechanical properties of the weld metal.

The classification of the fluxes is divided into seven parts:

1) the first part gives a symbol indicating the product/process (see 5.1);

2) the second part gives a symbol indicating the method of manufacture (see 5.2);

3) the third part gives a symbol indicating the type of flux, characteristic chemical constituents (see Table 1);

4) the fourth part gives a symbol indicating the applications, flux class (see 5.4);

5) the fifth part gives a symbol indicating the metallurgical behaviour (see 5.5);

6) the sixth part gives a symbol indicating the type of current (see 5.6);

7) the seventh part gives a symbol indicating the diffusible hydrogen content of deposited weld metal (see Table 6) — only applicable for class 1 fluxes.

The classification is divided into two sections.

a) the compulsory section, which includes the symbols for process, method of manufacture, characteristic chemical constituents, and applications, i.e. the symbols defined in 5.1, 5.2, 5.3 and 5.4.

b) the optional section, which includes the symbols for the metallurgical behaviour, type of current, and diffusible hydrogen, i.e. the symbols defined in 5.5, 5.6 and 5.7.

5 Symbols

5.1 Symbol for the product/process

The symbol for the flux used in submerged arc welding for joining and overlay welding shall be the letter S and for the flux used in electroslag welding for joining and overlay welding shall be the letters ES.

5.2 Symbol for method of manufacture

The symbol below indicates the method of manufacture:

— F: fused flux;

— A: agglomerated flux;

— M: mixed flux.

Fused fluxes are made by melting and granulating. Agglomerated fluxes are bound, granular mixtures of finer raw materials. Mixed fluxes comprise all fluxes which, after fusing or agglomerating, are mixed with one or more additional components or fluxes.

For particle size requirements in marking, see Clause 6.

5.3 Symbol for type of flux, characteristic chemical constituents

The symbols in Table 1 indicate the type of flux in accordance with the characteristic chemical constituents. Elemental analysis shall be performed on representative samples of the flux. Any suitable analytical technique may be used, but in cases of dispute reference shall be made to established methods. Based on the elemental analysis of the flux, the characteristic chemical constituents of the flux can be determined.

Examples of such determinations are shown in Annex A and descriptions of flux types are given in Annex B.

5.4 Symbol for applications, flux class

5.4.1 General

A given flux may carry more than one class as specified in 5.4.2 to 5.4.5.

5.4.2 Flux class 1

These are fluxes for submerged arc welding of non-alloy and fine grain steels, high-strength steels, creep-resisting steels, and atmospheric corrosion-resisting steels.

In general, the fluxes do not contain alloying elements, other than Mn and Si, thus the weld metal analysis is predominantly influenced by the composition of the wire/strip electrode and metallurgical reactions. The fluxes are suitable for joint welding and/or overlay welding. In the case of joint welding, some fluxes can be applied for both multi-run and single-run and/or two-run technique.

In the flux designation, the digit 1 indicates class 1.

5.4.3 Flux classes 2 and 2B

These are fluxes for joint welding of stainless and heat-resisting steels and/or nickel and nickel alloys and corrosion-resistant overlay welding[1)]. Fluxes of these classes can contain alloying elements compensating for the burn-out (elements lost to the slag).

In the flux designation, the digit 2 is used to indicate class 2 fluxes mainly suited for joint welding, but which can also be used for strip cladding. 2B is used for fluxes especially designed for strip cladding.

5.4.4 Flux class 3

These are fluxes mainly for hard-facing overlay welding by transfer of alloying elements from the flux, such as C, Cr or Mo.

In the flux designation, the digit 3 indicates class 3.

5.4.5 Flux class 4

These are other fluxes for which classes 1 to 3 are not applicable, e.g. fluxes for copper alloys.

In the flux designation, the digit 4 indicates class 4.

Table 1 — Symbol for type of flux, characteristic chemical constituents[a,b]

Symbol (description)	Characteristic chemical constituents	Limit of constituent % (by mass)
MS (Manganese-silicate)	$MnO + SiO_2$	≥50
	CaO	≤15
CS (Calcium-silicate)	$CaO + MgO + SiO_2$	≥55
	CaO + MgO	≥15
CG (Calcium-magnesium)	CaO + MgO	5 to 50
	CO_2	≥2
	Fe	≤10
CB (Calcium-magnesium basic)	CaO + MgO	30 to 80
	CO_2	≥2
	Fe	≤10

[a] Calculations can be made as shown in Annex A.

[b] A description of the characteristics of each of the types of flux is given in Annex B.

[c] Fluxes for which the chemical composition is not listed shall be symbolized by the letter Z. The chemical composition ranges are not specified and it is possible that two fluxes with the same Z classification are not interchangeable.

1) Not all fluxes suitable for use with stainless steel filler metal are also suitable for nickel and nickel alloy filler metal.

Table 1 *(continued)*

Symbol (description)	Characteristic chemical constituents	Limit of constituent % (by mass)
CG-I	CaO + MgO	5 to 45
(Calcium-magnesium with iron)	CO_2	≥2
	Fe	15 to 60
CB-I	CaO + MgO	10 to 70
(Calcium-magnesium basic with iron)	CO_2	≥2
	Fe	15 to 60
GS	MgO + SiO_2	≥42
(Magnesium-silicate)	Al_2O_3	≤20
	CaO + CaF_2	≤14
ZS	ZrO_2 + SiO_2 + MnO	≥45
(Zirconium-silicate)	ZrO_2	≥15
RS	TiO_2 + SiO_2	≥50
(Rutile-silicate)	TiO_2	≥20
AR	Al_2O_3 + TiO_2	≥40
(Aluminate-rutile)		
BA	Al_2O_3 + CaF_2 + SiO_2	≥55
(Basic-alumina)	CaO	≥8
	SiO_2	≤20
AAS	Al_2O_3 + SiO_2	≥50
(Acid-aluminium-silicate)	CaF_2 + MgO	≥20
AB	Al_2O_3 + CaO + MgO	≥40
(Aluminate-basic)	Al_2O_3	≥20
	CaF_2	≤22
AS	Al_2O_3 + SiO_2 + ZrO_2	≥40
(Aluminate-silicate)	CaF_2 + MgO	≥30
	ZrO_2	≥5
AF	Al_2O_3 + CaF_2	≥70
(Aluminate-fluoride-basic)		
FB	CaO + MgO + CaF_2 + MnO	≥50
(Fluoride-basic)	SiO_2	≤20
	CaF_2	≥15
Z[c]	Any other agreed composition	

[a] Calculations can be made as shown in Annex A.

[b] A description of the characteristics of each of the types of flux is given in Annex B.

[c] Fluxes for which the chemical composition is not listed shall be symbolized by the letter Z. The chemical composition ranges are not specified and it is possible that two fluxes with the same Z classification are not interchangeable.

5.5 Symbol for metallurgical behaviour

5.5.1 General

The metallurgical behaviour of a flux is characterized by the contribution (pick-up and/or burn-out) of alloying elements. Concerning fluxes for joining, the contribution is the difference between the chemical composition of the all-weld metal deposit and the composition of the specified electrode. Concerning fluxes for overlay welding, the contribution is the difference between the chemical composition of the deposited weld metal of the last bead/layer and the chemical composition of the specified wire/strip electrode.

5.5.2 Metallurgical behaviour, flux class 1

For determining the pick-up and burn-out behaviour, a wire electrode ISO 14171-A – S2 or ISO 14171-B – SU22 shall be used in accordance with 5.5.6. The pick-up or burn-out of the elements Si and Mn shall be stated in this sequence.

The symbols in Table 2 indicate the metallurgical behaviour of a welding flux class 1.

Table 2 — Symbol for metallurgical behaviour of class 1 fluxes

Metallurgical behaviour	Symbol	Contribution from flux on all-weld metal % (by mass)
Burn-out [a]	1	>0,7
	2	0,5 to 0,7
	3	0,3 to 0,5
	4	0,1 to 0,3
Neutral	5	0,0 to 0,1
Pick-up	6	0,1 to 0,3
	7	0,3 to 0,5
	8	0,5 to 0,7
	9	>0,7

[a] For Si, symbols 1, 2, 3 and 4 are not used.

5.5.3 Metallurgical behaviour, flux classes 2 and 2B

For determining the pick-up or burn-out behaviour, wire or strip electrodes shall be selected in accordance with Table 3 and shall be used in accordance with 5.5.6.

The pick-up or burn-out of the elements C, Si, Cr, and Nb shall be stated in this sequence. If the flux adds other elements, these shall be indicated by stating the corresponding chemical symbols (e.g. Ni, Mo) immediately after the symbols for C, Si, Cr, and Nb.

The symbols in Table 4 indicate the metallurgical behaviour for class 2 and class 2B fluxes.

Table 3 — Electrodes used for determination of metallurgical behaviour for class 2 and class 2B fluxes

Product/ process	Class	Electrode to be used			
		ISO 14343-A[a]	ISO 14343-B[a]	ISO 18274 (numerical)	ISO 18274 (chemical)
S	2	S 19 9 L	SS308L	N/A	N/A
ES	2	S 19 9 L	SS308L	N/A	N/A
S	2B	B 19 9 L	BS 308L	N/A	N/A
ES	2B	B 19 9 L	BS 308L	N/A	N/A
S	2	N/A	N/A	S Ni 6625	S NiCr22Mo9Nb
ES	2	N/A	N/A	S Ni 6625	S NiCr22Mo9Nb
S	2B	N/A	N/A	B Ni 6625	S NiCr22Mo9Nb
ES	2B	N/A	N/A	B Ni 6625	S NiCr22Mo9Nb

[a] To determine carbon burn-out, electrodes with minimum 0,04 % (by mass) C shall be used. To determine niobium burn-out, 19 9 Nb/347 electrodes shall be used.

N/A Not applicable.

5.5.4 Metallurgical behaviour, flux class 3

The pick-up of alloying elements shall be indicated by stating the corresponding chemical symbols (e.g. C, Cr, Mo) and approximate amount without the % symbol. For determining the pick-up behaviour a wire electrode, ISO 14171-A – S2 or ISO 14171-B – SU22, shall be used in accordance with 5.5.6.

5.5.5 Metallurgical behaviour, flux class 4

The pick-up of alloying elements shall be indicated by stating the corresponding chemical symbols.

Table 4 — Symbols for metallurgical behaviour for class 2 and class 2B fluxes

Metallurgical behaviour	Symbol	Contribution from flux on all-weld metal % (by mass)			
		C	Si	Cr	Nb
Burn-out	1	>0,020	>0,7	>2,0	>0,20
	2	symbol not used	0,5 to 0,7	1,5 to 2,0	0,15 to 0,20
	3	0,010 to 0,020	0,3 to 0,5	1,0 to 1,5	0,10 to 0,15
	4	symbol not used	0,1 to 0,3	0,5 to 1,0	0,05 to 0,10
Neutral	5	0,000 to 0,010	0,0 to 0,1	0,0 to 0,5	0,00 to 0,05
Pick-up	6	symbol not used	0,1 to 0,3	0,5 to 1,0	0,05 to 0,10
	7	0,010 to 0,020	0,3 to 0,5	1,0 to 1,5	0,10 to 0,15
	8	symbol not used	0,5 to 0,7	1,5 to 2,0	0,15 to 0,20
	9	>0,020	>0,7	>2,0	>0,20

5.5.6 Determination of symbols for metallurgical behaviour

For the determination of symbols for class 1 and 2 fluxes, a weld metal pad shall be prepared in accordance with Table 5. For class 3 and 4 fluxes, the weld pad shall be prepared as recommended by the manufacturer.

The surface oxide on the sampling portion of the specimen for chemical analysis shall be removed by machining or grinding. When taking chips from a milling, a shaping or a drilling machine, the use of cutting fluid shall be avoided. The specimen for chemical analysis shall be taken from the weld metal of the highest layer. The specimen shall not include the start or the crater.

Any suitable analytical technique may be used, but in cases of dispute reference shall be made to established methods.

Table 5 — Welding conditions for preparation of a weld metal pad

Product/process	S			ES
Flux class	**1**	**2**	**2B**	**2B**
Electrode dimension, mm	4,0	3,0	60 × 0,5	60 × 0,5
Runs per layer	2		1	
Number of layers	8		3	2
Length of weld deposit, mm	≥200			
Electrode extension, mm	30 ± 5	27 ± 3		
Type of current[a]	Direct current electrode positive (DCEP)			
Welding current, A	580 ± 20	480 ± 20	750 ± 25	1 250 ± 30
Welding voltage, V	29 ± 2	29 ± 2	28 ± 2	25 ± 2
Welding speed, mm/min	550 ± 50	500 ± 50	120 ± 10	160 ± 15
Interpass temperature, °C	150 ± 50	≤150		

[a] If AC only or AC and DC operations are claimed, the test welding shall be carried out using AC only (AC = alternating current; DC = direct current).

5.6 Symbol for type of current

The symbols below indicate the type of current (alternating or direct) for which the flux is suitable:

— DC is the symbol for direct current;

— AC is the symbol for alternating current.

Suitability for use with alternating current (AC) generally also implies suitability for use with direct current (DC).

5.7 Symbol for diffusible hydrogen content in deposited weld metal (class 1 fluxes only)

The symbols in Table 6 indicate the diffusible hydrogen content in deposited weld metal determined in accordance with the method specified in ISO 3690 using a wire electrode ISO 14171-A – S2 or ISO 14171-B – SU22.

Other methods of collection and measurement of the diffusible hydrogen can be used for testing provided they possess equal reproducibility with, and are calibrated against, the method specified in ISO 3690.

In cases of dispute, the method specified in ISO 3690 shall be used.

Table 6 — Symbol for diffusible hydrogen content in deposited weld metal

Symbol	Diffusible hydrogen content ml/100 g deposited weld metal maximum
H2	2
H4	4
H5	5
H10	10

If a diffusible hydrogen symbol is indicated, the manufacturer shall provide information on the recommended type of current and redrying conditions for achieving that hydrogen limit.

6 Particle size range

The particle category is not a part of the flux designation, but shall be used for information in the marking of packaging units.

The particle size range shall be indicated by the symbol for the smallest and largest particle size in accordance with Table 7 or directly expressed in millimetres.

Table 7 — Particle size

Particle size mm	**Symbol**
2,5	25
2,0	20
1,6	16
1,4	14
1,25	12
0,8	8
0,5	5
0,4	4
0,315	3
0,2	2
0,1	1
<0,1	0

The particle size range shall be measured by a suitable technique. The size range to be stated on the packaging shall be the range of particle diameters that includes minimum 90 % (by mass) of the flux.

An example of a typical symbol for particle range is 2 to 16 or 0,2 mm to 1,6 mm.

7 Rounding procedure

Actual test values obtained shall be subject to ISO 80000-1:2009, B.3, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this document, the measured values shall be converted to the units of this document before rounding. If an average value is to be compared to the requirements of this document, rounding shall be done only after calculating the average. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

8 Retest

If any test fails to meet the requirement(s), that test shall be repeated twice. The results of both retests shall meet the requirement. Specimens for the retest may be taken from the original test assembly or sample or from one or two new test assemblies. For chemical analysis, retests need only be for those specific elements that failed to meet the requirement. If the results of one or both retests fail to meet the requirement, the material under test shall be considered as not meeting the requirements of this document for that classification.

In the event that during preparation, or after completion of any test, it is clearly determined that prescribed or proper procedures were not followed in preparing the weld test assembly or sample(s) or test specimen(s), or in conducting the tests, the test shall be considered invalid. This determination is made without regard to whether the test was actually completed, or whether the test results met, or failed to meet, the requirements. That test shall be repeated, following proper prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

9 Technical delivery conditions

The flux shall be granular and so constituted that it can be conveyed freely by the flux feed system. The particle size distribution shall be uniform and consistent in the different packaging units. The fluxes can be obtainable in different particle size distributions.

The fluxes shall be supplied packaged. Subject to proper transportation and storage, the packaging shall be sufficiently robust to provide the contents with a high standard of protection against damage.

10 Marking

The packaging shall be clearly marked with the following details:

a) trade name;

b) classification in accordance with this document (see Clause 4);

c) production lot number;

d) net mass;

e) manufacturer or supplier;

f) particle size range in accordance with Clause 6;

g) health and safety warnings as required.

11 Designation

The designation of a flux shall follow the principle of the examples given below.

EXAMPLE 1 A flux for submerged-arc welding (S) manufactured by fusion (F), calcium-silicate-type (CS) for class 1 applications (1), with pick-up 0,2 % (by mass) for Si (6) and 0,4 % (by mass) for Mn (7), usable with AC or DC (AC) and producing a weld metal with a maximum of 10 ml diffusible hydrogen in 100 g deposited weld metal (H10) is designated as follows:

ISO 14174 — S F CS 1 67 AC H10

and the compulsory section:

ISO 14174 — S F CS 1

where

ISO 14174	represents the number of this document;
S	represents the flux for submerged arc welding (see 5.1);
F	represents the fused flux (see 5.2);
CS	represents the type of flux (see Table 1);
1	represents the application, flux class (see 5.4);
67	represents the metallurgical behaviour (see 5.5);
AC	represents the type of current (see 5.6);
H10	represents the hydrogen content (see Table 6).

EXAMPLE 2 A flux for submerged-arc welding (S) manufactured by agglomeration (A), aluminium-fluoride type (AF) for class 2 applications (2), with pick-up 0,008 % (by mass) for C (5), pick-up 0,2 % (by mass) for Si (6), burn-out 0,7 % (by mass) for Cr (4), burn-out 0,08 % (by mass) for Nb (4) and usable with DC (DC) is designated as follows:

ISO 14174 — S A AF 2 56 44 DC

and the compulsory section:

ISO 14174 — S A AF 2

EXAMPLE 3 A flux for electroslag welding (ES) manufactured by agglomeration (A), aluminium-fluoride type (AF) for class 2B applications (2B), with pick-up 0,002 % (by mass) for C (5), pick-up 0,2 % (by mass) for Si (6), burn-out 0,2 % (by mass) for Cr (5), burn-out 0,07 % (by mass) for Nb (4) and usable with DC (DC) is designated as follows:

ISO 14174 — ES A AF 2B 56 54 DC

and the compulsory section:

ISO 14174 — ES A AF 2B

EXAMPLE 4 A flux for submerged-arc hardfacing (S) manufactured by agglomeration (A), zirconium silicate type (ZS) for class 3 applications, with carbon pickup of 3 % (by mass), (C3), chromium pickup of 20 % (by mass) (Cr20), usable with DC (DC), is designated as follows:

ISO 14174 — S A ZS 3 C3 Cr20 DC

and the compulsory section:

ISO 14174 — S A ZS 3

EXAMPLE 5 A flux for submerged-arc welding (S) manufactured by agglomeration (A) and a chemical composition outside the limits given in Table 1 (Z) for class 1 applications (1), with neutral metallurgical behaviour for Si (5) and Mn (5), usable with AC or DC (AC) is designated as follows:

ISO 14174 — S A Z 1 55 AC

and the compulsory section:

ISO 14174 — S A Z 1

Annex A
(informative)

Characteristic chemical constituents of flux — Example of determination from elemental analysis

A.1 General

Based on the results of the elemental analysis of a flux sample, determination of the chemical constituents shall be performed as follows.

A.2 General case

Respective elements detected in the flux shall be converted to the following oxides and used to determine the flux type: Al_2O_3, CaO, MgO, MnO, SiO_2, TiO_2, and ZrO_2

A.3 Fluorspar present in the flux

F detected in the flux shall be reported as CaF_2, and the amount of CaO shall be calculated in accordance with Formula (A.1):

$$CaO_{rest} = CaO_{tot} - (0{,}718\ 2 \times CaF_2) \qquad \text{(A.1)}$$

If the resultant value of CaO is less than zero, it shall be disregarded in determining the flux type.

A.4 Carbonate present in the flux

Deliberately added carbonate in the flux shall be analysed and the percentage by mass of CO_2 shall be used to determine the flux type.

A.5 Deliberately added metallic Fe in the flux

Deliberately added metallic Fe in the flux shall be analysed and the percentage by mass of Fe in the flux shall be used to determine the flux type.

A.6 Examples of determinations

A flux containing fluorspar, magnesite, carbonate and Fe-powder giving a chemical analysis in accordance with Table A.1.

Table A.1 — Example 1, flux chemical analysis

Chemical analysis, % (by mass)				
F	**Ca_{tot}**	**Mg**	**Fe**	**CO_2**
1,6	7,9	12,0	32	4,6

All the quantity of F shall be converted to the amount of CaF_2 and the amount of CaO shall be calculated from the rest of Ca in accordance with Formula (A.2):

$$CaO_{rest} = CaO_{tot} - (0{,}718\,2 \cdot CaF_2) \tag{A.2}$$

All the quantity of Mg shall be converted to the amount of MgO. Thus, the flux composition, applicable for the requirements of flux type CG-I, is as shown in Table A.2.

Table A.2 — Example 1, flux composition, applicable for the requirements of flux type CG-I

Chemical composition, % (by mass)					
CaF_2	CaO_{rest}	MgO	CaO + MgO	Fe	CO_2
3,2	8,7	19,8	28,5	32	4,6

This flux is concluded to be type CG-I, in accordance with Table 1.

Annex B
(informative)

Description of flux types

B.1 General

Round robin testing of flux analysis conducted by IIW Commission II, Arc Welding and Filler Metals, has shown that more than one classification can be applied to many commercial fluxes[2]. Therefore, it cannot be assumed that fluxes with the same classification will perform identically. It should also be noted that the specific usability (or operating) characteristics of the various fluxes of the same classification may differ in one respect or another.

B.2 Manganese-silicate, MS

Welding fluxes of this type contain significant amounts of MnO and SiO_2. Many fluxes of this type produce higher oxygen weld deposits with limited toughness. These fluxes have a relatively high current-carrying capacity and are often used for single and multiple arc welding at high speeds. Weld metal often exhibits a good resistance to porosity, even on rusty or heavily scaled plate. High levels of alloy build-up usually exclude these fluxes from being used in multiple pass welding of thick sections.

B.3 Calcium-silicate, CS

Welding fluxes of this type are composed essentially of CaO, MgO and SiO_2. The group contains a variety of types; the more acid fluxes have the highest current-carrying capacity and are often used for multiple arc welding applications. The more basic fluxes within this group are often used for multiple pass welding where strength and toughness requirements are more stringent. These fluxes are also used in hard-facing and cladding applications and may contribute alloying elements.

B.4 Calcium-magnesium, CG

Welding fluxes of this type are composed essentially of CaO, MgO and CaF_2. Carbonates, which generate CO_2 gas during welding, can reduce weld metal nitrogen and diffusible hydrogen levels. These fluxes are often used in multiple pass or high heat input applications requiring high impact toughness.

B.5 Calcium-magnesium basic, CB

Welding fluxes of this type are composed essentially of CaO, MgO, CaF_2 and Al_2O_3. Carbonates, which generate CO_2 gas during welding, can reduce weld metal nitrogen and diffusible hydrogen levels. These fluxes are often used in multiple pass or high heat input applications requiring high impact toughness.

B.6 Calcium-magnesium with iron, CG-I

Welding fluxes of this type are essentially calcium-magnesium (CG) type with additions of iron powder to increase deposition rates. Carbonates, which generate CO_2 gas during welding, can reduce weld metal nitrogen and diffusible hydrogen levels. These fluxes are often used for high heat input welding of thick plate where mechanical property requirements are not stringent.

B.7 Calcium-magnesium basic, CB-I

Welding fluxes of this type are essentially calcium-magnesium basic (CB) type with additions of iron powder to increase deposition rates. Carbonates, which generate CO_2 gas during welding, can reduce weld metal nitrogen and diffusible hydrogen levels. These fluxes are often used for high heat input welding of thick plate where mechanical property requirements are more stringent.

B.8 Magnesium-silicate, GS

Welding fluxes of this type are composed essentially of MgO and SiO_2 but with a limited amount of CaO and CaF_2. These fluxes may contain metal powders for alloying purposes and are particularly suited for overlay welding producing a specific weld metal composition.

B.9 Zirconium-silicate, ZS

Welding fluxes of this type are composed essentially of ZrO_2 and SiO_2. These fluxes are often used for making high-speed, single pass welds on clean plate and sheet steel. They may also contribute alloy.

B.10 Rutile silicate, RS

Welding fluxes of this type are composed essentially of TiO_2 and SiO_2. They are often used in conjunction with electrodes having medium or high manganese content. The toughness of the weld remains limited due to relatively high oxygen content. These fluxes are often used in two-run applications with single and multiple arcs at high travel speeds.

B.11 Aluminate-rutile, AR

Welding fluxes of this type are composed essentially of Al_2O_3 and TiO_2. They are available in a wide range of metallurgical activity and basicity. These fluxes are often used for single and multiple arc high speed welding applications, including thin wall and fillet welds.

B.12 Basic-alumina, BA

Welding fluxes of this type contain essentially Al_2O_3 and CaF_2, and with a limited amount of SiO_2, thus contributing to reasonably low oxygen in the weld metal. As a result, good toughness in the weld metal can be achieved, especially in multi-run applications.

B.13 Acid-aluminium-silicate, AAS

Welding fluxes of this type contain essentially Al_2O_3 and SiO_2, but also MgO and CaF_2. These fluxes are particularly suited for various overlay welding applications.

B.14 Aluminate-basic, AB

Welding fluxes of this type are composed essentially of Al_2O_3 and basic oxides. This group encompasses a wide range of metallurgical activities. Due to high Al_2O_3 content the liquid slag is fast freezing. They are used in a variety of applications including single and multiple pass welding with one or more arcs.

B.15 Aluminate-silicate, AS

Welding fluxes of this type are composed essentially of basic oxides balanced with substantial amounts of SiO_2, Al_2O_3 and ZrO_2. As a result of high slag basicity, low oxygen weld metal and high toughness can be achieved. Fluxes of this type are used for a wide variety of joining and overlay applications.

B.16 Aluminate-fluoride-basic, AF

Welding fluxes of this type are composed essentially of basic oxides and CaF_2 with relatively low levels of SiO_2. These fluxes are primarily applied in joining and cladding applications combined with alloyed wires, such as stainless steel and nickel alloys.

B.17 Fluoride-basic, FB

Welding fluxes of this type are composed essentially of basic oxides with relatively low levels of SiO_2. As a result of high slag basicity, weld metal with very low oxygen and high toughness can be achieved. Fluxes of this type are used for a wide variety of single and multiple arc joining and cladding applications, including electroslag.

B.18 Any other composition, Z

Other compositions not covered by B.1 to B.16.

The chemical composition ranges are not specified and therefore two fluxes with the same Z classification can be significantly different.

Bibliography

[1] EN 760:1996, *Welding consumables — Fluxes for submerged arc welding — Classification*

[2] KOTECKI. D. J., 2016, IIW commission II round robin of flux analysis. *Welding in the World*. 2016, **60** p. 373

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