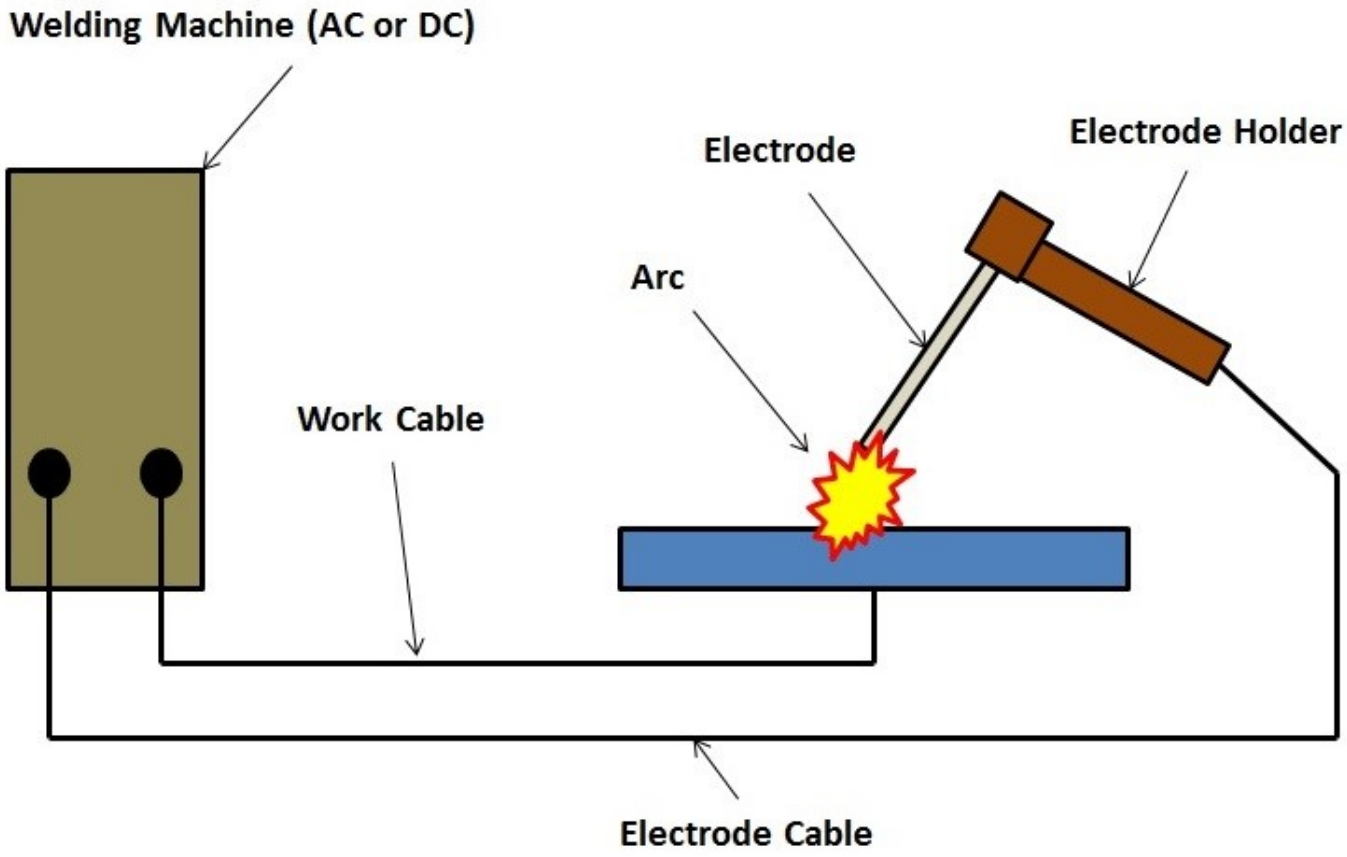
Arc welding

- Electric arc is produced when current flows across the air gap between the end of metal electrode and work surface.
- Electric discharge occurring in the air gap.
- The temperature at centre of arc is 6500C.
- Only 3600C is utilized for melting of metal.
- **Arc welding** is a welding process that is used to join metal to metal by using electricity to create enough heat to melt metal, and the melted metals when cool result in a binding of the metals.

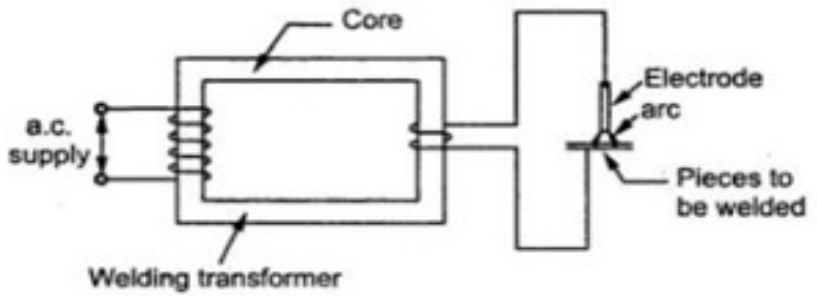


Basic Arc Welding Circuit Diagram

- Equipments:
- Transformer: To change high voltage and low amperage to a low voltage 20-80 V and high 80-500 amps.
- In arc welding, the voltage is directly related to the length of the arc, and the current is related to the amount of heat input.
- Generator: Driven by motor. Generates D.C.
- Rectifier: The output of step down transformer is to rectifier to converts A.C. to D.C.
- Electrode: Metal stick to create arc.

A.C.plant:

- Simple, less cost, No moving parts, low maintenance cost, no change of polarity.
- Gives smoother arc when using high current.
- Not suitable for non-ferrous and thin sheets.
- Electric shock is more intense.



- D.C.Plant
- Can be used for ferrous ,non-ferrous & thin sheets
- Stable arc, fine settings are possible
- Easy of operation, suitable for over head welding.
- Safer to use.
- More expensive, high maintenance cost, arc blow(arc is forced away from weld point).

- Polarity: It indicates the direction of current flow in D.C. In D.C. 2/3 of heat is liberated from + end and 1/3 of heat is liberated from

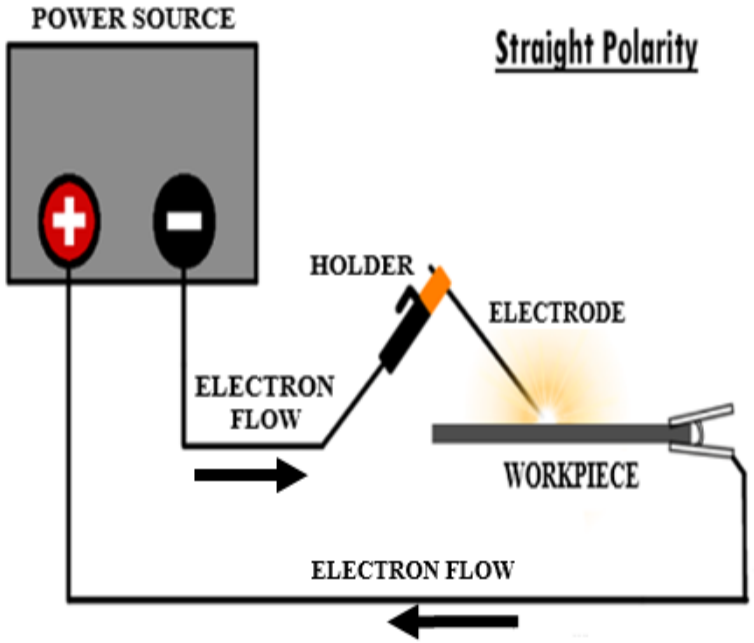
 - end.

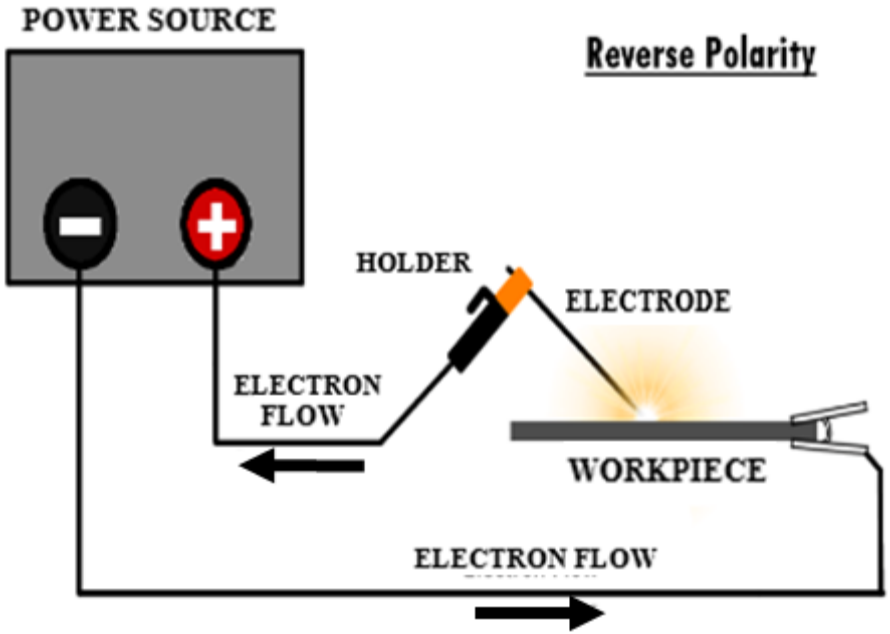
Straight polarity(-) : the electrode is connected to – terminal and work piece is to + terminal.

It is used for thicker sections with light and medium coated electrodes.

Reverse polarity(+) : the electrode is connected to + terminal and work piece is to – terminal.

- It is used for non-ferrous & cast Iron with heavy coated electrodes.





- Welding Positions: Flat, Horizontal, vertical, over head . The electrode is inclined 10-25 degrees I the direction of travel.
- Flux: Acidic, Basic, cellulose, Rutile, any other.
- Coating factor: ratio of dia. of electrode with coating to the core.
- Light coated C.F.= 1.25-1.3
- Medium coated C.F.=1.4-1.5
- Heavy coated C.F.=1.6-2.2

- Flux provides gaseous shielding from the atmosphere , stabilizes the arc, to prevents formation of oxides on surface, dissolves impurities forms slag, slowdown the rate of cooling, provides alloying elements.
- Electrodes:
- Consumable: It creates arc & feeds filler metal
- Bare (Extra shielding is required) and coated.
- Non-consumable: It creates only arc. Extra filler rod is required.

- Codification of electrodes:
- 1) IS:814
- Prefix letter ‘E’ covered electrode manufactured by extrusion process.
- Second letter A,B,C,R,S
- First digit: 4 – UTS-410-510N/mm2 YS 330

  5- UTS-510-610N/mm2 YS 360

Second digit for 4--- 1,2,3,4 % of elongation, Impact strength.

5---- 1,2,3,4,5,6.

- Third digit welding position:

1-all, 2-all except VD, 3-flat butt, Flat fillet, horizontal/vertical fillet., 4-flat butt, Flat fillet,

5-VD, flat butt, Flat fillet, horizontal/vertical fillet,6-any other positions.

Fourth digit: Current conditions:

Additional: H1- 15ml diffusible H,

H2 -10ml diffusible H,

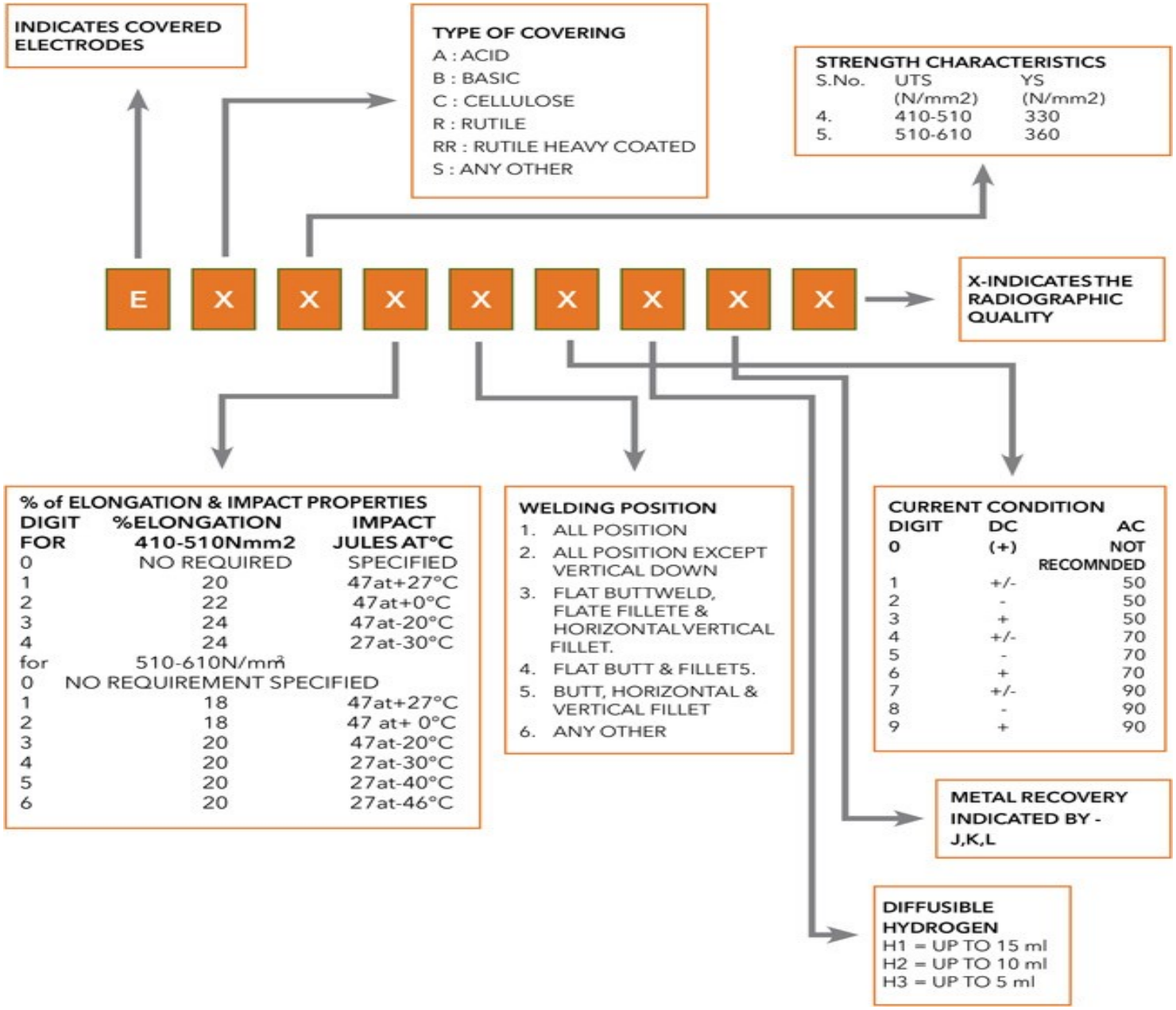
H3- 5ml diffusible H,

J- 110-129% metal recovery

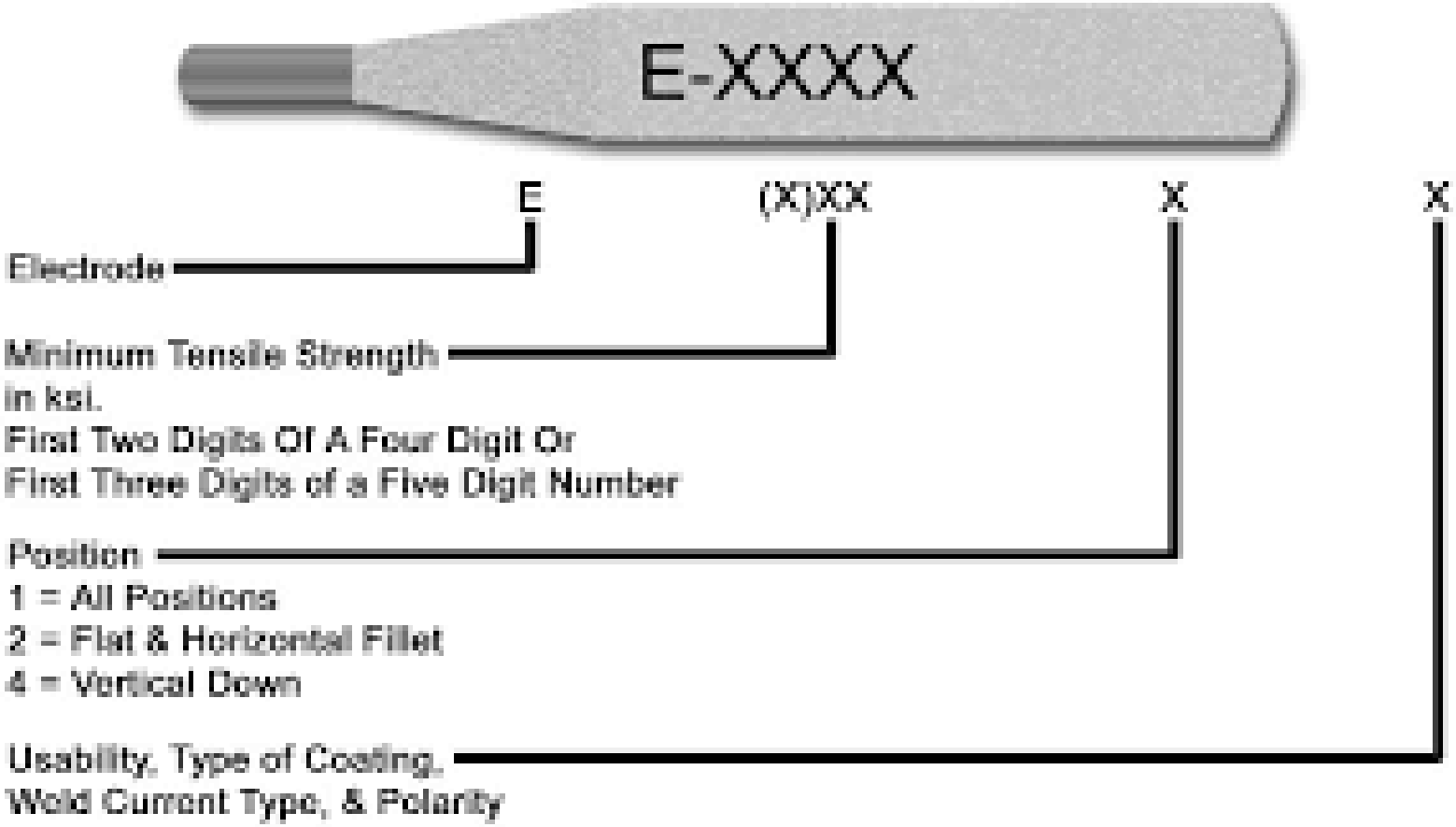
K-130-149% metal recovery

L-150% and above metal recovery

X- radiography quality.

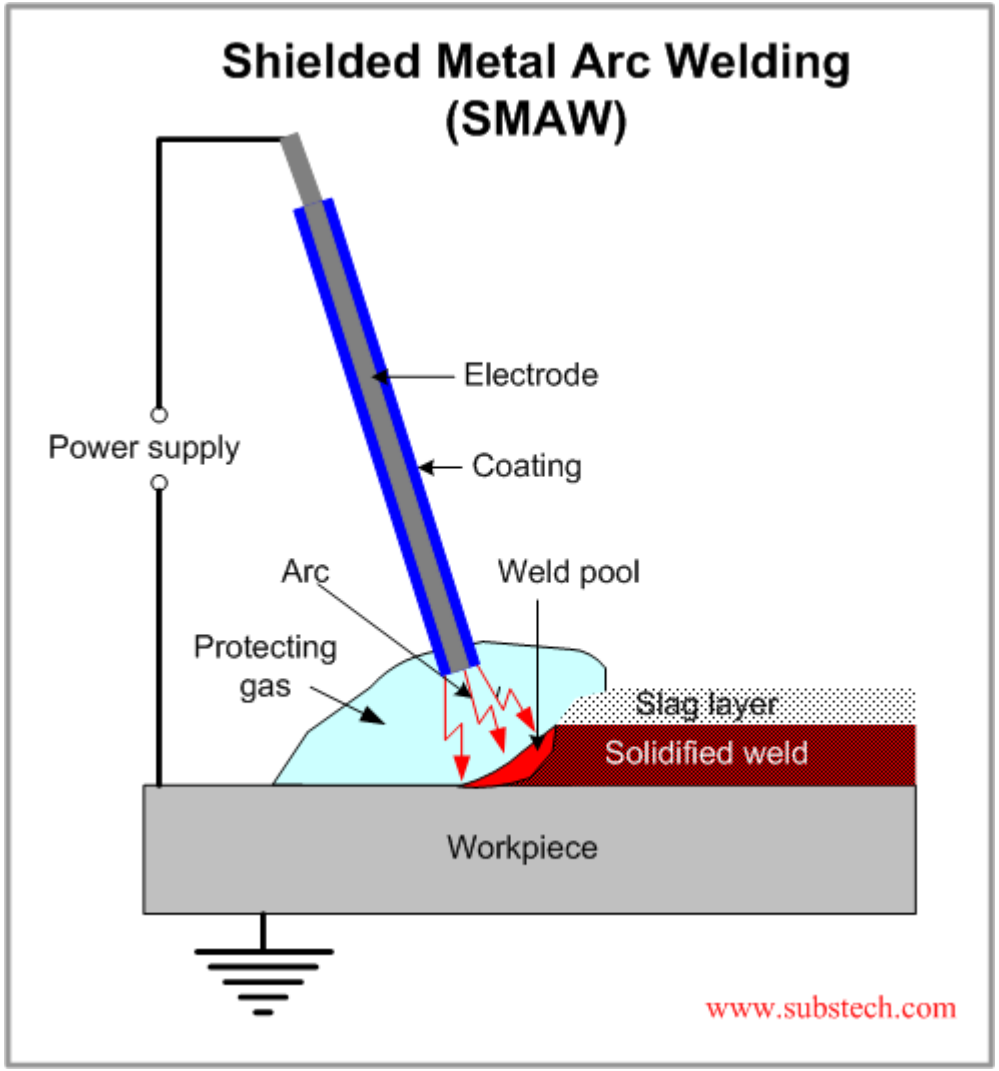

INDICATES COVERED ELECTRODES
TYPE OF COVERING
A : ACID
B : BASIC
C : CELLULOSE
R : RUTILE
RR : RUTILE HEAVY COATED
S : ANY OTHER
STRENGTH CHARACTERISTICS
S.No. UTS (N/mm2) YS (N/mm2)
4. 410-510 330
5. 510-610 360
E X X X X X X X X
X-INDICATES THE RADIOGRAPHIC QUALITY
% of ELONGATION & IMPACT PROPERTIES
DIGIT FOR %ELONGATION 410-510Nmm2 IMPACT JULES AT°C
0 NO REQUIRED SPECIFIED
1 20 47at+27°C
2 22 47at+0°C
3 24 47at-20°C
4 24 27at-30°C
for 510-610N/mm2
0 NO REQUIREMENT SPECIFIED
1 18 47at+27°C
2 18 47 at+ 0°C
3 20 47at-20°C
4 20 27at-30°C
5 20 27at-40°C
6 20 27at-46°C
WELDING POSITION
1. ALL POSITION
2. ALL POSITION EXCEPT VERTICAL DOWN
3. FLAT BUTTWELD, FLATE FILLETE & HORIZONTALVERTICAL FILLET.
4. FLAT BUTT & FILLET5.
5. BUTT, HORIZONTAL & VERTICAL FILLET
6. ANY OTHER
CURRENT CONDITION
DIGIT DC (+) AC
0 NOT RECOMNDED
1 +/- 50
2 - 50
3 + 50
4 +/- 70
5 - 70
6 + 70
7 +/- 90
8 - 90
9 + 90
METAL RECOVERY INDICATED BY - J,K,L
DIFFUSIBLE HYDROGEN
H1 = UP TO 15 ml
H2 = UP TO 10 ml
H3 = UP TO 5 ml

- 2)American Welding Society:



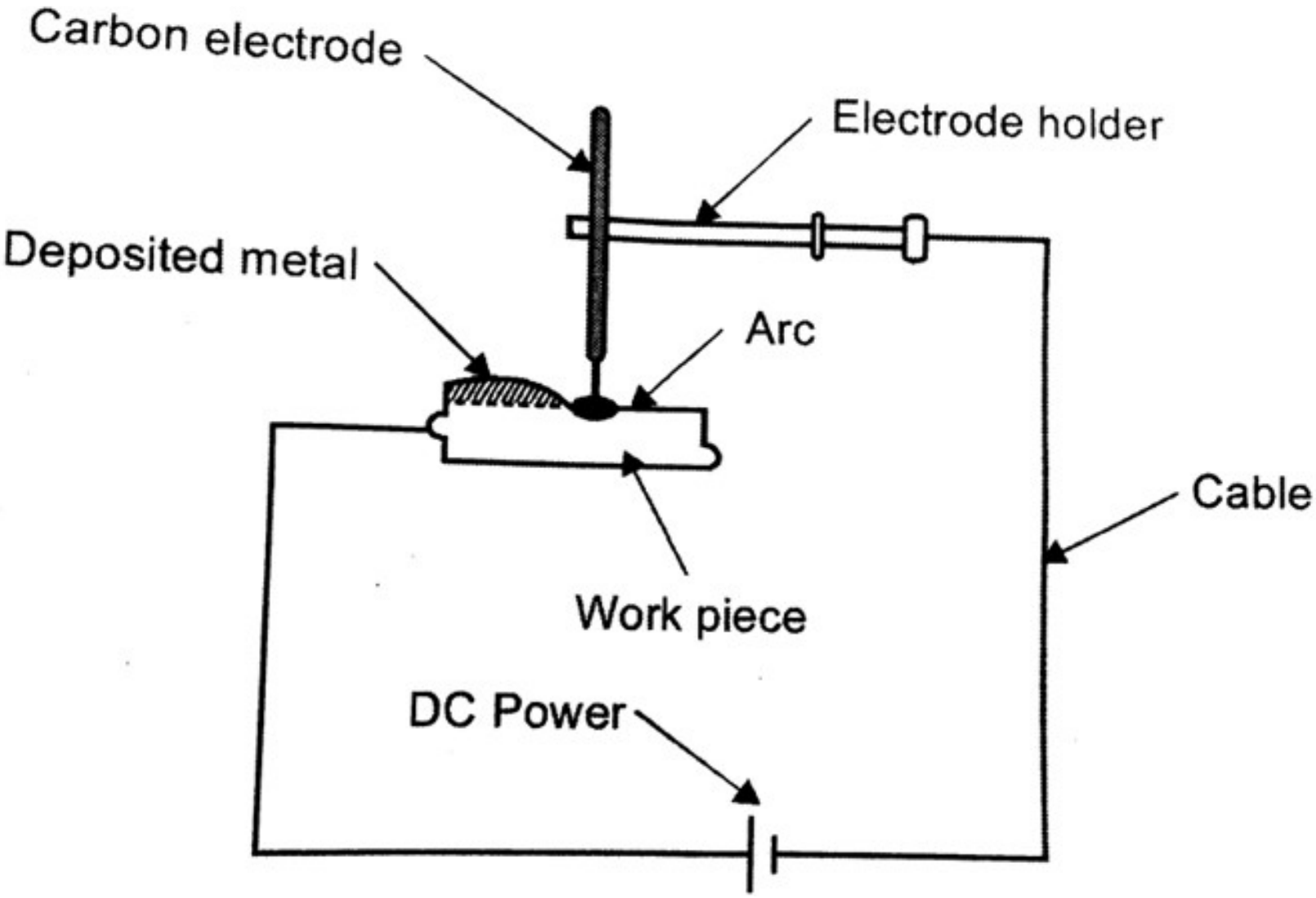
MMAW/SMAW

- **Shielded metal arc welding** (**SMAW**), also known as **manual metal arc welding** (**MMA** or **MMAW**), **flux shielded arc welding**[1] or informally 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.


Shielded Metal Arc Welding
(SMAW)
Electrode
Coating
Power supply
Arc
Weld pool
Protecting
gas
Slag layer
Solidified weld
Workpiece
www.substech.com

Carbon Arc Welding

- **Carbon arc welding** (CAW) is a process which produces coalescence of metals by heating them with an **arc** between a non-consumable **carbon** (graphite) electrode and the work-piece. In **carbon**-**arc welding** a **carbon** electrode is used to produce an electric **arc** between the electrode and the materials being bonded.
- DC-RP for single electrode & AC for twin electrodes.

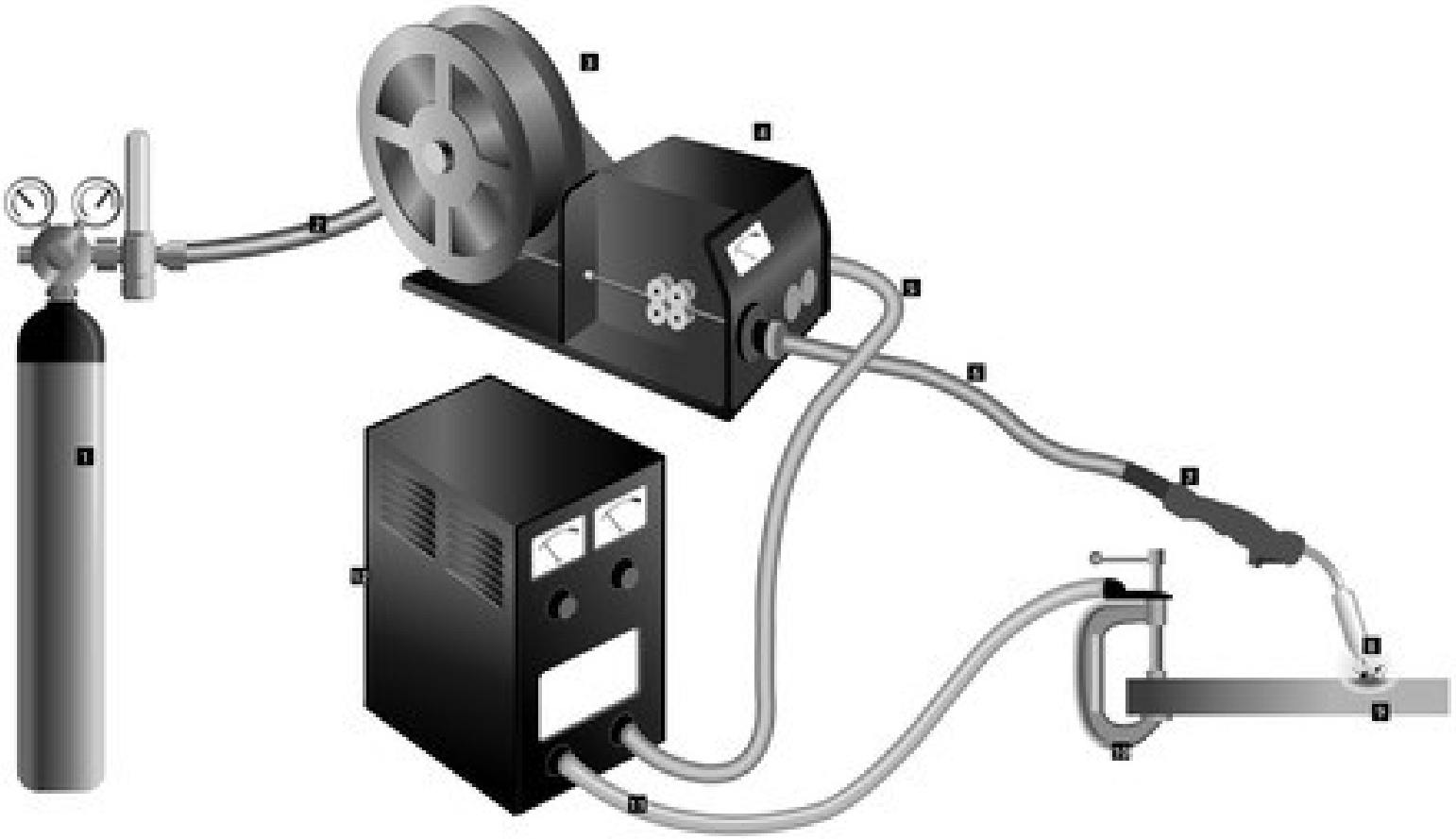

Carbon electrode
Electrode holder
Deposited metal
Arc
Cable
Work piece
DC Power

M A G/ M I G Welding

- **MIG (Metal Inert Gas) welding** is a welding process in which an electric arc forms between a consumable wire Spool electrode and the work piece. This process uses inert gases or gas mixtures as the shielding gas. Argon and helium are typically used for the MIG welding of non-ferrous metals such as aluminium.
- **MAG (Metal Active Gas) welding** is an arc welding process where an electric arc is created between a consumable wire Spool electrode and the material to be joined. MAG welding uses active shielding gases, primarily for the welding of steels. These shielding gases are mixtures of carbon dioxide, argon and oxygen.
- Examples of these active gases include CO_2 , Ar + 2 to 5% O_2 , Ar + 5 to 25% CO_2 and Ar + 10% CO_2 + 5% O_2.

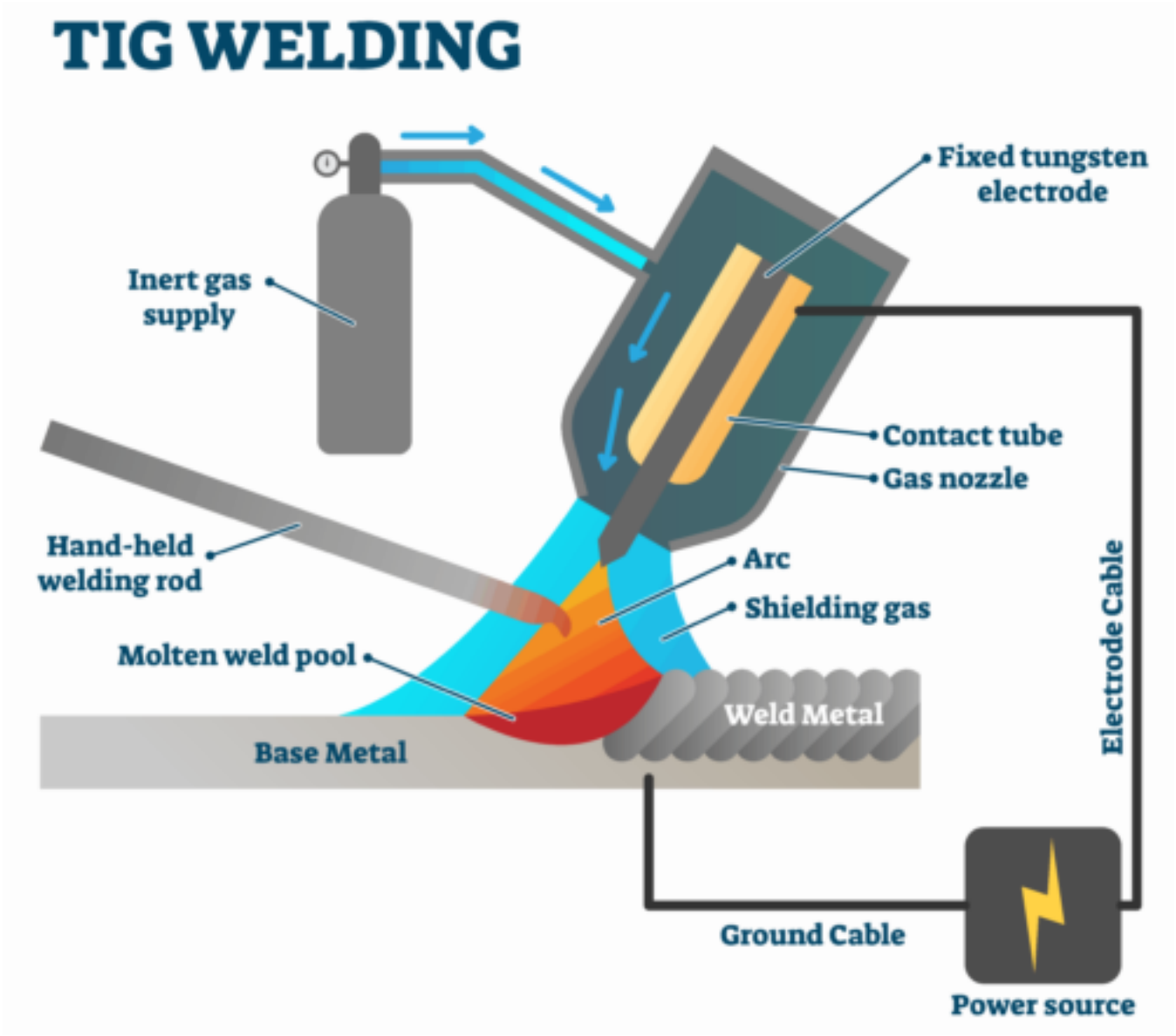
Process schematic diagram for MIG/MAG, FCAW and MCAW

1 Gas cylinder, 2 Gas hose, 3 Continous wire, 4 Wire feed unit, 5 Power cable, 6 Torch conduit, 7 Welding torch, 8 Arc, 9 Workpiece, 10 Earth clamp, 11 Return cable, 12 Power source



TIG welding

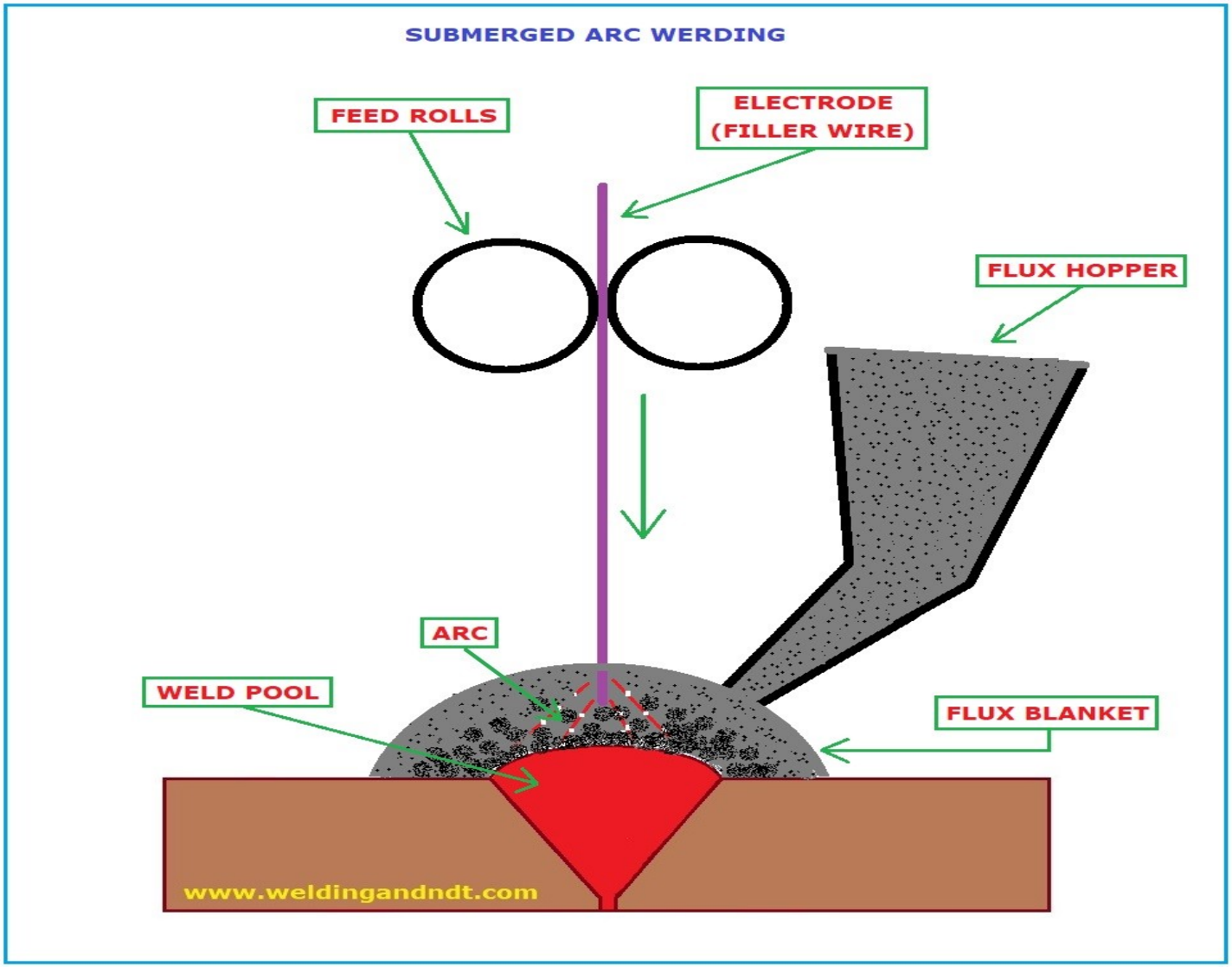
- **Gas tungsten arc welding** (**GTAW**), also known as **tungsten inert gas** (**TIG**) **welding**, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area and electrode is protected from oxidation or other atmospheric contamination by an inert shielding gas (argon or helium), and a filler metal is normally used
- GTAW is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, and copper alloys.


TIG WELDING
Fixed tungsten electrode
Inert gas supply
Contact tube
Gas nozzle
Hand-held welding rod
Arc
Shielding gas
Molten weld pool
Weld Metal
Base Metal
Electrode Cable
Ground Cable
Power source

Submerge Arc Welding

- SAW involves formation of an arc between a continuously-fed bare wire electrode and the work piece. A shielding gas is not required. Prior to welding, a thin layer of flux powder is placed on the work piece surface. Excess flux is recycled via a hopper. Remaining fused slag layers can be easily removed after welding. As the arc is completely covered by the flux layer, heat loss is extremely low. This produces a thermal efficiency as high as 60% (compared with 25% for manual metal arc). There is no visible arc light, welding is spatter-free and there is no need for fume extraction.

Figure - 1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FEED ROLLS
ELECTRODE
(FILLER WIRE)
FLUX HOPPER
ARC
WELD POOL
FLUX BLANKET
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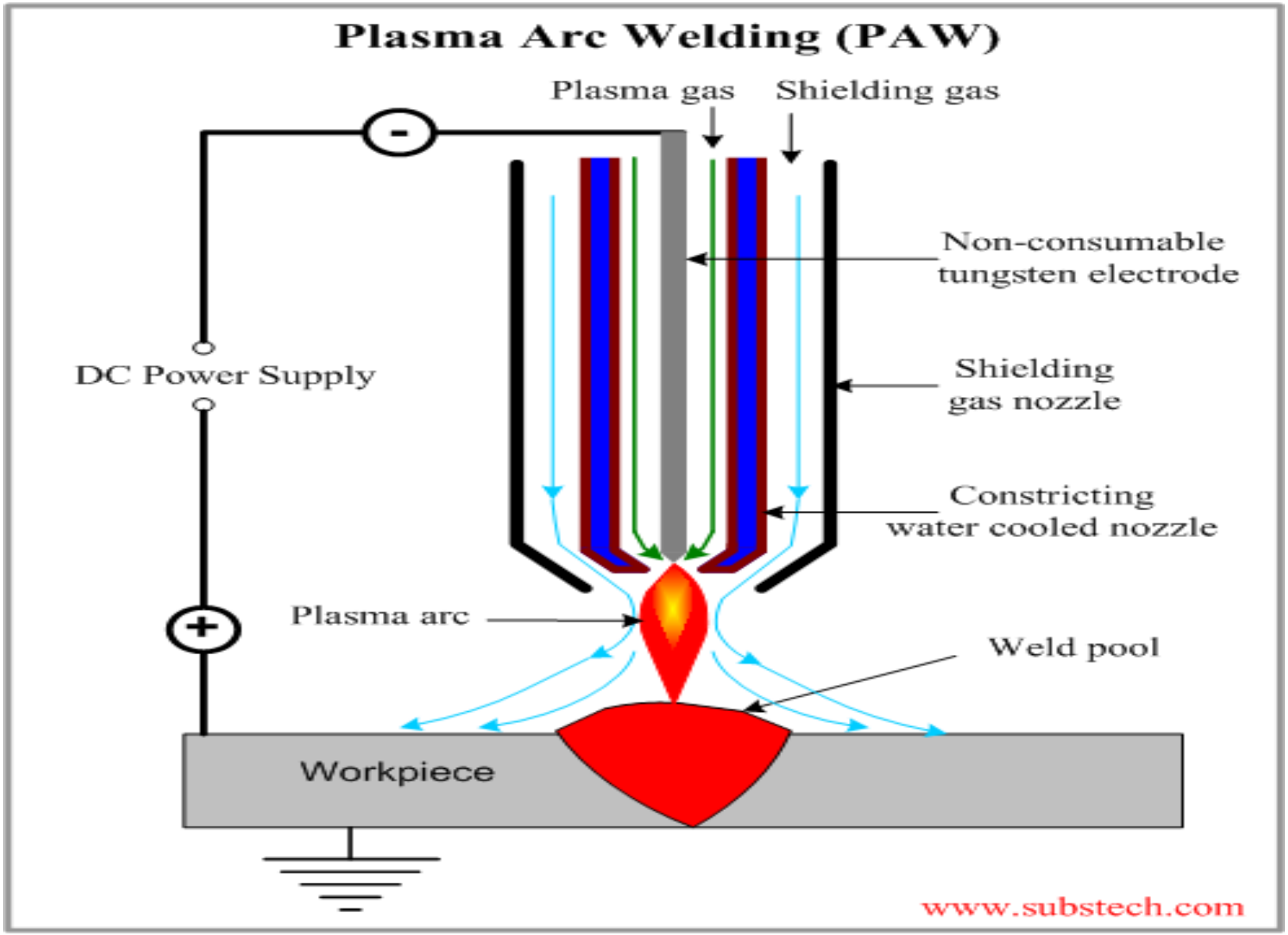
Plasma Arc Welding

- **Plasma arc welding** (**PAW**) is an arc welding process similar to TIG. The electric arc is formed between an electrode and the workpiece. The key difference from TIG is that in PAW, the electrode is positioned within the body of the torch, so the plasma arc is separated from the shielding gas envelope. The plasma is then forced through a fine-bore copper nozzle which constricts the arc and the plasma exits the orifice at high velocities and a temperature approaching 28,000 °C or higher.
- Arc plasma is a temporary state of a gas. The gas gets ionized by electric current passing through it and it becomes a conductor of electricity. In ionized state, atoms are broken into electrons (−) and cations (+) and the system contains a mixture of ions, electrons and highly excited atoms.


Plasma Arc Welding (PAW)
Plasma gas
Shielding gas
Non-consumable tungsten electrode
Shielding gas nozzle
Constricting water cooled nozzle
DC Power Supply
Plasma arc
Weld pool
Workpiece
www.substech.com