International Standard 6848

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Tungsten electrodes for inert gas shielded arc welding, and for plasma cutting and welding — Codification

Électrodes de tungstène pour soudage à l'arc en atmosphère inerte, et pour soudage et coupage plasma — Codification

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Foreword

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0 Introduction

In inert gas shielded arc welding and in plasma cutting and welding, it is essential that the electrode be carefully selected. Its nature, diameter, surface condition and the type of current used greatly influence work quality and arc stability.

Owing to the development of arc temperatures in the order of 4 000 °C, it is necessary to use a metal with an extremely high melting point for the manufacture of an electrode which is non-consumable by definition.

Tungsten meets this requirement and, in addition, provides the advantage of a high thermionic emission; it is therefore a prime material for making such electrodes.

Certain substances, added during manufacture of the electrodes, promote the electron emission. The most common substances are: thoria (ThO_2), zirconia (ZrO_2), lanthanum oxide (LaO_2) and cerium oxide (CeO_2), the amounts of which range from 0,3 to 4 % depending on the element.

These dopes are responsible for increasing the usable life of the electrodes because of their higher electron emission, better arc starting and arc stability. Adding these oxides reduces the risk of tungsten contaminating the welds.

Given similar diameters, electrodes containing oxides can take a higher current than pure tungsten ones; lower diameter electrodes therefore may be used.

The effect of oxide additions is also more noticeable with large diameter electrodes because of the greater size of the tip covered with a layer of emissive substance.

1 Scope and field of application

This International Standard lays down requirements for tungsten electrodes for inert gas shielded arc welding, and for plasma cutting and welding.

2 Definition

tungsten electrode: Current-carrying bare tungsten rod, with or without oxide additive, serving as anode or cathode for the generation of an electric arc.

3 Composition

Tungsten electrodes may contain oxide additives to improve the emission characteristics.

The chemical composition of these electrodes shall be in accordance with the requirements given in table 1.

4 Designation

The codification of tungsten electrodes is based on their chemical composition in accordance with table 1:

a) the first letter indicates the primary element;

b) the second letter indicates the oxide additive (the letter selected is the initial of the element name); the following number is the mean oxide content multiplied by 10.

Table 1 — Codification, composition and identification colour

Codification	Composition				Identification colour [2]
	Oxide additive [1]		Impurities	Tungsten	
	% (m/m)	nature	% (m/m)	% (m/m)	
WP	—		⩽0,20	99,8	green
WT 4	0,35 to 0,55	ThO_2	⩽0,20	balance	blue
WT 10	0,80 to 1,20	ThO_2	⩽0,20	balance	yellow
WT 20	1,70 to 2,20	ThO_2	⩽0,20	balance	red
WT 30	2,80 to 3,20	ThO_2	⩽0,20	balance	violet
WT 40	3,80 to 4,20	ThO_2	⩽0,20	balance	orange
WZ 3	0,15 to 0,50	ZrO_2	⩽0,20	balance	brown
WZ 8	0,70 to 0,90	ZrO_2	⩽0,20	balance	white
WL 10	0,90 to 1,20	LaO_2	⩽0,20	balance	black
WC 20	1,80 to 2,20	CeO_2	⩽0,20	balance	grey

1) The oxide additives are generally finely dispersed in the tungsten matrix, but the so-called composite electrodes are made up of a pure tungsten core with an oxide coating. This type of electrode combines the qualities of pure tungsten with those of the tungsten containing oxides, but have the disadvantage that they cannot be tapered.

2) The composite electrodes shall be identified by a second, pink ring.

5 Marking

In accordance with table 1, tungsten electrodes shall be marked on the basis of their chemical composition, with one (or possibly, as in the case of composite electrodes, two) colour ring(s) at one end of the electrode. The width of each ring shall be 3 mm or more.

6 Technical delivery conditions

6.1 Diameter

The diameter, expressed in millimetres, shall be selected from the following range:

0,5 — 1,0 — 1,6 — 2 — 2,5 — 3,2 — 4 — 5 — 6,3 — 8 — 10

The tolerances on the standard sizes are as follows:

a) for diameters <2,5 mm: ±0,05 mm

b) for diameters ⩾2,5 mm: ±0,1 mm

6.2 Length

The length, expressed in millimetres, shall be selected from the following range:

50 — 75 — 150 — 175

with a tolerance of ±1 mm.

6.3 Straightness

Straightness plays an important role in plasma cutting. This is why the electrodes used for this purpose shall not deviate from the straight by more than +0,5 mm over their length. They shall be measured along a generatrix.

6.4 Electrode quality

The electrode shall show neither surface defects (microfissures, cracks, scale, etc.) nor internal defects (porosity, inclusions, etc.).

The electrode surface shall be free of oil, grease or other impurities. The smooth and clean surface condition required may be achieved by dressing.

The electrode tips in particular shall be perfectly dressed and free of burrs.

6.5 Marking of boxes or unit packages

The following information shall either be printed directly on each box or unit package or appear on a glued-on label:

a) name of manufacturer or supplier;

b) diameter of the electrodes;

c) length of the electrodes;

d) symbols for the chemical composition in accordance with table 1;

e) colour identification in accordance with table 1.

6.6 Packing

Tungsten electrodes shall be packed so that their surfaces are protected from all damage or stain when they are properly transported and stored.

Annex

Conditions of use

A.1 Influence of the type of current

The electric arc may be supplied with either direct current or alternating current.

NOTE — Table 2 indicates which type of current is more suitable to the type of metal or alloy to be welded.

A.1.1 Direct current supply

The arc behaviour is different depending on whether the electrode is connected to the positive or negative terminal of the power source.

With the electrode positive, there is a greater output of heat at the electrode and less penetration of the work than with negative polarity. The current-carrying capacity of an electrode of a given size will therefore be lower with positive polarity than with negative polarity.

A.1.2 Alternating current supply

With this type of supply, the current changes direction each half-cycle: the electrode is in turn anode and cathode.

A.2 Amperage

The electrode size should be selected so that the current value is high enough for the arc to cover the whole area of the electrode tip, which is then heated up to a temperature approaching its melting temperature.

If the current is too low for the electrode size selected, the arc is erratic and unstable, and tungsten particles may be ejected.

If, however, the current is too high, it will cause the electrode to overheat and its tip to melt; drops of molten tungsten will fall into the weld, and the arc will become erratic and unstable.

NOTE — Table 3 gives the recommended current ranges, depending on the type of supply and electrode diameter.

A high current value provides, in addition to a perfectly stable arc, a better concentration of heat, but this value is limited depending on the conditions of use. However, an adequate degree of taper of the electrode tip permits improvement of these conditions, for example the degree of taper of the electrode with d.c. negative polarity should be chosen according to the current used. A more obtuse angle is recommended at higher currents for a given electrode diameter.

A.3 Further remarks

The choice of an electrode type and size and of the welding current is influenced by the type and thickness of the parent metal to be welded or cut. The capacity of tungsten electrodes to carry current is dependent upon a number of other factors, in particular, type and polarity of the current, the shielding gas used, the type of equipment used (gas or water cooled), the extension of the electrode beyond the nozzle and the welding position employed.

An electrode of a given size will have its greatest current-carrying capacity with direct current, electrode negative; less with alternating current, and still less with direct current, electrode positive.

Table 3 lists some typical current values that may be used with argon shielding. However, the other factors mentioned above should be carefully considered before selecting an electrode for a specific application.

Table 2 — Suitability of current supply type

Type of metal or alloy to be welded	Direct current		Alternating current
	Electrode negative (−)	Electrode positive (+)	
Aluminium (thickness ⩽2,5 mm)	2	2	1
Aluminium (thickness >2,5 mm) and its alloys	2	3	1
Magnesium and its alloys	3	2	1
Carbon steels and low alloy steels	1	3	3
Stainless steels	1	3	3
Copper	1	3	3
Bronze	1	3	2
Aluminium bronze	2	3	1
Silicon bronze	1	3	3
Nickel and its alloys	1	3	2
Titanium	1	3	2

NOTE — The numbers indicate, as a guide only, the suitability of the current:

1 = type of supply giving the best results;

2 = type of supply giving good results;

3 = type of supply not recommended or impossible.

Table 3 — Recommended current ranges depending on the electrode diameter

Electrode diameter mm	Direct current A				Alternating current A	
	Electrode negative (−)		Electrode positive (+)			
	Pure tungsten	Tungsten with oxide additives	Pure tungsten	Tungsten with oxide additives	Pure tungsten	Tungsten with oxide additives
0,5	2 to 20	2 to 20			2 to 15	2 to 15
1,0	10 to 75	10 to 75			15 to 55	15 to 70
1,6	40 to 130	60 to 150	10 to 20	10 to 20	45 to 90	60 to 125
2	75 to 180	100 to 200	15 to 25	15 to 25	65 to 125	85 to 160
2,5	130 to 230	170 to 250	17 to 30	17 to 30	80 to 140	120 to 210
3,2	160 to 310	225 to 330	20 to 35	20 to 35	150 to 190	150 to 250
4	275 to 450	350 to 480	35 to 50	35 to 50	180 to 260	240 to 350
5	400 to 625	500 to 675	50 to 70	50 to 70	240 to 350	330 to 460
6,3	550 to 875	650 to 950	65 to 100	65 to 100	300 to 450	430 to 575
8						650 to 830
10						

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