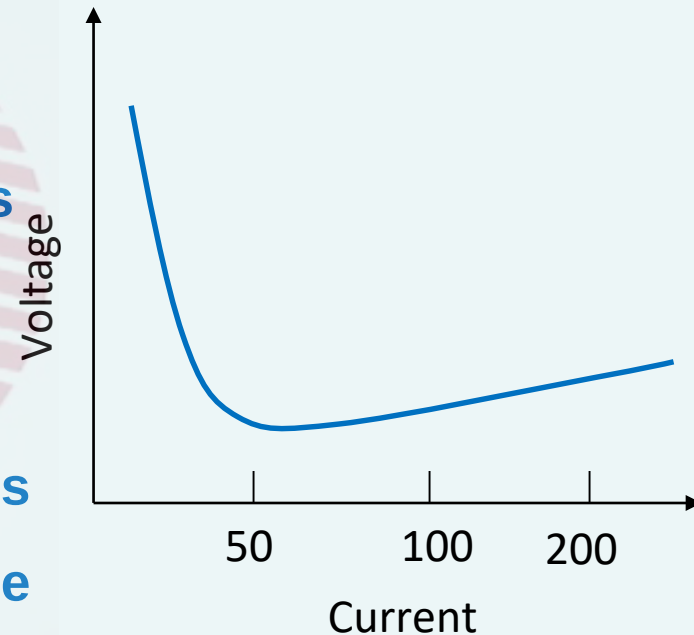


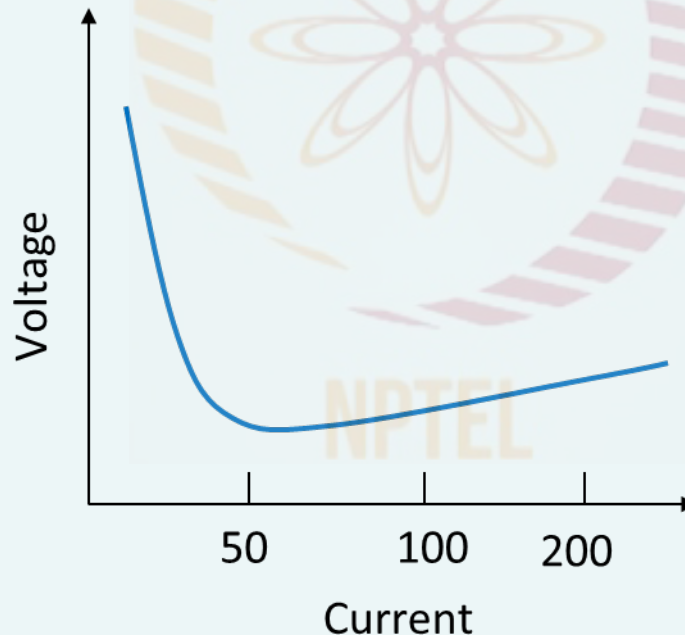
Current voltage characteristic of an arc

- For a given electrode material, voltage reduces with increasing current up to 50 Amp and increases thereafter.
- Until 50 Amps, shape of the arc is almost cylindrical. Surface/volume ratio decreases with increasing radius.
- Until 50 Amp, the arc radius increases and shape remains cylindrical $\rightarrow$ dissipates less heat $\rightarrow$ conductivity increases $\rightarrow$ resistance R decreases $\rightarrow$ voltage V decreases



Current voltage characteristic of an arc

- Beyond 50 Amps, the arc bulges out → the current path becomes more than the arc gap → resistance to current flow increased → voltage increases



Electrode polarity

Typically, direct current is used, and two different polarity is considered:

DCEN (Straight polarity): Direct Current Electrode Negative. Electrode is -ve and workpiece is +ve.

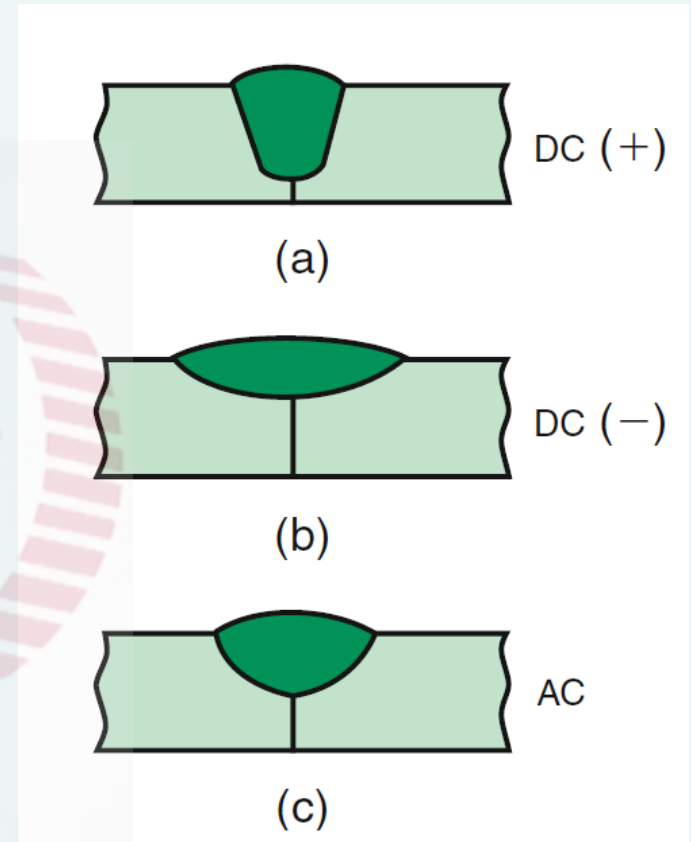
This method produces deep and narrow weld.

DCEP (Reverse polarity): Direct Current Electrode Positive. Electrode is +ve and workpiece is -ve.

This method produces wider and shallower weld.

Weld penetration is less – used for welding sheet metals

Using an **AC current supply**, the current pulsates rapidly. This method is suitable for welding thick sections and for using large diameter electrodes at maximum currents.



The effect of polarity and current type on weld beads (a) DCEN (b) DCEP (c) AC current

Shielded Metal Arc Welding (SMAW)

Uses a consumable electrode consisting of a filler metal rod coated with chemicals that provide flux and shielding

- Sometimes called "stick welding" **[VIDEO]**

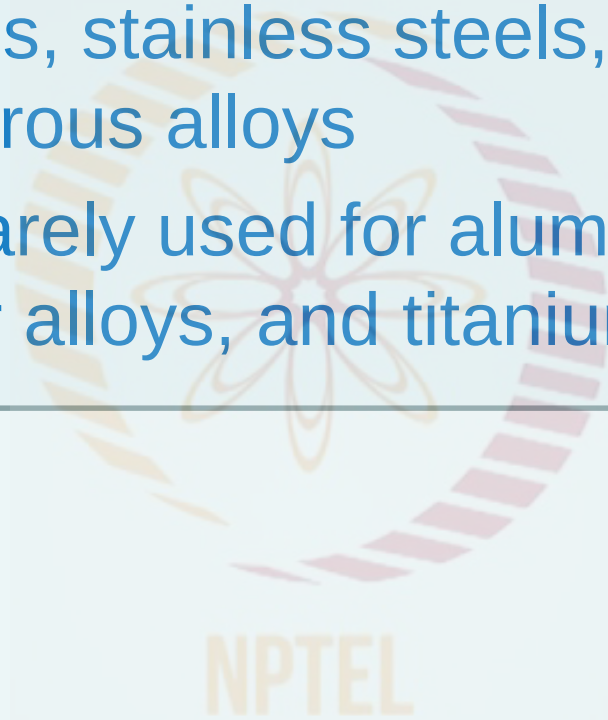


Welding Stick in SMAW

- Composition of filler metal usually close to base metal
- Coating consists of powdered cellulose mixed with oxides, carbonates, and other ingredients, held together by a silicate binder
- Welding stick is clamped in electrode holder connected to power source
- Disadvantages of stick welding:
 - Sticks must be periodically changed
 - High current levels may melt coating prematurely

SMAW Applications

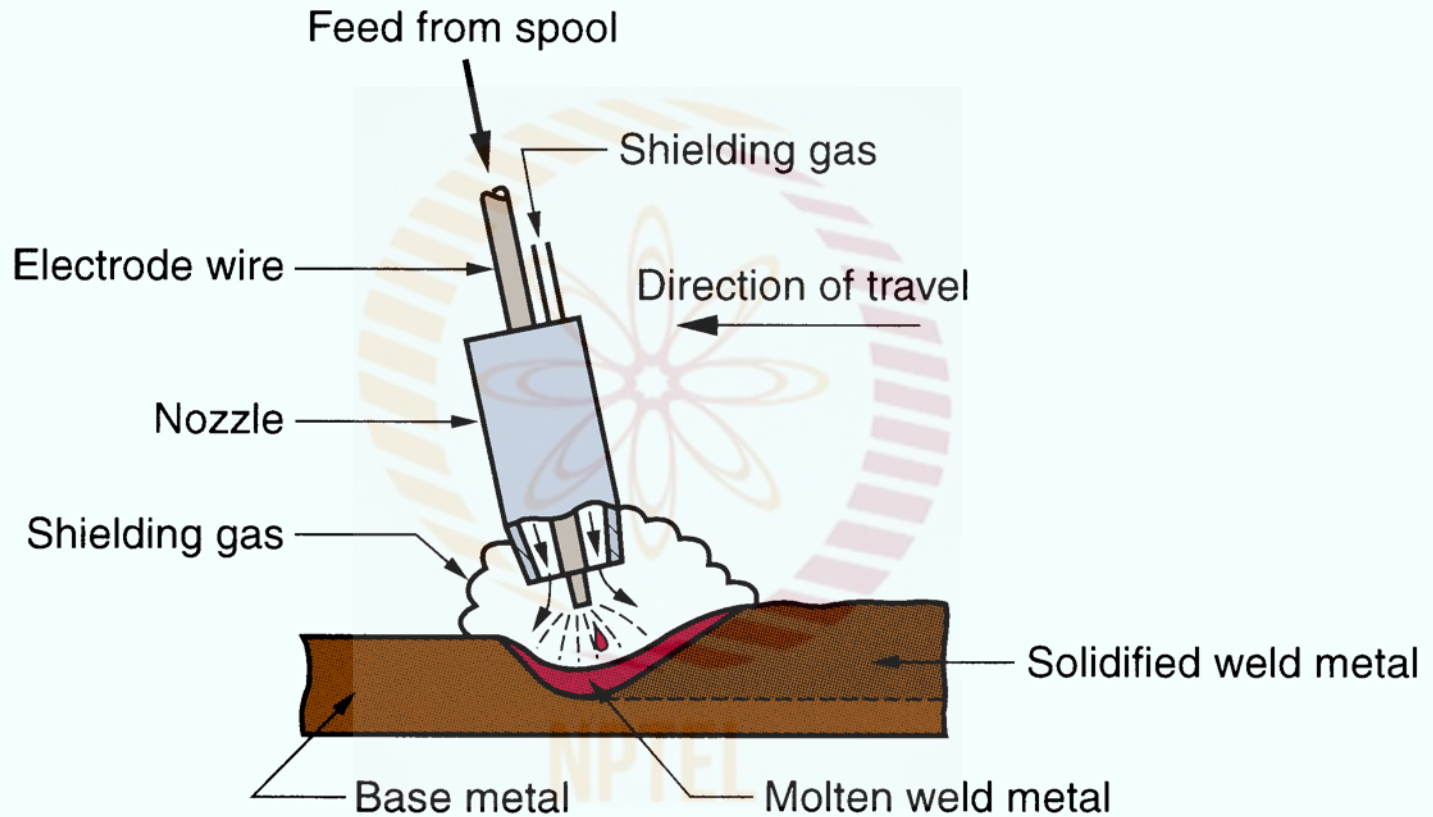
- Used for steels, stainless steels, cast irons, and certain nonferrous alloys
- Not used or rarely used for aluminum and its alloys, copper alloys, and titanium



Gas Metal Arc Welding (GMAW)

Uses a consumable bare metal wire as electrode and shielding accomplished by flooding arc with a gas

- Wire is fed continuously and automatically from a spool through the welding gun
- Shielding gases include inert gases such as argon and helium for aluminum welding, and active gases such as CO_2 for steel welding
- Bare electrode wire plus shielding gases eliminate slag covering on weld bead - no need for manual grinding and cleaning of slag

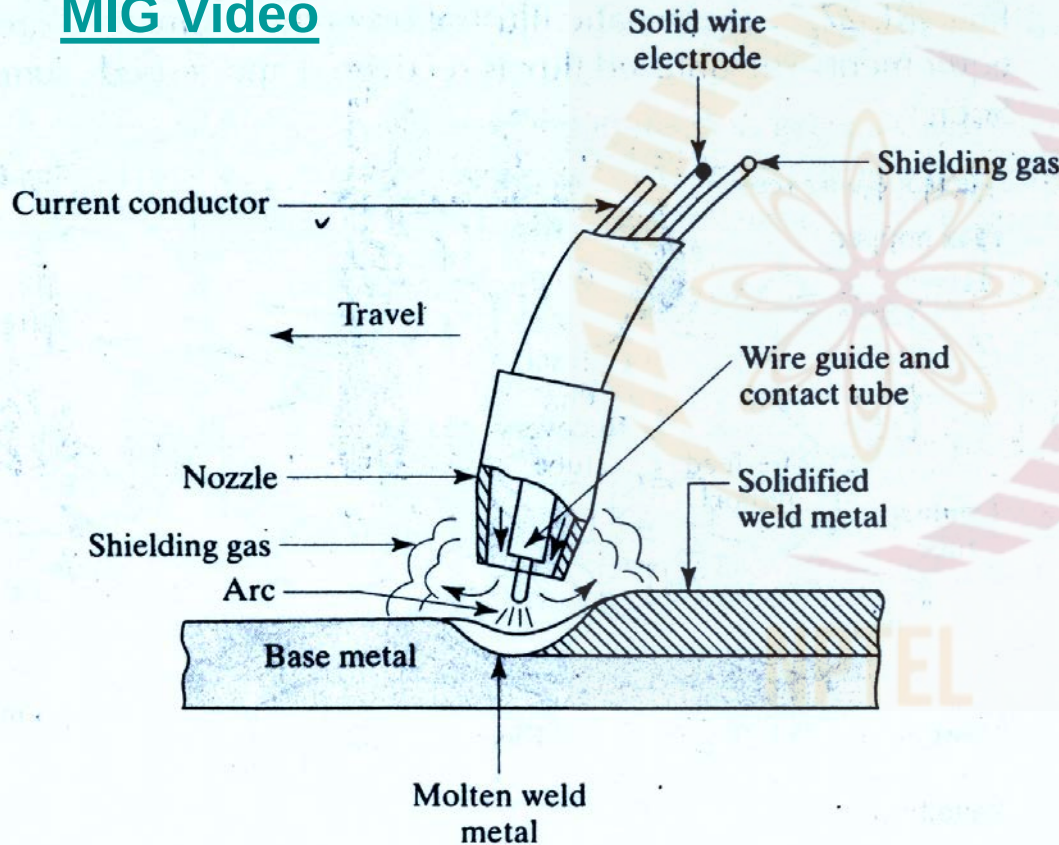


Gas metal arc welding (GMAW)

Liquid State (Fusion) Welding

Metal-Inert Gas Welding (MIG) or Gas Metal Arc Welding

MIG Video



- Weld area shielded by inert gas: Ar, He, CO₂

- Used for welding a variety of ferrous & non-ferrous metals

- The coiled electrode wire is fed by drive rolls as it melts away at the tip.

- Except for Aluminium, a DC source is used with the consumable electrode as + ive terminal.

Current density – 10,000 amp/cm²; Welding current is 100 – 300 amp.

Gas Metal Arc Welding Advantages over Shielded Metal Arc Welding

- Better arc time because of continuous wire electrode
 - Sticks must be periodically changed in SMAW
- Better use of electrode filler metal than SMAW
 - The end of the stick cannot be used in SMAW
- Higher deposition rates
- Eliminates problem of slag removal
- Can be readily automated

Arc Welding Processes that use Nonconsumable Electrodes

- Gas Tungsten Arc Welding
- Plasma Arc Welding
- Carbon Arc Welding
- Stud Welding



Gas Tungsten Arc Welding (GTAW)

Uses a nonconsumable tungsten electrode and an inert gas for arc shielding

- Melting point of tungsten = 3410°C (6170°F)
- Also called *TIG welding* (Tungsten Inert Gas welding)
 - In Europe, called "WIG welding"
- Used with or without a filler metal
 - When used, filler metal is added to weld pool from separate rod or wire
- Applications: aluminum and stainless steel most common