

API 577

Chapter-5

Key points

- Basic processes: **SMAW, GTAW, GMAW, FCAW, SAW, SW.**

SMAW:

- Most widely used process.
- **Uses an arc between a covered electrode and the weld pool.**
- Employs the heat of an arc coming from the tip of an electrode to melt the base metal
- Shielding is provided from the decomposition of the electrode covering, without the application of pressure and with filler metal from the electrode.
- Either AC or DC may be employed
- CC supply is preferred
- Manual welding process
- Electrode covering:
- Provides a gas to shield the arc and prevent excessive atmospheric contamination of the molten filler metal
- Provides scavengers, deoxidizers, and fluxing agents to cleanse the weld and prevent excessive grain growth in the weld metal.
- Establishes the electrical characteristics of the electrode
- Provides a slag blanket to protect the hot weld metal from the air and enhances the mechanical properties, bead shape, and surface cleanliness of the weld metal.
- Provide means of adding alloying elements to change the mechanical properties of the weld metal.

Advantages and disadvantages:

Advantages

- Equipment relatively simple
- Process can be used in areas of limited access
- Less sensitive to wind and draft than other welding processes
- Suitable for most of the commonly used metals and alloys

Disadvantages

- Deposition rates are lower than for other processes such as GMAW
- Slag removal at start and stops before depositing to a weld bead adjacent to or onto a previously deposited weld bead.

GTAW:

- Uses an arc between a non-consumable tungsten electrode and the weld pool
- Process is used with shielding gas and without the application of pressure
- Can be used with or without the addition of filler metal
- CC power supply can be used with either dc or ac, choice largely depends on the metal to be welded

- DC welding is normally performed with EN polarity i.e. DCEN
- DCEN offers the advantage of deeper penetration and faster welding speeds
- AC provides a cathodic cleaning(sputtering) that removes refractory oxides from the surfaces of the weld joint, which is necessary for the welding of Al and Mg. The cleaning action occurs during the portion of ac wave, when the electrode is positive with respect to the work piece.

Advantages:

1. Produces high purity welds, **generally free from defects**
2. **Little post weld cleaning**
3. Allows excellent control of **root pass weld penetration**
4. Can be used with or without filler metal, dependent on the application

Disadvantages:

1. Lower deposition rates than consumable electrode arc welding processes
2. Low tolerance for contaminants on filler or base metal
3. **Difficulty in shielding the weld zone properly in drafty environments**

GMAW:

- Uses an arc between continuous filler metal electrode and the weld pool
- The process is used with shielding from and externally supplied gas and without the application of pressure
- Operates in semiautomatic, machine or automatic modes
- Employs a CV supply
- Uses either **short circuiting, globular or spray methods** to transfer metal from the electrode to work
- Type of transfer depends on number of factors such as

1. Magnitude and type of welding current
2. Electrode dia
3. Electrode composition
4. Electrode extension
5. Shielding gas

▪ Short circuiting transfer(GMAW-S)

Produces a **fast freezing weld pool** that is generally **suited for joining thin sections, out of position, or root pass**. Due to this nature there are **chances of Lack of side wall fusion when welding thick wall equipment or a nozzle attachment**.

▪ Globular Transfer

1. Encompasses relatively low current
2. Characterized by a drop size with a diameter greater than that of the electrode
3. **Limited to flat position** and can produce spatter

▪ Spray transfer

1. Highly directed stream of discrete drops that are accelerated by arc forces
2. Spatter is negligible
3. Due to high arc forces with high current, applying this process to thin sheets may be difficult
4. This thickness limitation can be overcome by the use of pulsed GMAW. Pulsed GMAW is a variation of the GMAW in which the current is pulsed to obtain the advantage of spray transfer at the less average currents than that of spray transfer mode.

Advantages of GMAW:

1. The only consumable electrode process that can be used to weld most commercial metals and alloys
2. Deposition rates are significantly higher than those obtained with SMAW
3. Minimal post cleaning is required due to absence of a slag

Disadvantages of GMAW:

1. Welding equipment is more complex, more costly and less portable than that for SMAW
2. The welding arc should be protected from air drafts that will disperse the shielding gas
3. When using GMAW-S process, the weld is more susceptible to Lack of adequate fusion.

FCAW:

1. Arc welding process that uses an arc **between continuous tubular filler metal electrode and the weld pool**
2. The process is used **with shielding gas evolved from a flux obtained within the tubular electrode, with or without additional shielding from an externally supplied gas, and without the application of pressure.**
3. DC constant voltage type(CV) similar to sources used for GMAW

Advantages of FCAW:

1. **Metallurgical benefits can be derived from a flux**
2. **Slag that supports and shapes the weld bead**
3. **High deposition and productivity rates** than other processes such as SMAW
4. **Shielding is produced at the surface of the weld that makes it more tolerant for stronger air currents than GMAW**

Disadvantages of FCAW:

1. **Equipment is more complex, more costly and less portable than that for SMAW**
2. Self-shielding FCAW **generates large volumes of welding fumes, and requires suitable exhaust equipment**
3. **Slag removal between passes**
4. **Backing material is required for root pass welding**

SAW:

1. Uses an arc or arcs between a flux covered bare metal electrode and the weld pool
2. The arc and the molten metal are shielded by a blanket of granular flux, supplied through the welding nozzle from a hopper
3. Process is used without pressure and filler metal from the electrode and sometimes from a supplemental source

4. Can be applied in 3 different modes: Semi-automatic, automatic and Machine
5. Can utilize either a **CV** or a **CC power** supply
6. Use extensively in shop vessel fabrication and pipe manufacturing

Advantages:

1. Provides very high metal deposition rates
2. Produce repeatable high quality welds for large weldments and repetitive short welds

Disadvantages:

1. A power supply capable of providing high amperage at 100% duty cycle is recommended
2. Weld is not visible during the welding process
3. Equipment required is more costly and extensive, and less portable
4. Process is limited to shop fabrication and **flat position**.

SW (Stud arc welding):

1. An arc welding process **that uses an arc between a metal stud or similar part and the work piece**
2. **Shielding gas or flux may be used**
3. Process may be **fully or semi-automatic**
4. **DC is typically used with the stud Gun is connected to Negative terminal(DCEN)**
5. **CC type power source**
6. Uses in **welding insulation** and **refractory support pins to tanks, pressure vessels and heater casing**

Advantages:

1. High productivity rates compared to manually welding stud to base metal
2. Considered in all position processes

Disadvantages:

1. **Primarily suitable only for CS and LAS**
2. Only specialized for few applications