

# What is TIG welding and how does it work?

Tungsten inert gas (TIG) is a [welding](#) process that uses electricity to melt and join pieces of metal. This blog explains how it works, and when you should use it for your sheet metal [fabrication](#) projects.

TIG [welding](#) was invented in the 1940s to meet the challenge of [welding](#) light metals such as magnesium and aluminium in the Californian [aerospace](#) industry. (Both metals heat up very fast, melt easily and have oxidation issues.) Since then, the popularity of TIG has grown, due largely to its versatility with so many different metals, cleanliness and minimal [finishing](#) requirement. Essentially, TIG [welding](#) has enabled significant advancements and innovations in technology.

TIG [welding](#) uses electricity to create an arc (a short circuit) between a non-consumable tungsten electrode (a positive anode) and the metal being welded (a negative cathode). The arc is shielded by a flow of inert gas, typically argon. TIG also known as gas tungsten arc [welding](#) – GTAW – is a process of joining pieces of metal together through a welding current. An inert gas is supplied to the welding torch that flows along the arc to protect the metals from oxidation and from forming small, circular gaps.

## How does TIG differ from MIG?

TIG welding is sometimes confused with MIG welding (metal inert gas), yet it differs in a number of ways. TIG is popular for joining pipes and thin materials, thanks to its low heat input which preserves the microstructure of the metals. When it comes to thicker materials, MIG welding is preferred. Its comparatively low cost and ability for high speed welds also makes MIG (or spot welding) the preferred process for mass production.

Where TIG really scores as a welding process is when aesthetic qualities are involved in a project. TIG rarely creates spatter and typically requires only light polishing to remove any discoloration. Thus it's ideal when the workpiece is not going to be coated or painted as, for example, with aluminium and stainless steel.

## **The TIG welding process**

Several things should be considered to ensure a smooth flow of operation with the TIG welding process. For example, arc length, travel speed, torch angle and voltage. The TIG torch should also be modified according to the project requirements and choice of material. Modifications can range from the size of the electrode diameter down to the electric arc applied to the material. TIG can use filler rods or metal coils as dictated by the project. Alternatively, the process can run weld beads without filler material, melting only the base metals.

### **6 key tips for TIG welding:**

1. A forward angle of the torch will prevent air pocket build-up making the bead porous.
2. A short, and thereby narrow arc length, will give optimal control.
3. Consistent travel speed is the key to keeping a consistent bead.
4. Care must be taken to avoid touching the weld pool with the tungsten electrode.
5. The size of the filler metal is critical as is a controlled manner of feeding it to the weld.
6. The shape of the tip of tungsten electrode must be checked and, if necessary, sharpened on a grinding wheel.

## **Materials used in TIG welding**

The most widely used materials in TIG welding are stainless steel, aluminium and nickel alloys. TIG is ideal for welding thin metals – for example sheets of less than 4 mm. Other metals that TIG can weld include cast iron, copper and magnesium, though you will have to factor in extra work such as pre-heating, using helium instead of argon or

pre-cleaning.

## Advantages of TIG welding

- TIG welding is very clean, with less spatter, smoke, sparks or fumes than other welding techniques. Consequently, TIG welding requires minimal cleaning or [finishing](#), thereby saving time and money.
- The availability of different welding positions: vertical, horizontal, overhead
- The ability to weld thin metals.
- Superior control of arc and weld puddle (or 'pool'), delivering clean, attractive welds.
- TIG welds are extremely ductile (less brittle), stronger and more corrosion resistant than other welds.
- Minimal smoke and colourless shielding gas means it's easy to see your workpiece while welding.

## Disadvantages of TIG welding

- TIG welding requires a high degree of skill. For example, when feeding filler rods to the weld pool, TIG welders have to use both hands meaning heat input is controlled by a foot pedal. With MIG, the filler wire is automatically fed from the torch. (Most welders generally start out as MIG operators and then transition to TIG welding.)
- The process is often slower than other welding processes, even for skilled TIG welders.
- Rust must be removed completely from the material before welding.
- TIG welding is not suitable for very thick material
- It's vital that a constant flow of gas is maintained over the weld pool. For this reason TIG welding can be very challenging outside of a controlled (wind-free) environment.
- TIG welding machines are more expensive than basic stick welding ones.

## **FAQs**

These are the questions we are frequently asked about TIG welding:

### **When is TIG welding better than MIG welding?**

TIG welding is preferable to MIG welding in a number of circumstances. Primarily, it's preferred for 'cosmetic' projects – sculptures, architectural features and for automotive work. TIG rarely creates spatter and typically requires only light polishing to remove any discoloration. Consequently, the welds are cleaner and neater, and the material doesn't need to be coated or painted. The other main reason for using TIG is its low heat input. This preserves the microstructure of the metals so it's ideal for joining pipes and where thin materials feature.

### **Why is TIG welding used for stainless steel?**

Choosing the right method for welding stainless steel really depends on the qualities you're seeking. If you need a more affordable weld, spot welding might be the best option for the job. As stainless steel is often used for aesthetic reasons, TIG welding is the ideal choice because the welds are cleaner and neater so coating or painting isn't necessary. Also, if the material you're working with is thin, then TIG welding is the better choice because of the low heat input.

### **Which TIG welder is the best?**

Choosing the best TIG welding machine depends on a number factors, particularly budget. Like any piece of equipment, you generally get what you pay for in terms of quality, durability and how advanced you need the machine to be. For example, TIG can weld more metals and alloys than any other process: stainless steel, aluminium, magnesium, copper, brass, bronze and even gold can be welded. For that kind of flexibility, however, you need a TIG machine that enables you to switch between AC and DC polarity (see below).

### **Does TIG welding use gas?**

Yes, TIG uses an inert gas together with a non-consumable tungsten electrode to create high-quality welds. (An inert gas does not form a chemical reaction with other chemical substances.)

## **Will TIG welding warp sheet metal?**

Sheet metal is much more prone to warping during any kind of welding because you're adding heat to thin metal. However, the skilled TIG welder, using a low amp rate, can minimise and manage any warpage.

## **What polarity is used for TIG welding?**

Polarity refers to the direction of current flow when welding. There are two main choices for TIG welding:

### **Electrode Negative TIG (DC-)**

TIG welding steel, stainless steel, titanium and chromoly requires DCEN. DCEN is a negative current or Direct Current Electrode Negative. This means that the torch hose is attached to the negative terminal of your machine and the ground clamp lead is attached to the positive terminal on your machine. This is the most commonly used polarity in TIG welding.

### **Alternating Current TIG (AC)**

Aluminium TIG welding requires AC in which the machine is constantly switching between positive and negative currents – approximately 50 times every second. The alternating current provides a cleaning action to remove the oxide film present on the surface of the metal.

## **TIG: the versatile process for high quality welds**

Of all the welding processes, TIG remains the most versatile and the one capable of delivering the neatest and highest quality welds. Investing in good-quality equipment, and having welders experienced and skilled in the use of TIG machines, is key.