Plasma Welding

Manual Plasma Welding

Introduction:

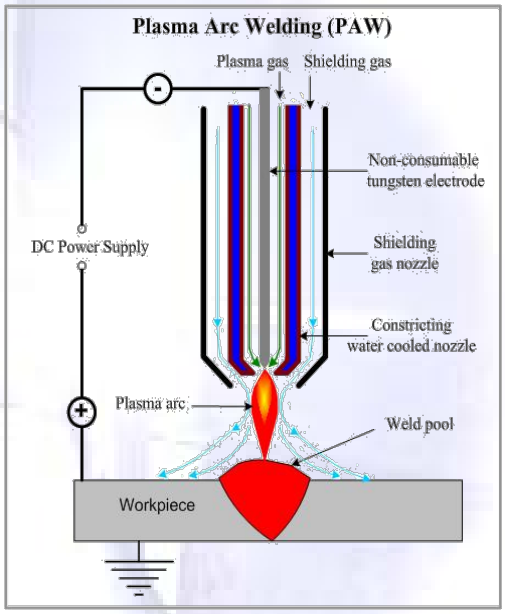
Plasma welding a modern high quality welding process which is very similar to TIG as the arc is formed between a pointed tungsten electrode and the workpiece. Plasma welding has greater energy concentration and allow higher welding speeds and less distortion. Additionally plasma welding has greater torch standoff. Plasma welding also has improved arc stability.

WHAT IS PLASMA?

Plasma is commonly known as fourth state of matter after solid, liquid and gas. This is an extremely hot substance which consists of free electrons, positive ions, atoms and molecules. It conducts electricity.

How it works:
By positioning the electrode within the body of the torch, the plasma arc can be separated from the shielding gas envelope. Plasma is then forced through a fine-bore copper nozzle which constricts the arc. There are three operating modes which can be produced by varying bore diameter and plasma gas flow rate:

- Microplasma: 0.1 to 15A.
- Medium current: 15 to 200A.
- Keyhole plasma: over 100A.



The plasma arc is usually operated with a DC, drooping characteristic power source. Because its unique operating features are results of the special torch arrangement and separate plasma and shielding gas flows, a plasma control console can be added on to a normal TIG power source.

Plasma Torch

The plasma arc is not stabilised with sine wave AC. Arc reignition is difficult when there is a long electrode to workpiece distance and the plasma is constricted, extreme heating of the electrode during the positive half-cycle causes balling of the tip which can disturb arc stability. Special-purpose switched DC power sources are available by misbalancing the waveform to reduce the duration of electrode positive polarity, the electrode is kept passably cool to maintain a pointed tip and achieve arc stability.

Although the arc is initiated using HF, it is first formed between the electrode and plasma nozzle. This 'pilot' arc is held within the body of the torch until required for welding then it is transferred to the workpiece.

Plasma Welding

Electrode

The electrode used for the plasma process is tungsten and the plasma nozzle is copper. The electrode tip diameter is not as critical as for TIG and should be maintained at around 30-60 degrees. The plasma nozzle bore diameter is critical and too small a bore diameter for the current level and plasma gas flow rate will lead to excessive nozzle erosion or even melting. Large bore diameter should be carefully used for the operating current level. Because too large a bore diameter, may give problems with arc stability and maintaining a keyhole.

Mechanised Plasma Welding

Plasma and shielding gases

The normal combination of gases is argon for the plasma gas, with argon plus 2 to 5% hydrogen for the shielding gas only for austenitic stainless steels. Helium can be used for plasma gas but because it is hotter this reduces the current rating of the nozzle. Helium's lower mass can also make the keyhole mode more difficult.

Plasma Arc

Applications:

Microplasma welding:
Microplasma was traditionally used for welding thin sheets (down to 0.1 mm thickness), and wire and mesh sections. The needle-like stiff arc minimises arc wander and distortion.

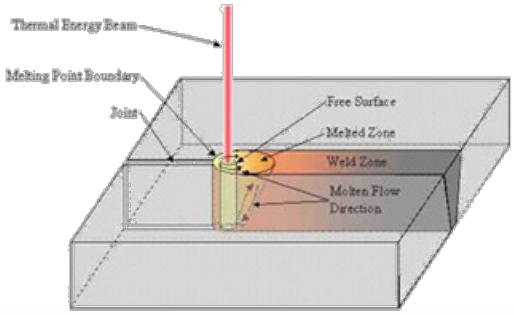
The advantages on the normal plasma welding are:
1-Deeper penetration (from higher plasma gas flow).
2-Greater tolerance to surface contamination including coatings (the electrode is within the body of the torch).

The major disadvantage lies in the bulkiness of the torch, making manual welding more difficult. In mechanised welding, greater attention must be paid to maintenance of the torch to ensure consistent performance.

Keyhole welding:

This has several advantages which can be exploited: deep penetration and high welding speeds. Compared with the TIG arc, it can penetrate plate thicknesses up to l0mm, but when welding using a single pass technique, it is more usual to limit the thickness to 6mm.

For thicknesses up to 15mm, a vee joint preparation is used with a 6mm root face. As the welding parameters, plasma gas flow rate and filler wire addition (into the keyhole) must be carefully balanced to maintain the keyhole and weld pool stability, this technique is only suitable for mechanised welding. When pipe welding, the slope-out of current and plasma gas flow must be carefully controlled to close the keyhole without leaving a hole.



Keyhole welding