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Industrial Welding Safety

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***Abstract*—Safety in welding is a very important aspect. Welding is one of the most widely used metal fabrication methods in world wide. Welding is safe operation when carried out under normal and correct workshop conditions, but it must be pointed out that equipment free from defects and well arranged, properly ventilated , tidy workplace are important factors for safe working.**

Even though, welding is carried out widely across the world, when certain basic measures and precautions are not followed, it results in injuries, so we suggest a better safety welding Techniques to reduce injuries and death.

***Index Terms*— Welding, Metal, Workshop, Death.**

I. Introduction

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal. In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that, based on weld configuration (butt, full penetration, fillet, etc.), can be stronger than the base material (parent metal). Pressure may also be used in conjunction with heat, or by itself, to produce a weld. Welding also requires a form of shield to protect the filler metals or melted metals from being contaminated or oxidized.

II. Major Welding Types

- Oxy-fuel welding – also known as oxyacetylene welding or oxy welding, uses fuel gases and oxygen to weld and cut metals.
- Shielded metal arc welding (SMAW) – also known as "stick welding" or "electric welding", uses an electrode that is coated in flux to protect the weld puddle. The electrode holder holds the electrode as it slowly melts away. Slag protects the weld puddle from atmospheric contamination.
- Gas tungsten arc welding (GTAW) – also known as TIG (tungsten, inert gas), uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas such as argon or helium.
- Gas metal arc welding (GMAW) – commonly termed MIG (metal, inert gas), uses a wire feeding gun that feeds wire at an adjustable speed and flows an argon-based shielding gas or a mix of argon and carbon dioxide (CO2) over the weld puddle to protect it from atmospheric contamination. MAG welding (metal, active gas) is similar but uses an active gas such as 75% Argon and 25% Carbon Dioxide which reacts with the molten weld puddle while also shielding it.
- Flux-cored arc welding (FCAW) – almost identical to MIG welding except it uses a special tubular wire filled with flux; it can be used with or without shielding gas, depending on the filler.
- Submerged arc welding (SAW) – uses an automatically fed consumable electrode and a blanket of granular fusible flux. The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under the flux blanket.
- Electroslag welding (ESW) – a highly productive, single pass welding process for thicker materials between 1 inch (25 mm) and 12 inches (300 mm) in a vertical or close to vertical position.
- Electric resistance welding (ERW) – a welding process that produces coalescence of laying surfaces where heat to form the weld is generated by the electrical resistance of the material. In general, an efficient method, but limited to relatively thin material.

III. Major Welding Methods

A. Submerged Arc Welding (SAW)

(SAW) is a common arc welding process. The first patenton the submerged-arc welding (SAW) process was taken out in 1935 and covered an electric arc beneath a bed of granulated flux. Originally developed and patented by Jones, Kennedy and Rothermund, the process requires a continuously fed consumable solid or tubular (metal cored) electrode. The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under a blanket of granular fusible flux consisting of lime, silica, manganese oxide, calcium fluoride, and other compounds. When molten, the flux becomes conductive, and provides a current path between the electrode and the work. This thick layer of flux completely covers the molten metal thus preventing spatter and sparks as well as suppressing the intense ultraviolet radiation and fumes that are a part of the shielded metal arc welding (SMAW) process. SAW is normally operated in the automatic or mechanized mode, however, semi-automatic (hand-held) SAW guns with pressurized or gravity flux feed delivery are available. The process is normally limited to the flat or

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horizontal-fillet welding positions (although horizontal groove position welds have been done with a special arrangement to support the flux). Deposition rates approaching 45 kg/h (100 lb/h) have been reported-this compares to ~5 kg/h (10 lb/h) (max) for shielded metal arc welding. Although currents ranging from 300 to 2000A are commonly utilized, currents of up to 5000 A have also been used (multiple arcs).Single or multiple (2 to 5) electrode wire variations of the process exist. SAW strip-cladding utilizes a flat strip electrode (e.g. 60 mm wide x 0.5 mm thick). DC or AC power can be used, and combinations of DC and AC are common on multiple electrode systems. Constant voltage welding power supplies are most commonly used; however, constant current systems in combination with a voltage sensing wire-feeder are available.

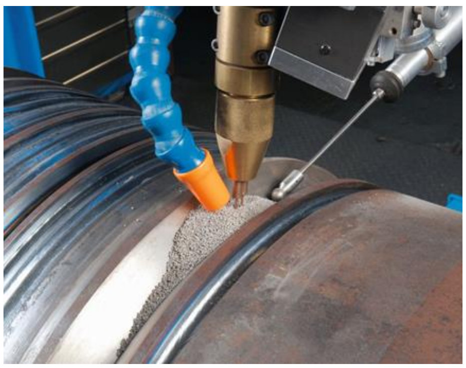

Fig. 1. Submerged arc welding

B. Shielded Metal Arc Welding

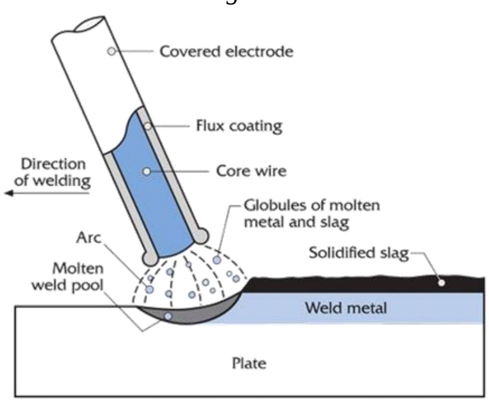

Fig. 2. Shielded metal arc welding

Shielded metal arc welding (SMAW), also known as manual metal arc welding (MMA or MMAW), flux shielded arc welding orinformally as stick welding, is a manual arc welding process that uses a consumable electrode covered with a flux to lay the weld.An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. The work piece and the electrode melts forming a pool of molten metal (weld pool) that cools to form a joint. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapors that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination. Because of the versatility of the process and the simplicity of its equipment and operation, shielded metal arc welding is one of the world's first and most popular welding processes. It dominates other welding processes in the maintenance and repair industry, and though flux-cored arc welding is growing in popularity, SMAW continues to be used extensively in the construction of heavy steel structures and in industrial fabrication. The process is used primarily to weld iron and steels (including stainless steel) but aluminium, nickel and copper alloys can also be welded with this method.

C. Oxy Fuel Welding

Oxy-fuel welding (commonly called oxyacetylene welding, oxy welding, or gas welding in the U.S.) and oxy-fuel cutting are processes that use fuel gases and oxygen to weld and cut metals, respectively. French engineers Edmond Fouché and Charles Picard became the first to develop oxygen-acetylene welding in 1903.Pure oxygen, instead of air, is used to increase the flame temperature to allow localized melting of the workpiece material (e.g. steel) in a room environment. A common propane/air flame burns at about 2,250 K (1,980 °C; 3,590 °F), a propane/oxygen flame burns at about 2,526 K (2,253 °C; 4,087 °F),an oxyhydrogen flame burns at 3,073 K (2,800 °C; 5,072 °F), and an acetylene/oxygen flame burns at about 3,773 K (3,500 °C; 6,332 °F).Oxy-fuel is one of the oldest welding processes, besides forge welding. In recent decades it has been obsolesced in almost all industrial uses due to various arc welding methods offering more consistent mechanical weld properties and faster application. Gas welding is still used for metal-based artwork and in smaller home based shops, as well as situations where accessing electricity (e.g., via an extension cord or portable generator) would present difficulties. In oxy-fuel welding, a welding torch is used to weld metals. Welding metal results when two pieces are heated to a temperature that produces a shared pool of molten metal. The molten pool is generally supplied with additional metal called filler. Filler material depends upon the metals to be welded.

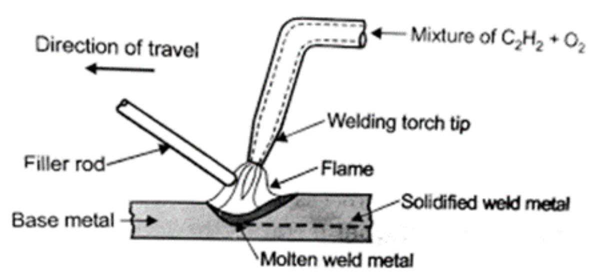

Fig. 3. Oxy fuel welding

D. Gas Tungsten Arc Welding

Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area and electrode is protected from oxidation or other atmospheric contamination by an inert shielding gas (argon or helium), and a filler metal is normally used, though some welds, known as autogenous welds, do not require it. A constant-current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionized gas and metal vapors known as a plasma. GTAW is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, and copper alloys. The process grants the operator greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, GTAW is comparatively more complex and difficult to master, and furthermore, it is significantly slower than most other welding techniques. A related process, plasma arc welding, uses a slightly different welding torch to create a more focused welding arc and as a result is often automated.

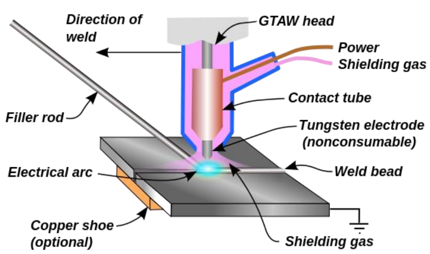

Fig. 4. Gas tungsten arc welding

E. Gas Metal Arc Welding

Gas metal arc welding (GMAW), sometimes referred to by its subtypes metal inert gas (MIG) welding or metal active gas (MAG) welding, is a welding process in which an electric arc forms between a consumable wire electrode and the work piece metal(s), which heats the work piece metal(s), causing them to melt and join. Along with the wire electrode, a shielding gas feeds through the welding gun, which shields the process from contaminants in the air. The process can be semi-automatic or automatic. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. There are four primary methods of metal transfer in GMAW, called globular, short-circuiting, spray, and pulsed-spray, each of which has distinct properties and corresponding advantages and limitations. Originally developed in the 1940s for welding aluminium and other non-ferrous materials, GMAW was soon applied to steels because it provided faster welding time compared to other welding processes. The cost of inert gas limited its use in steels until several years later, when the use of semi-inert gases such as carbon dioxide became common. Further developments during the 1950s and 1960s gave the process more versatility and as a result, it became a highly used industrial process. Today, GMAW is the most common industrial welding process, preferred for its versatility, speed and the relative ease of adapting the process to robotic automation. Unlike welding processes that do not employ a shielding gas, such as shielded metal arc welding, it is rarely used outdoors or in other areas of moving air. A related process, flux cored arc welding, often does not use a shielding gas, but instead employs an electrode wire that is hollow and filled with flux.

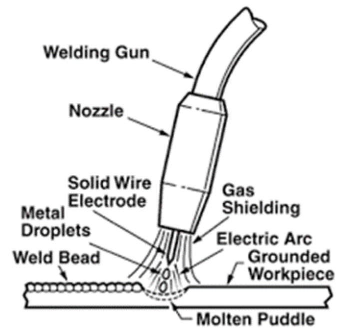

Fig. 5. Gas metal arc welding

IV. Major Welding Injuries

A. See the Danger

- Injuries to the eyes are among the most common concerns:
- Welder’s flash, arc eye or flash burn – caused by Ultraviolet (UV) and Infrared (IR) light (radiation) from the welding arc. UV affects the eye like a bad sunburn, but you probably won’t notice for a couple of hours. IR feels like intense heat as it scorches the retina and eventually causes cataracts. Radiation exposure is painful, will cost you a doctor’s visit and workdays.
- Sparks and hot metal drops/particles saturating the air
- Improper head distance from welders arc.


Fig. 6. Seeing the danger

B. Hear the Danger


Fig. 7. Hearing the danger

- If you can’t hear the guy standing next to you talking, then your ears and hearing may be vulnerable to common welding injuries:

- Flying debris and particles- penetrate and attack the ear canals
- Excessive noise (above 85 decibels averaged during 8-hour workday). That's about as loud as a bull-dozer idling.
- Ultra high-pitched, sustained noise damages the eardrums and inner ear.
- Possible hearing loss

C. A Nose for Trouble

- Inhaling toxic fumes from welding, such as paint, solvent residue and smoke.
- Inhaling chemicals like Manganese, found in welding rods, electrodes and wire.
- Causes a debilitating illness known as "Welder's Parkinson's."
- Chronic respiratory illnesses, due to inhaling metallic or mineral particles, such as iron oxide.
- Disorientation

Fig. 8. Nose for trouble

V. Welding Injuries Reduction Methods

- Provide enough ventilation wherever gas welding, cutting, and heating operations are performed. Proper ventilation will protect the operator from the evolving noxious fumes and gases.
- Protect against eye injury, mechanical injury, or other mishaps. Wear safety glasses with side shields when you are in any work area.
- Wear clean, fire-resistant, protective clothing. Some operations produce sparks and spatter. Protect all skin areas from sparks or spatter. Avoid spark and spatter traps by wearing a jacket with no pockets, and pants with no cuffs.
- Do not bring gas cylinders into confined areas
- Do not leave gas equipment in confined areas when not in use
- Cylinders, if mishandled, can rupture and violently release gas. Handle all cylinders with care. Misuse can cause injury or death.
- Use suitable hand trucks or racks for moving cylinders.
- Unless in use, cylinder valves should be kept closed at all times. This will prevent accidental release of gas.
- When manually lifting cylinders, do not raise them by the valve-protection cap. The cap may accidently and suddenly come loose. The cylinder may fall and rupture.
- Never use slings or electromagnets for lifting and transporting cylinders. Use a cradle or suitable platform when transporting them by crane or derrick.
- Never let the recessed top of a cylinder become filled with water, or be used as a place for tools. Nothing should interfere with quick closing of the cylinder valve, or possibly damage the fusible plugs or other safety-relief devices in the cylinder head.
- Never use any cylinder, full or empty, as a roller or support. The cylinder walls may be damaged and result in rupture or explosion.
- Never transfer any gas from one cylinder to another or attempt to mix any gases in a cylinder. Any attempt to transfer or mix gases could result in a cylinder rupture or explosion.
- Cylinders should not be placed where they might become part of an electrical circuit. They must never be used as a grounding connection. Accidental arcing could cause a local defect (arc-burn) which could lead to eventual cylinder rupture.
- Store all gas cylinders in a separate, dry, well-ventilated room. Do not let full or empty cylinders stand around and clutter up work areas. They may interfere with operations, and they may be subjected to damage. Do not drop stub ends of welding rods on the floor. Put them in a suitable container. Aside from the fire hazard created by carelessly dropped stub ends, a serious fall might result from stepping on them. A container partly filled with water and within easy reach is a good place to dispose of these short ends.
- Bushings in castings should be either removed or securely fastened in place before heating the casting. Bronze bushings expand more than cast iron when heated. Besides the possibility of damaging the bushing if left in place, the greater expansion may cause it to fly out, unexpectedly. If the bushing cannot be removed, it should be securely fastened in place. Bolting large washers or pieces of plate over the ends of the bushing is a suit-able method.

VI. Results

A. Good Housekeeping

Good housekeeping, especially the removal of combustible materials, is essential.

B. Gas

If you can smell gas – don't light any gas torches or use electric welding equipment, but don't rely wholly on your sense of smell to warn you.

C. Eye Protection

Wear eye protection and cover bare skin.

D. Hot Surfaces

Mark hot surfaces as such. Better still, assume everything is hot.

E. First Aid

In addition to standard training, first-aiders in welding situations should know about the symptoms of electric shock, arc flash and the consequences of exposure to heated coatings on metals (e.g. when galvanized metal is welded).

F. Safety Equipment and Clothing

Safety equipment is a must when welding. Start with gauntlet-style welding gloves that are dry and water resistant with no holes or tears, a welding helmet and either a heavy cotton shirt or a jacket made specifically for welding. Wear heavy boots and pants that cover the tops of the boots. Make sure you are not wearing loose or long pieces of clothing. When welding in a confined space, use a welding helmet with forced air or use respirators. Respirators should be applicable and suitable for the purpose intended. Depending on the type of respirator, the employee may have to be fit-tested as well. This requires a medical evaluation.

G. Secure Your Surroundings

Make sure your surroundings are safe and secure. Remove flammable material from the work space, including paper, clothing, combustible items and liquids. Frequently check that all wires and electrical circuits are functioning and not damaged. Any damaged electrical outlets or wires must be tagged and replaced before returning them to work. Turn off and disconnect all equipment when not in use, out of service or damaged.

VII. Conclusion

Fig. 9. Provide proper gas lines

Fig. 10. Wear proper welding uniform

Fig. 11. Provide underground electric cables

Fig. 12. Provide first aid kit on every welding areas

Fig. 13. Provide fire extinguisher in every welding areas

Fig. 14. Provide safety signs in all over industry

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