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Gas Tungsten Arc Welding

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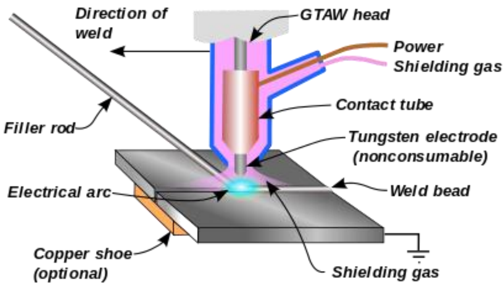
Manual gas tungsten arc welding is a relatively difficult welding method, due to the coordination required by the welder. Similar to torch welding, GTAW (see box №1) normally requires two hands, since most applications require that the welder manually feeds a filler metal into the weld area with one hand while manipulating the welding torch in the other [1]. Maintaining a short arc length, while preventing contact between the electrode and the workpiece, is also important.



Box №1 GTAW weld area

To strike the welding arc, a high frequency generator (similar to a Tesla coil) provides an electric spark. This spark is a conductive path for the welding current through the shielding gas and allows the arc to be initiated while the electrode and the workpiece are separated, typically about 1.5–3 mm (0.06–0.12 in) apart.

Once the arc is struck, the welder moves the torch in a small circle to create a welding pool, the size of which depends on the size of the electrode and the amount of current. While maintaining a constant separation between the electrode and the workpiece, the operator then moves the torch back slightly and tilts it backward about 10–15 degrees from vertical. Filler metal is added manually to the front end of the weld pool as it is needed.

Welders wear protective clothing, including light and thin leather gloves and protective long sleeve shirts with high collars, to avoid exposure to strong ultraviolet light. Due to the absence of smoke in GTAW, the electric arc light is not covered by fumes and particulate matter as in stick welding or shielded metal arc welding, and thus is a great deal brighter, subjecting operators to strong ultraviolet light. The welding arc has a different range and strength of UV light wavelengths from sunlight, but the welder is very close to the source and the light intensity is very strong. Potential arc light damage includes accidental flashes to the eye or arc eye and skin damage similar to strong sunburn. Operators wear opaque helmets with dark eye lenses and full head and neck coverage to prevent this exposure to UV light. Modern helmets often feature a liquid crystal-type face plate that self-darkens upon exposure to the bright light of the struck arc. Transparent welding curtains, made of a polyvinyl chloride plastic film, are often used to shield nearby workers and bystanders from exposure to the UV light from the electric arc.

Welders often develop a technique of rapidly alternating between moving the torch forward (to advance the weld pool) and adding filler metal. The filler rod is withdrawn from the weld pool each time the electrode advances, but it is always kept inside the gas shield to prevent oxidation of its surface and contamination of the weld. Filler rods composed of metals with a low melting temperature, such as aluminium, require that the operator maintain some distance from the arc while staying inside the gas shield. If held too close to the arc, the filler rod can melt before it makes contact with the weld puddle. As the weld nears completion, the arc current is often gradually reduced to allow the weld crater to solidify and prevent the formation of crater cracks at the end of the weld [2].

Gas tungsten arc welding is most commonly used to weld stainless steel and nonferrous materials, such as aluminium and magnesium, but it can be applied to nearly all metals, with a notable exception being zinc and its alloys. Its applications involving carbon steels are limited not because of process restrictions, but because of the existence of more economical steel welding techniques, such as gas metal arc welding and shielded metal arc welding. Furthermore, GTAW can be performed in a variety of other-than-flat positions, depending on the skill of the welder and the materials being welded [3].

For GTAW of carbon and stainless steels, the selection of a filler material is important to prevent excessive porosity. Oxides on the filler material and workpieces must be removed before welding to prevent contamination, and immediately prior to welding, alcohol or acetone should be used to clean the surface. Preheating is generally not necessary for mild steels less than one inch thick, but low alloy steels may require preheating to slow the cooling process and prevent the formation of martensite in the heat-affected zone. Tool steels should also be preheated to prevent cracking in the heat-affected zone. Austenitic stainless steels do not require preheating, but martensitic and ferritic chromium stainless steels do [4].

Welding dissimilar metals often introduces new difficulties to GTAW welding, because most materials do not easily fuse to form a strong bond. However, welds of dissimilar materials have numerous applications in manufacturing, repair work, and the prevention of corrosion and oxidation. In some joints, a compatible filler metal is chosen to help form the bond, and this filler metal can be the same as one of the base materials (for example, using a stainless steel filler metal with stainless steel and carbon steel as base materials), or a different metal (such as the use of a nickel filler metal for joining steel and cast iron). Very different materials may be coated or *buttered* with a material compatible with a particular filler metal, and then welded. In addition, GTAW can be used in cladding or overlaying dissimilar materials.

When welding dissimilar metals, the joint must have an accurate fit, with proper gap dimensions and bevel angles. Care should be taken to avoid melting excessive base material. Pulsed current is particularly useful for these applications, as it helps limit the heat input. The filler metal should be added quickly, and a large weld pool should be avoided to prevent dilution of the base materials.

Welders are also often exposed to dangerous gases and particulate matter. While the process doesn't produce smoke, the brightness of the arc in GTAW can break down surrounding air to form ozone and nitric oxides. The ozone and nitric oxides react with lung tissue and moisture to create nitric acid and ozone burn. Ozone and nitric oxide levels are moderate, but exposure duration, repeated exposure, and the quality and quantity of fume extraction, and air change in the room must be monitored. Welders who do not work safely can contract emphysema and oedema of the lungs, which can lead to early death. Similarly, the heat from the arc can cause poisonous fumes to form from cleaning and degreasing materials. Cleaning operations using these agents should not be performed near the site of welding, and proper ventilation is necessary to protect the welder.

References:

1. American Welding Society. – Welding handbook, welding processes. – Part 1. Miami Florida: American Welding Society. – 2004.

2. Cary, H.B. Modern welding technology / H.B. Cary, S.C. Helzer. – Upper Saddle River. – New Jersey: Pearson Education. – 2005.
3. Jeffus, L.F. Welding: Principles and Applications / L.F. Jeffus. – Fourth edition. – Thomson Delmar. – 1997.
4. Tungsten Selection [Electronic resource]. – Mode of access: www.Arc-Zone.com. – Date of access: 03.03.2018.