

Introduction to Welding Technology

Introduction to Welding Technology – Study Notes

1. What Is Welding?

- **Definition:** A fabrication process that joins two or more metal (or thermoplastic) parts by heating the material to its melting point, applying pressure, and/or adding filler material.
 - **Purpose:** Create permanent, strong, and leak-tight joints for structures, machines, pipelines, and consumer products.
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2. Basic Concepts & Terminology

Term	Meaning
Base Metal	The workpiece(s) being joined.
Filler Metal (Electrode)	Consumable material added to the joint to fill the gap.
Heat-Affected Zone (HAZ)	Area of the base metal whose microstructure changes due to welding heat, but which does not melt.
Weld Pool	Molten metal pool created during the welding operation.
Penetration	Depth that the weld metal extends into the base metal.
Joint Design	Geometry of the parts to be joined (e.g., butt, lap, fillet, corner).
Shielding	Gas or flux used to protect the molten weld from atmospheric contamination.

3. Major Welding Processes

Process	Energy Source	Typical Applications	Advantages	Limitations
Shielded Metal Arc Welding (SMAW)	Manual electric arc	Construction, repair, pipelines	Simple, portable, inexpensive	Slower, limited to thicker sections

Introduction to Welding Technology

Process	Energy Source	Typical Applications	Advantages	Limitations
Gas Metal Arc Welding (GMAW / MIG)	Continuous wire feed + shielding gas	Automotive, fabrication	High deposition rate, easy automation	Sensitive to wind, requires gas supply
Gas Tungsten Arc Welding (GTAW / TIG)	Non-consumable tungsten electrode + shielding gas	Aerospace, thin sheet, stainless steel	Precise control, clean welds	Slower, higher skill level
Flux-Cored Arc Welding (FCAW)	Wire with flux core (with/without shielding gas)	Shipbuilding, heavy structural steel	High productivity, can be used outdoors (self-shielded)	More smoke, heavier equipment
Submerged Arc Welding (SAW)	Arc beneath a blanket of granular flux	Long straight seams, pipe production	Very high deposition, deep penetration	Limited to flat/horizontal positions
Resistance Spot Welding (RSW)	Electrical resistance + pressure	Automotive body panels	Fast, repeatable, no filler metal	Limited to thin sheet metal
Laser & Electron Beam Welding	High-energy laser or electron beam	High-precision, aerospace, medical	Minimal HAZ, high speed, deep penetration	Expensive equipment, requires vacuum (EBW)
Friction Stir Welding (FSW)	Rotating tool generates frictional heat	Aluminum, aerospace, shipbuilding	Solid-state (no melting), low distortion	Limited to compatible materials, tool wear

4. Joint Preparation & Design

1. **Cleaning** – Remove rust, oil, paint, and scale (mechanical grinding, chemical cleaning).
2. **Fit-up** – Align parts with proper gap, root opening, and bevel angles.
3. **Root Gap** – Typical 1–2 mm for most butt joints; larger gaps may be needed for thick plates.
4. **Bevel Angles** – Commonly 30°–45° for V-groove butt joints; adjust for material thickness.

Introduction to Welding Technology

5. **Tack Welding** – Small welds to hold parts in place before the final pass.