Code of Practice for TIG Welding

Plasma arc welding and cutting methods with non-melt-off electrode can be used universally in respect of material qualities to be used, welding positions and wall thicknesses. Besides applications in plasma arc cutting and plasma arc welding, tungsten electrodes are used primarily for TIG welding.
All plasma processes are based on conversion of electrical energy to thermal energy by means of an arc. The electrons required to generate the arc are emitted by applying high temperatures. Since a higher temperature allows a higher current density, tungsten, as the metal with the highest melting point (3,410°C), is used for this method.
Moreover, the achievable current density and the ignition characteristics are determined by the electron affinity (work function). Adding specific elements has a positive influence on arc starting capability and current density. The table below lists all available tungsten electrode types.

	Composition				Colour coding
Code	Doping level % (min/max)		Type	Impurity %	
WP*				≤ 0.2	Green
WT 20*	1.8	2.2	ThO_2	≤ 0.2	Red
WT 40*	3.8	4.2	ThO_2	≤ 0.2	Orange
WS 2			Mixed oxides	≤ 0.2	Turquoise
WL 10*	0.8	1.2	La_2O_3	≤ 0.2	Black
WL 15	1.3	1.7	La_2O_3	≤ 0.2	Gold
WL 20	1.8	2.2	La_2O_3	≤ 0.2	Blue
WC 20*	1.8	2.2	CeO_2	≤ 0.2	Grey
WZ 8*	0.7	0.9	ZrO_2	≤ 0.2	White

* Delivery to DIN EN 26848 (Oct. 1991)

WP -electrodes are suitable for AC operation owing to good arc stability and can also be used with direct current. The current-carrying capacity is lower than that of doped electrodes.

WS2 -electrodes feature optimum arc starting characteristics with long service lives, particularly when subject to moderate and low current loading. Consequently, they are the first choice for mechanised and automated welding. In AC operation, they form smaller spherical caps than resistance spot electrodes and more regular spherical caps than thoriated electrodes.

WL20 -electrodes are suitable for all base metals and feature good arc starting characteristics and maximum service lives with shorter arc durations (< 5 min.). By comparison with resistance spot electrodes, they form small spherical caps in AC operation and more regular spherical caps than thoriated electrodes.

WC20 -electrodes can be used universally. These electrodes strike an arc better than WT20 electrodes. By comparison with resistance spot electrodes, they form small spherical caps in AC operation and more regular spherical caps than thoriated electrodes.

WZ8-electrodes are used chiefly for AC welding if particularly low tungsten impurities of the weld metal are required. They can also be used for DC operation.

WT20- WT40-electrodes are doped with thorium. Thorium is a weakly radioactive element. The arc starting characteristics of thoriated electrodes are good and they improve with increasing thorium content. Thoriated electrodes are used chiefly for DC welding of stainless and high-alloy steels. Preference should be given to thoriated electrodes in the case of high loads per surface area.

All electrodes are available as standard in lengths 50, 75, 150 and 175 mm and with diameters 1.0, 1.6, 2.0, 2.4, 3.0, 3.2 and 4.0 mm. Other dimensions are also available on request.

Application hints

- For perfect welding results, the use of a good power source with features such as HF ignition, current setting accuracy and pulse facility are essential.
- Avoid all contact between a hot electrode at a temperature of 300°C and oxygen since, otherwise, the arc starting characteristics will worsen dramatically. For this reason, the electrode and the weld metal should be protected with inert gases based on argon, helium and hydrogen during and after welding. In order to avoid turbulence, ensure that optimum flow velocities are set. In general, an inert gas flow velocity of 8 l/min. is recommended.
- There may be no draughts in order to avoid oxidation.
- The electrode should not project by more than 5 mm from the tip.
- The distance between electrode and workpiece will influence the arc voltage and, thus, the welding behaviour. You should thus ensure that the distance is kept as small as possible. It has been demonstrated that a distance corresponding to the electrode's diameter is well-suited.
- Contamination of the tip, e.g. by immersing it in a weld pool, should be avoided at all costs since this would greatly change the welding characteristics and material properties of the electrode.
- Depending on current loading and required weld geometry, it is advisable to adapt the tip angle and blunt the tip (truncated-cone tip). This is because, the lower the electrode's grinding angle, the deeper and narrower will be the fusion penetration and the greater will be the loading on the tip. The following rule of thumb applies: The tip angle should be 30° – 45° and the diameter of the truncated tip should be approx. 0.1 - 0.2 of the diameter of the electrode. The table below provides information on the use of electrode diameter, grinding angle and amperage (DC).

Diameter	Grinding angle 15°	30°	45°	60°	75°
1.0 mm	5 – 20 A	10 – 30 A	20 – 80 A	–	–
1.6 mm	10 – 50 A	20 – 75 A	30 – 100 A	50 – 140 A	–
2.4 mm	10 – 50 A	20 – 90 A	30 – 140 A	50 – 180 A	80 – 230 A
3.2 mm	30 – 80 A	40 – 140 A	50 – 220 A	70 – 300 A	80 – 230 A
4.0 mm	50 – 100 A	50 – 150 A	60 – 250 A	70 – 350 A	90 – 450 A

- Precautions should be taken to prevent incorporation of thorium which poses a health risk, in particular when grinding thorium electrodes. It is advisable to use an extraction system or to grind wet.
- The grind should be as fine as possible, i.e. the centre-line average c.l.a. should not exceed 1 µm. Careful grinding allows a service life which is up to three times as long.
- Longitudinal grinding should be given preference over radial grinding, particularly in the case of DC welding.
- Good centricity of the tip is important both for the welding result and for electrode service life.
- Use an extraction system to prevent inhalation of plasma vapour and radioactive constituents when welding.
- If the arc starting capability or the electrode stability of the electrode declines, sever the tip by grinding and regrind the tip. Tip break-off may lead to fan-out and thus render the electrode unserviceable. In order to avert the risk of fan-out, the electrodes are also available "annealed". Here as well, you should avoid breaking off the tip.
- Selection of the current type will depend on material.

Materials	**DC** + Pole	- Pole	**AC**	**Ar**	**He**	**Filler material to DIN**
Unalloyed and alloyed steels		•		•		8559 8575 8556
		•		•$_1$		
Copper and copper alloys		•		•	•	1733
Nickel and nickel alloys		•		•	•	1736
Aluminium and aluminium alloys	(•)	•	•	(•) •	(•) • •	1732
Magnesium and magnesium alloys	(•)		•	(•) •	(•) •	
Titanium, titanium alloys, zirconium, tantalum, molybdenum and tungsten		•		•		

(•) in the case of thin walls only
•$_1$ Argon or argon with slight hydrogen fractions