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TIG Welding

Introduction

The Gas Tungsten Arc Welding – commonly referred to as Tungsten Inert Gas (TIG) – process uses the heat generated by an electric arc struck between a non-consumable tungsten electrode and the workpiece to fuse metal in the joint area and produce a molten weld pool. The arc area is shrouded in an inert or reducing gas shield to protect the weld pool and the non-consumable electrode. The process may be operated autogenously (without filler), or filler may be added by feeding a consumable wire or rod into the established weld pool.

- The addition of filler is optional
- Only inert or reducing gases can be used as the shielding gas
- TIG welding is a high quality, versatile and commonly-used process
- TIG is suitable for welding ferrous and non-ferrous materials
- The TIG process can be run on DC-, DC+, or AC

The TIG process is capable of producing very high quality welds in a wide range of materials and in thicknesses up to about 8 or 10 mm. It is particularly suited to welding of sheet material and for putting in the root run of pipe butt welds.

The process tends to be very clean, producing little particulate fume, although it is capable of generating ozone in appreciable amounts and is not regarded as a high-productivity process.

Operation

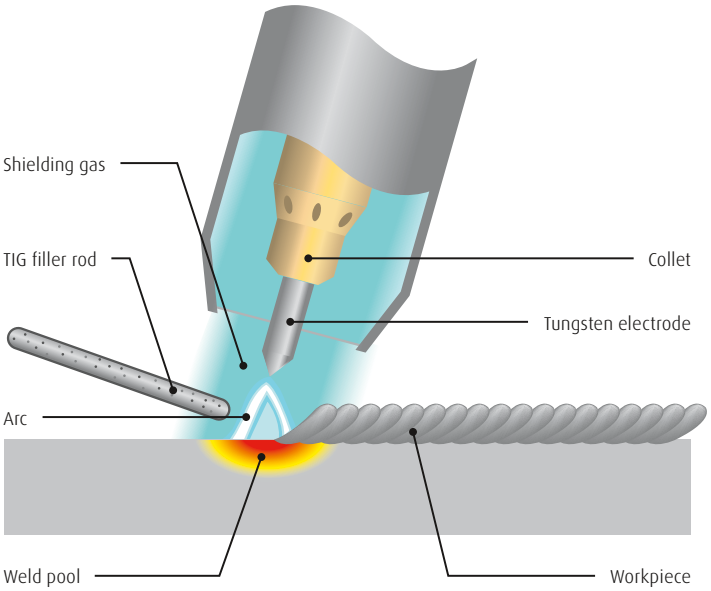
Direct or alternating current power sources with constant current output characteristics are normally employed to supply the welding current. For DC operation, the tungsten may be connected to either output terminal, but is most often connected to the negative pole. The output characteristics of the power source can have an effect on the quality of the welds produced. Shielding gas is directed into the arc area by the welding torch, and a gas lens within the torch distributes the shielding gas evenly over the weld area. In the torch, the welding current is transferred to the tungsten electrode from the copper conductor. The arc is then initiated by one of several methods between the tungsten and the workpiece.

Operating Modes

The TIG process may be operated in one of the following modes:

- Direct Current Electrode Negative (DCEN)
- Direct Current Electrode Positive (DCEP)
- Alternating Current (AC)

The mode used is largely dependent on the parent material being welded.



Schematic of the TIG welding process

DC Electrode Negative (DCEN)
In this mode the tungsten electrode is the negative pole in the welding circuit, the workpiece being the positive pole.

DC Electrode Positive (DCEP)
In this mode the tungsten electrode is the positive pole in the welding circuit, the workpiece being the negative pole.

Alternating Current (AC)
In this mode the polarity of the tungsten electrode and the workpiece alternate between negative and positive at the frequency of the applied welding current.

Process Variants
There are three main variations of the TIG process designed to improve productivity:

- Orbital TIG
- Hot-wire TIG
- Narrow-gap TIG
- Cold-wire TIG

Application

The TIG process is very versatile and may be used to weld any metal or alloy system over a wide range of thicknesses, but is usually restricted to 10mm and under for economic reasons. It is particularly suited to welding sheet materials and for the root run in pipe butt welds.

DCEN is the most common mode of operation and is widely used for welding all carbon, alloy and stainless steels, as well as nickel and titanium alloys. Copper alloys, with the exception of those containing aluminium in significant amounts, can also be welded with this polarity.

DCEP is used for aluminium alloys when welding, with pure helium as the shielding gas, since this polarity has a strong cathodic cleaning effect capable of removing the tenacious aluminium oxide film from the surface. It may also be used for TIG welding magnesium alloys.

AC polarity is used most commonly when welding aluminium and its alloys with pure argon or argon-helium mixtures to take advantage of the combination of the cyclic heating and cleaning action. It is also suitable for welding magnesium alloys and aluminium bronze.

Hot-wire TIG is used predominantly for steel and nickel alloys where the electrical resistance of the wire can be used to increase productivity.

Applications
- High quality fabrications in stainless steel
- Aluminium, copper and nickel alloys
- Welding reactive and refractory metals such as titanium, tantalum and zirconium

The process is used extensively in the nuclear and aerospace industries and in the construction and maintenance of chemical and cryogenic process plant and pipework. It is also used for fabrication of tube heat-exchangers in petrochemical and power-generation plant, and for brewing and foodprocessing vessels.

Orbital TIG welding is used in the nuclear, pharmaceutical, semiconductor and food industries for the installation of pipework – especially where high quality standards are required.

Specialist equipment for tube and tube-plate welding for heat exchangers has been developed. These systems may operate from the outside or inside, depending on tube diameter and the size of the welding head.

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