

Training Objective

After watching this video and reviewing the printed material, the student/trainee will gain a knowledge and understanding of the role of various welding processes used in industry today.

- A guide to process selection is presented
- Fusion welding methods are explained
- Solid state welding methods are detailed
- The operative aspects of the processes and their applications are given.

Welding Processes

The selection of a specific welding process is dependent upon many factors. The geometric shape of the weldment itself is the result of joint designs which, in several forms, is central to the issue of process applicability. Additionally, alloys to be welded, size and thickness', costs, portability, and skills needed, are among the many important weld process characteristics to be considered.

The two basic forms of joining, or the coalescing of metals, are by fusion and solid state welding. The principle fusion welding processes include:

- arc welding
- resistance welding
- laser beam welding
- electron beam welding

Common to these methods is the melting of the base metal and, though not always, the addition of a filler metal.

Electric arc welding, in general, will use a consumable electrode to create the arc and then as melting occurs, the rod itself becomes part of the fused joint. Some arc welding methods use a tungsten electrode which is non-consumable and if a filler metal is required, it is added separately as a bare wire. The major arc welding processes are:

- shielded metal arc welding
- submerged arc welding
- gas metal arc welding
- flux-cored arc welding
- gas tungsten arc welding
- plasma arc welding

Shielded metal arc welding uses a flux covered consumable electrode which in the heat of the arc forms a gaseous shield to protect the weld puddle from the atmosphere. Welding current is either AC or DC and the process is used primarily on the ferrous metals.

Submerged arc welding is a semi or fully automatic process in which the arc takes place under or submerged in a blanket of granular flux. Equipment includes weld wire feeding devices and joint-tracking mechanisms which move either the welding head or the work.

Gas metal arc welding uses a bare wire fed through a manually manipulated gun or torch. Weld shielding is obtained from a flow of inert gas, usually argon or argon mixtures. Weld characteristics are largely determined by the actual mode of metal transfer across the arc. The three basic modes are short circuiting, spray transfer, and globular transfer.

Flux-cored arc welding is essentially a variation of the gas metal arc welding process. The principle difference is in the use of weld wire that is tubular and contains within its core a granulated flux.

Gas tungsten arc welding uses a non-consumable tungsten electrode along with argon, helium, or mixtures of the two to shield the weld. Weld filler rod is usually manually added and depending on the type of metal being welded will use either AC or DC straight polarity current.

Plasma arc welding utilizes a constricted arc made up of a high velocity stream of ionized gas or plasma. Additionally, there is a separate shielding gas of argon or argon mixtures used. The plasma arc process affords very deep penetration at higher welding speeds.

Resistance welding includes the spot, seam, and projection welding processes. Spot welding occurs when the work is squeezed between two copper electrodes which have an electric current flowing between them. In seam welding, the electrodes are in the form of opposing wheels which effect a continuous fused joint or seam. In projection welding, fusion occurs at predetermined locations characterized by embossments, projections, or joint intersections. Most resistance welding methods are semi-automatic and manually operated or may be fully automatic.

Laser beam welding uses a focused beam of light as a heat source. The two most common types are the gas or "CO₂" laser and the solid state or "YAG" laser. The more powerful gas laser can weld thick as well as very thin workpieces, while the solid state laser is used only for the thinner work. Laser welding is particularly useful in joining dissimilar metals and in welding the refractory metals. Welding may take place in a high or partial vacuum or at atmospheric pressures.

Solid State Welding

The two most used solid state welding processes are friction welding and ultrasonic welding. Friction welding is accomplished by the action of friction and axial force. Usually appearing as either butt or T-joints, one rapidly rotating member is brought into contact with a stationary member. When, through friction, the proper surface temperature is reached, an upsetting action or motion completes the weld. Friction welding is used to join many combinations of metallic and non-metallic materials.

Ultrasonic welding occurs when two pieces, in a lap joint configuration, are subjected to a high frequency vibratory energy with the same amount of force or pressure. There is relatively little heat generated by the process. The workpieces are clamped between two welding tips called sonotrodes. Vibrating energy passes through one or both which oscillate laterally as a perpendicular force maintains contact between the work surfaces. Such interfacing generates temperatures reaching only 35 to 50 percent of the workpiece's melting temperature. Basic equipment includes a power supply and a frequency generator which increase line frequency to generally 15,000 to

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75,000 hertz. There are also transducers that convert that power to an acoustical power of the same frequency.

Ultrasonic welding usually requires that one of the workpieces be thinner than it's mating piece. The usual weld joints are spot or straight and circular seams. Metals welded are commonly the more ductile types, either similar or dissimilar. The principle users of the process are the electrical and electronic industries.

Review Questions

1. Weld process applicability is most dependent upon:
 - a. portability
 - b. size
 - c. cost
 - d. joint design

2. A consumable electrode is one which:
 - a. is replaceable
 - b. becomes part of the weld
 - c. generates a shield
 - d. is made of tungsten

3. Submerged arc welding takes place:
 - a. underwater
 - b. in a cloud of gas
 - c. between work surfaces
 - d. under a blanket of granular flux

4. A principle shielding gas is:
 - a. oxygen
 - b. helium
 - c. nitrogen
 - d. argon

5. Plasma arc welding requires:
 - a. consumable electrode
 - b. a separate gas shielding system
 - c. AC current
 - d. slower welding speeds

6. Resistance welding is:
 - a. non-fusing or melting
 - b. suitable for non-ferrous metals only
 - c. uses copper electrodes
 - d. requires full automation

7. Laser beam welding usually takes place in:
 - a. a high vacuum
 - b. a partial vacuum
 - c. the atmosphere
 - d. all of the above

8. Friction welding joints are:
 - a. usually lap joints

 - b. butt or T-joints
 - c. always T-joints
 - d. applicable to any joint type

9. Ultrasonic welding uses:
 - a. high frequency energy
 - b. intense heat
 - c. high compression forces
 - d. radiation

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10. Ultrasonic welding usually requires:
 - a. workpieces of equal thickness
 - b. workpieces of unequal thickness
 - c. very thin workpieces
 - d. very thick workpieces

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Answer Key

1. d
2. b
3. d
4. d
5. b
6. c
7. d
8. b
9. a
10. b