# KEYHOLE GTAW & OTHER GTAW VARIANTS

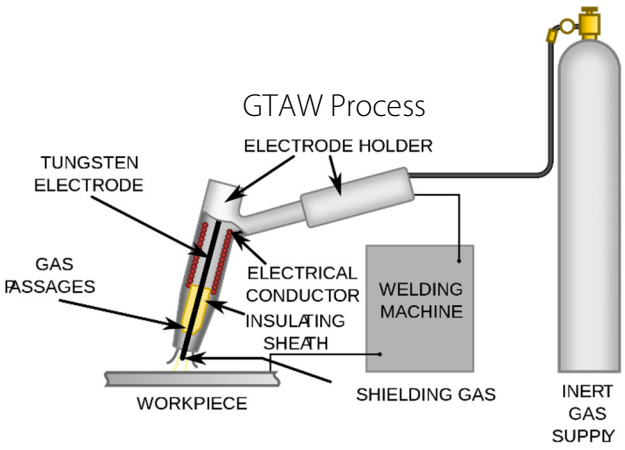

## SUMMARY

- Keyhole GTAW (K-TIG) is defined by ASME as one of 10 variants of the GTAW (Gas Tungsten Arc Welding) process.
- All variants share a set of basic GTAW/TIG characteristics, which are defined by ASME.
- All variants including K-TIG are, by definition, GTAW processes.


## ASME DEFINITION OF GTAW

The **definition of the GTAW process** is governed by **ASME Section IX** and is defined as follows:

> *"Welding, gas tungsten arc welding (GTAW): An arc welding process which produces coalescence of metals by heating them with an arc between a tungsten (non-consumable) electrode and the work. Shielding is obtained from a gas or gas mixture. Pressure may or may not be used and filler metal may or may not be used. (This process has sometimes been called TIG welding, a non-preferred term.)"*




Additionally, ASME QW-256 *(Essential, Supplementary Essential and Non-Essential Variables for GTAW)* does not distinguish between GTAW modes/variants, ensuring that all GTAW modes/variants fall under this section, including K-TIG, meaning that K-TIG and all other GTAW variants share identical *Essential, Supplementary Essential and Non-Essential Variables*

## GTAW VARIATIONS

ASME does not distinguish between GTAW process variants (or modes of operation).

K-TIG, A-TIG, AA-TIG, U-TIG, TOPTIG, TIPTIG, Buried Arc TIG, Dual-Shielded TIG, Multi-Cathode TIG, Low Frequency TIG, High Frequency TIG and Hot Wire TIG are all significantly different in terms of their welding effect, however all are GTAW process variants.

The GTAW process variants are described in "Advanced Welding Processes", Norrish (1992 & 2006) as follows:

### Buried Arc GTAW

Buried Arc GTAW technique, where the arcs plasma force depresses the molten pool and the electrode is lowered below the surface of the parent material. The arc operates in a "cavity" and helps to increase the arcs thermal efficiency and welding speed

### Hot Wire GTAW

Hot Wire GTAW where wire is continuously fed from a separate power source through a contact tip onto the front of the molten pool via resistive heating

### Ultrasonic GTAW (U-TIG)

Ultrasonic GTAW or U-TIG. Ultrasonic energy improves the arc push force and causes a constant high frequency oscillation in the arc plasma and increases weld penetration. These effects enhance the welding efficiency and improves the appearance of stainless steel weld joints in particular

### Narrow Gap GTAW

Narrow Gap GTAW techniques, where the cross sectional weld area deposited is reduced compared to other joints such as v-preps. Also improved deposition faster weld speeds, improved mechanical properties due to lower heat inputs, and generally better economics

### Dual Shield GTAW

Dual Shield GTAW, where arc constriction is induced by thermal constriction using cold gas jets on the outer region of the arc which restricts the number of charge carries in the outer zone of the arc thereby intensifying the arc cores temperature and current density

### TOPTIG

TOPTIG is an automated GTAW welding process where a consumable welding wire is fed directly into the arc zone where the temperature is higher. The main technology in this process is the design of the welding torch which allows the wire to be fed at a particular angle (~ 20°)

### TIPTIG

TIPTIG involves wire being constantly directed to the center of the fluid weld pool, and the wire vibration agitates the weld driving the most fluid part of the weld outwards towards the cooler weld periphery. The mechanical weld action changes the weld surface tension and reduces the sensitivity to the weld receiving the weld wire.

### Multi-Cathode TIG

Multi-Cathode TIG uses two or three GTAW/TIG torches in a line, with each torch responsible for different melting jobs. For example, a tri-cathode torch may consist of three TIG torches with the first torch responsible for pre-heating, the second torch responsible for welding and the third torch responsible for capping/smoothing.

### Keyhole GTAW (K-TIG)

Keyhole GTAW, where a “keyhole” is initiated and the molten weld pool solidifies and closes the keyhole behind the direction of torch travel by surface tension forces.

### Active GTAW (A-TIG)

Active GTAW is better known as A-TIG. An active flux is used on the surface of the joint, similar to when brazing, which acts as a promoter of positive surface tension which in turn provides a reversed Marangoni flow, and therefore has increased penetration (this change in direction of the fluid flow is related the Thermal Coefficient of Surface Tension (TCST) of the molten pool)

### Advanced Active GTAW (AA-TIG)

Advanced Active GTAW (AA-TIG) is a newer GTAW mode developed which utilizes two concentric streams of shielding gas rather than the traditional single shielding gas. The inner layer of shielding gas is the normal inert gas used to protect the weld pool and the tungsten electrode. Around this gas stream is an added layer of an oxidative gas that reacts with the molten puddle.