

TIG OR GTAW

Definition

Gas tungsten arc welding is a process in which the joining of metals is produced by the heat of an arc between a non consumable tungsten electrode and the base metal. Protection from atmospheric contamination is provided from a separately supplied shielding gas, filler metal may or may not be added.

Process Description

The gas tungsten process equipment is illustrated in **Figure 3:1**

The process uses a non consumable tungsten or tungsten alloy electrode held in a torch. Shielding gas is fed through the torch to protect the weld pool. The electric arc is produced by the passage of current through the conductive ionised shielding gas. The heat generated by the arc creates the weld pool to which a filler metal may be added by hand or automatically.

GTAW Process Advantages

1. It produces superior quality welds generally free of defects.
2. It is free of spatter which occurs in other arc welding processes.
3. It can be used with or without filler metal as required by the application.
4. It allows excellent control of root pan weld.

5. It can produce inexpensive autogenous welds at high speeds
6. It can use relatively inexpensive power supplies
7. It allows precise control of the process variables. (Arc length and voltage, current travel speed and shielding gas).
8. It can be used to weld almost all metal including dissimilar joints.
9. It allows heat source and filler metal additions to be controlled independently.

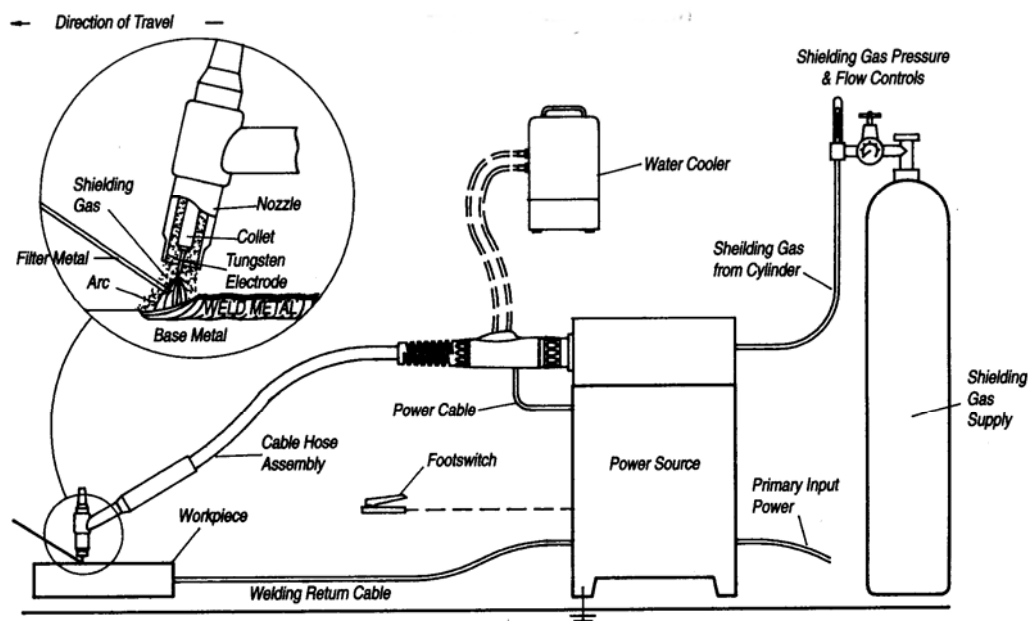
GTAW Process Limitations

1. Deposition rates are considerably lower than consumable electrode arc welding processes.
2. There is a need for more dexterity and welder co-ordination than with GMAW or SMAW.
3. It is less economical than GMAW for thicker sections.
4. There may be shielding problems in draughty environments.

GTAW Potential Process Problems

1. Tungsten inclusions can occur if the electrode is allowed to contact the weld pool.
2. Tungsten contamination can occur if the filler metal is contacted.
3. Contamination of the weld metal can occur if proper shielding is not maintained.
4. There is a low tolerance for contaminants on either the filler metal or base metal

Figure 1.1
Gas Metal Arc Welding GMAW / TIG



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Arc Initiation Methods

Scratch Or Touch Start

With the power supply energised and shielding gas flowing the torch is lowered to the workpiece until the tungsten electrode makes contact with the workpiece. The torch must be immediately withdrawn to prevent workpiece and electrode contamination.

High Frequency Start

High Frequency start can be used with DC or AC power sources for both manual and automatic arc initiation. A high frequency AC output is superimposed over the welding current. The high voltage ionizes the base between the electrode and workpiece initiating the welding arc. This is sometimes referred to as a transferred arc i.e.: electrode to workpiece.

Pulse Start

This method is generally used in automated DC applications. A high voltage pulse superimposed over the welding current ionizes the shielding gas between the electrode and work to establish the arc.

Pilot Arc Start

Pilot arc starting can be used on DC power sources. The pilot arc is maintained between the torch electrode and the nozzle. The voltage supplied by the pilot arc ionizes the shielding gas between the electrode and workpiece, initiating the welding arc. This is sometimes referred to as a non-transferred arc i.e.; electrode to torch

Classification of Electrodes

Tungsten electrodes are classified on the basis of their chemical compositions.

Table 1:1
Identification of Tungsten Electrodes

Composition	Colour	General Use
99.8% Tungsten	Green	AC
0.80 – 1.20% ThO ₂	Yellow	DC
1.70-2.20% ThO ₂	Red	DC
0.70-0.90% ZrO ₂	White	AC
1.80-2.20% CeO ₂	Grey	AC + DC
1% La ₂	Black	AC + DC

The Table below shows the composition and identification colours to tungsten electrodes under BS EN 26848:1991 (equivalent to ISO 6848:1984)

Table to insert here

Pure Tungsten Electrodes

Pure tungsten electrodes contain a minimum of 99.5% tungsten with no intentional alloying elements. The current carrying capacity of pure tungsten electrodes is lower than that of alloyed

electrodes. They are typically used with AC for welding aluminium and magnesium. The tip of pure tungsten electrodes maintains a clean balled end and provides good arc stability.

The thermionic emission of tungsten can be improved by alloying it with metal oxides. As a result these electrodes are able to handle higher welding currents without failing.

Thoriated Tungsten Electrodes

Two types of thoriated electrodes are available containing 1% and 2% thorium oxide (ThO₂) dispersed evenly throughout the length of the electrode.

Thoriated electrodes are superior to pure electrodes in several respects. The thorium provides approximately 20% higher current carrying capacity, generally they have extended life and a greater resistance to contamination of the weld. Arc initiation is generally easier and the arc more stable than pure or zirconiated electrodes.

The 1% and 2% thoriated electrodes were designed for DCEW applications. They maintain a sharp tip configuration during welding which is desirable when welding steel.

Thorium has a low level of radio active material and care must be maintained when grinding.

Ceriated Tungsten Electrodes

Ceriated electrodes contain 2% cerium oxide (CeO₂). These electrodes were developed as a replacement for thoriated electrodes. Cerium unlike Thorium is non-radioactive. Compared with pure tungsten ceriated electrodes exhibit longer life which increases proportionately with cerium content. Ceriated electrodes operate successfully with AC or DC.

Lanthanum Tungsten Electrodes

Lanthanum electrodes contain 1% Lanthanum Oxide (La₂O₃). These electrodes were developed at the same time as ceriated electrodes and the operating characteristics are very similar.

Zirconiated Tungsten Electrodes

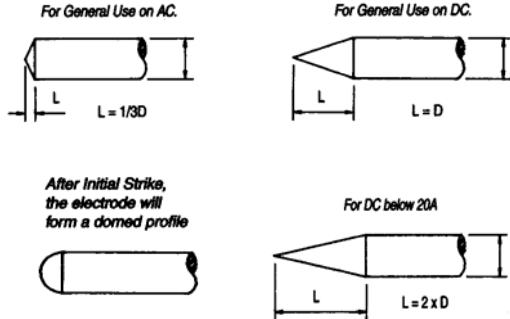
Zirconiated electrodes contain a small amount of zirconium oxide (ZrO₂).

Zirconiated tungsten electrodes exhibit welding characteristics that fall between those of pure and thoriated tungstens. They are the electrode of choice for AC welding because they combine the desirable arc stability characteristics and balled end typical of pure tungsten with the current carrying capacity and starting characteristics of thoriated tungstens. They have a higher resistance to contamination than pure tungsten and are preferred for radiographic

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quality welding applications where tungsten contamination of the weld must be minimal.

Table 1.2 Electrode Tip Configuration



Tungsten electrode sizes and current ranges are listed in the Table 1.4 along with recommended gas cup diameters.

Current levels in excess of those recommended for a given electrode size and tip configuration will cause the electrode to erode and melt. Tungsten particles may fall into the weld pool and contaminate the joint. Current too low for a specific diameter can cause arc instability.

Table 1:3 Electrode Grinding

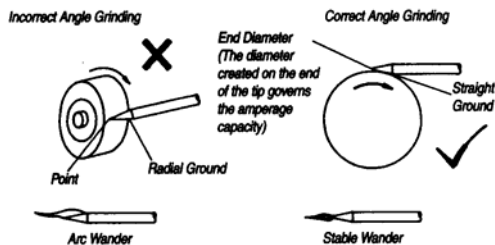


Table 1:4 Electrode current and minimum nozzle bore size

Electrode Diameter (mm)	DC								AC							
	0.5	1.0	1.6	2.4	3.2	4.0	4.8	6.4	0.5	1.0	1.6	2.4	3.2	4.0	4.8	6.4
Maximum Welding Current (Amps)																
Thoriated Electrode	20	60	70	120	200	300	370	500	15	25	50	80	120	160	200	320
Zirconiated Electrode									15	25	50	80	120	160	200	320
Ceriated/Lanthanum		60	70	120	200	300	370	500		25	50	80	120	160	200	320
Ceramic Nozzle	6	6	6	10	11	13	13	18	6	6	6	10	13	13	113	18
Bore size (mm)	8	8	8	11	13	18	18		8	8	8	11	13	18	18	
			10	13	18							10		18		

The shape of the tungsten electrode tip is an important process variable in GTAW. With AC welding pure or zirconiated tungsten electrodes form a hemispherical balled end. With DC welding using thoriated or lanthanum electrodes the end is typically ground to a specific angle and truncated.

Variations in electrode tip geometry affect weld bead shape and size.

Tungsten tips are generally prepared by balling, grinding or chemical sharpening.

Ball

For AC welding, usually with pure or zirconiated tungstens a hemispherical tip is most desirable. An electrode tip can be balled by striking on a water cooled copper block or other suitable material using AC or DCEP.

Grinding

Optimum arc stability is achieved by grinding electrodes perpendicular to the axis of the grinding wheel. Grinding wheels should be reserved for the grinding of tungstens to alleviate electrode contamination. Exhaust should be used when grinding thoriated electrodes.

Chemical Sharpening

Chemical sharpening is achieved when dipping red hot tungsten into sodium nitrate. The chemical reaction between the hot tungsten and the sodium nitrate causes erosion of the tungsten at a uniform rate around the circumference and end of the electrode.

Repeated heating and dipping will form a tapered tip.

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