UNIT – II

METAL JOINING PROCESS

1 List out any four arc welding equipment. (May 2006)

Ans: The most commonly used equipments for arc welding are as follows:

(a) A.C or D.C. machine
(b) Wire brush
(c) Cables and connectors
(d) Ear thing clamps
(e) Chipping hammer

2 What are the special features of friction welding? (May 2007)

Ans:

- Friction welding is a solid state welding process where coalescence is produced by the heat obtained from mechanically induced sliding motion between rubbing surfaces.
- The work parts are held together under pressure.
- Its operating is simple.
- Power required for the operation is low.
- It is used for joining steels, super alloys, non-ferrous metals and combinations of metals.

3.Define resistance welding process. (May 2006, May 2007)

Ans: Resistance welding is a process where coalescence is produced by the heat obtained from resistance offered by the workpiece to the flow of electric current in a circuit of which the workpiece is a part and by the application of pressure.

4.What is the purpose of flux? (May 2008)

Ans: 1) It acts as shield to weld.
2) To prevent atmospheric reaction of molten metal with atmosphere.

5. How can slag inclusions in welding be avoided? (May 2008)

Ans: Avoid multi layer welding

- Reduce arc length
- Increase electrode angle
- Avoid using large electrode

6 **How does brazing differ from braze welding? (Dec. 2008)**

Ans:

Brazing	**Braze Welding**
The filler alloy is fed to one or more points in the assembly and it is drawn into the rest of the joint by capillary action.	The filler alloy is deposited directly at the point where it is desired.

7 **Why flux is coated on filler rods? (Dec. 2008)**

Ans: The coating improves penetration and surface finish.

- Suitable coating will improve metal deposition rates.

8 **What is the application of carburizing flame? (Dec. 2009) Ans:**

- Carburizing flame is generally used for: o Welding of low alloy steel rods
  o Non-ferrous metals
  o High carbon steel

9 What are the diameter and length of the electrodes available in the market? (Dec. 2009)

Ans: Standard length of electrodes are 250 mm, 300 mm and 450 mm.

- Standard diameters of electrodes are 1.6,2 ,2.5, 3.2, 4,5,6,7,8, and 9 mm.

10. Classify various ARC welding processes

(i) **Arc welding**

- Carbon arc
- Metal arc
- Metal inert gas
- Tungsten inert gas
- Plasma arc
- Submerged arc
- Electro-slag

11. Classify various GAS welding processes

(ii) **Gas Welding**

- Oxy-acetylene
- Air-acetylene
- Oxy-hydrogen

12. Name the various methods of Resistance Welding

B UTT
Spot
Seam
Projection & Percussion.

13. What is 'Brazing'

It is defined as the t3echnique of joining two dissimilar or similar materials by addition of special filler material. Brazing gives a much stronger joint than soldering but requires greater heat which cannot be obtained from copper in soft soldering.

14.Mention the applications of friction welding.

Used in refrigeration.
Used in super alloys.
Making simple forging.
Production of taper and reamer drills
Production of axle shafts , valves and gears.

15.Name the chemicals used in flux Manufacure.

1.Chlorides
2.Borax and boric
acid. 3.Borates
4.Fluorides.

Part-B (16Marks)

1. **Define welding, mention its types, Explain Arc welding with a neat sketch and Mention its advantages and limitations. (16) (NOV/DEC 2010)**

Welding

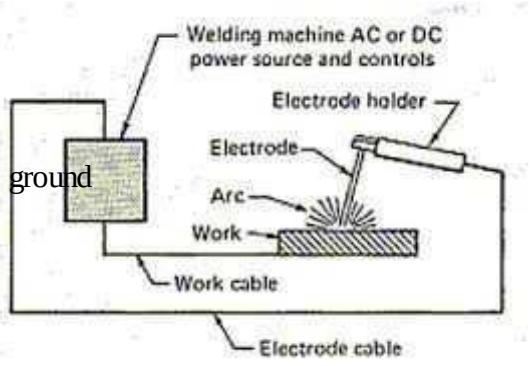
Welding is a materials joining process which produces coalescence of materials by heating them to suitable temperatures with or without the pplication of pressure or by the application of pressure alone, and with or without the use of filler material. Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

Types of welding

ARC Welding
Gas Welding

Arc welding

Uses an electric arc to coalesce metals
Arc welding is the most common method of welding metals
Electricity travels from electrode to base metal to ground



Arc welding Equipments

- A welding generator (D.C.) or Transformer (A.C.)
- Two cables- one for work and one for electrode
- Electrode holder

- Electrode
- Protective shield
- Gloves
- Wire brush
- Chipping hammer
- Goggles

Electrode

Electrode is a thin rod made up of same as that of parent material. Flux is coated over the electrode to avoid oxidation. It is mostly connected to the negative polarity.

Two Basic Types of AW Electrodes

Consumable – consumed during welding process
Source of filler metal in arc welding
Nonconsumable – not consumed during welding process
Filler metal must be added separately

Consumable Electrodes

Forms of consumable electrodes

- Welding rods (a.k.a. sticks) are 9 to 18 inches and 3/8 inch or less in diameter and must be changed frequently
- Weld wire can be continuously fed from spools with long lengths of wire, avoiding frequent interruptions

In both rod and wire forms, electrode is consumed by arc and added to weld joint as filler metal.

Nonconsumable Electrodes

Made of tungsten which resists melting
Gradually depleted during welding (vaporization is principal mechanism)
Any filler metal must be supplied by a separate wire fed into weld pool

Flux

A substance that prevents formation of oxides and other contaminants in welding, or dissolves them and facilitates removal
Provides protective atmosphere for welding
Stabilizes arc
Reduces spattering

Welding practice & equipment

STEPS :

- Prepare the edges to be joined and maintain the proper position
- Open the acetylene valve and ignite the gas at tip of the torch
- Hold the torch at about 45deg to the work piece plane

- Inner flame near the work piece and filler rod at about 30 – 40 deg
- Touch filler rod at the joint and control the movement according to the flow of the material

Advantages

Most efficient way to join metals
Lowest-cost joining method
Affords lighter weight through better utilization of materials
Joins all commercial metals
Provides design flexibility

Disadvantages

- Manually applied, therefore high labor cost.
- Need high energy causing danger
- Not convenient for disassembly.
- Defects are hard to detect at joints.

2. Define welding, mention its types, Explain Gas welding with a neat sketch and Mention the equipments used , types of flames produced and give its advantages and limitations. (16) APR /MAY -2010

Welding

Welding is a materials joining process which produces coalescence of materials by heating them to suitable temperatures with or without the application of pressure or by the application of pressure alone, and with or without the use of filler material. Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

Types of welding

ARC Welding
Gas Welding

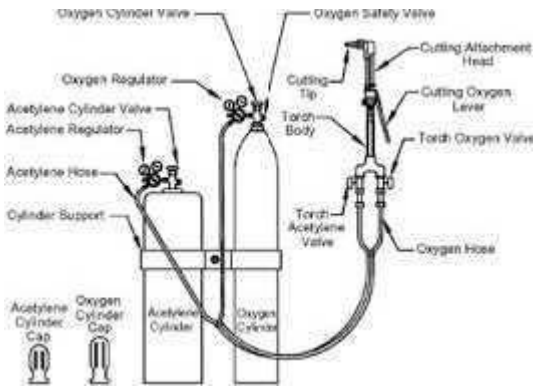
GAS WELDING

Sound weld is obtained by selecting proper size of flame, filler material and method of moving torch

The temperature generated during the process is 33000c.

When the metal is fused, oxygen from the atmosphere and the torch combines with molten metal and forms oxides, results defective weld

Fluxes are added to the welded metal to remove oxides

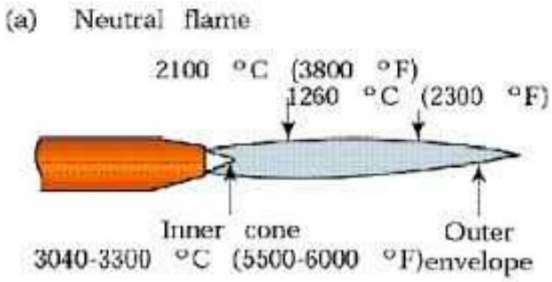


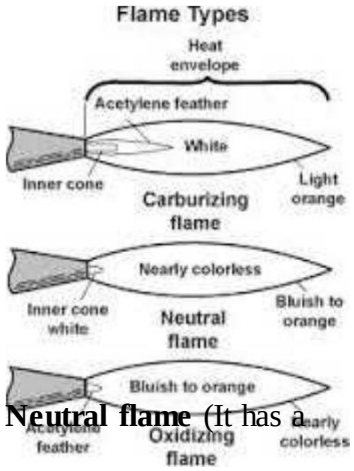
Common fluxes used are made of sodium, potassium. Lithium and borax.
Flux can be applied as paste, powder, liquid. solid coating or gas.

GAS WELDING EQUIPMENT

1.Gas Cylinders
Pressure
Oxygen – 125 kg/cm2
Acetylene – 16
kg/cm2 2. Regulators
Working pressure of oxygen 1 kg/cm2
Working pressure of acetylene 0.15 kg/cm2
Working pressure varies depends upon the thickness of the work pieces welded.
3. Pressure Gauges
4. Hoses
5. Welding torch
6. Check valve
7. Non return valve

Three basic types of oxyacetylene flames used in oxyfuel-gas welding and cutting operations:
(a) neutral flame; (b) oxidizing flame; (c) carburizing, or reducing flame.





Addition of more oxygen give a bright whitish cone surrounded by the transparent blue envelope is called **Neutral flame** (It has a balance of fuel gas and oxygen) (32000c)

- Used for welding steels, aluminium, copper and cast iron

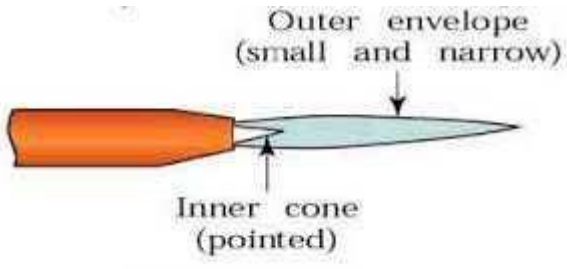
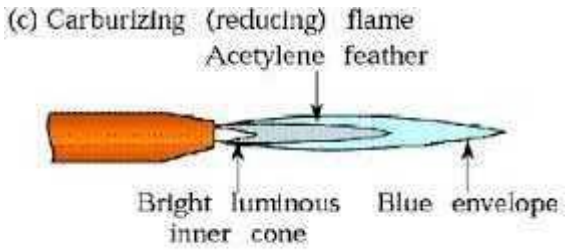


Figure3: Oxidizing Flame

oxygen give a bright whitish cone surrounded by the transparent blue envelope is called **Neutral flame** (It has a balance of fuel gas and oxygen) (32000c)

- Used for welding steels, aluminium, copper and cast iron



Oxygen is turned on, flame immediately changes into a long white inner area (Feather) surrounded by a transparent blue envelope is called **Carburizing flame** (30000c)

Advantages of Gas welding.

1.Simple Equipment
2.Portable
3.Inexpensive
4.Easy for maintenance and repair

Disadvantages Of Gas welding

1.Limited power Density
2.Very low welding speed.
3.High total heat input per unit length
4.Large Heat affected Zone
5.Severe Distortion
6.Not recommended for welding reactive metals such as titanium and Zirconium.

3. Give the Difference between Gas Welding and Arc Welding.

Sr No	GAS WELDING	ARC WELDING
1.	Heat is produced by the Gas Flame	Heat is produced by Electric Arc
2.	The flame temperature is about $3200^{o}C$	The temperature of Arc is about $4000^{o}C$

3.	Separate Filler rod introduced	Arc Producing as well as filler rod material is the electrode.
4.	Suggested for thin materials	Suggested for medium and thick materials
5.	Gas welded parts do not have much strength	Arc welded parts have very high strength
6.	Filler metal may not be the same parent metal	Filler metal must be same or an alloy of the parent metal
7.	Brazing and soldering are using gas	Brazing and soldering can't be carried out by electric arc. done

4. **Explain Submerged arc welding with a neat sketch. State its advantages and disadvantages**. (NOV/DEC-2011).

Submerged arc welding

- Weld arc is shielded by a granular flux , consisting of silica, lime, manganese oxide, calcium fluoride and other compounds.
- Flux is fed into the weld zone by gravity flow through nozzle

Thick layer of flux covers molten metal

- Flux acts as a thermal insulator ,promoting deep penetration of heat into the work piece
- Consumable electrode is a coil of bare round wire fed automatically through a tube
- Power is supplied by 3-phase or 2-phase power lines

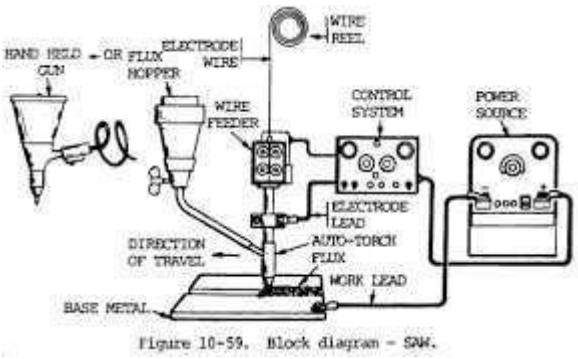
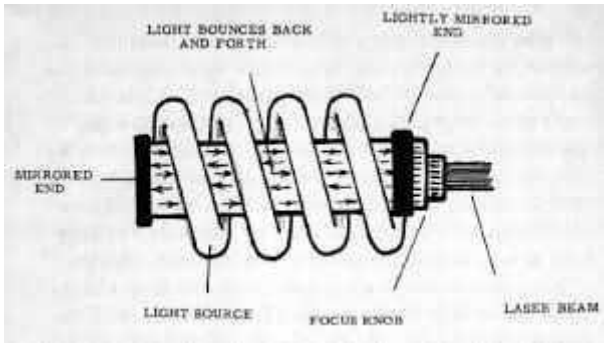


Figure 10-59. Block diagram - SAW.

5. Explain the method of laser beam welding and give their applications (APR/MAY 2014) (16)



Laser Beam Welding (LBW)

Fusion welding process in which coalescence is achieved by energy of a highly concentrated, coherent light beam focused on joint

Laser = "light amplification by stimulated emission of radiation"

LBW normally performed with shielding gases to prevent oxidation

Filler metal not usually added

High power density in small area, so LBW often used for small parts

Working

The laser WELDING system consists of a power source, a flash lamp filled with Xenon, lasing material, focusing lens mechanism and worktable. The flash tube flashes at a rate of thousands per second. As a result of multiple reflections, Beam power is built up to enormous level.

The output laser beam is highly directional and strong, coherent and unicromatic with a wavelength of 6934^{o}A. It goes through a focusing device where it is pinpointed on the work piece, fusion takes place and the weld is accomplished due to concentrated heat produced. Laser beam welding process is shown in the figure.

Advantages.

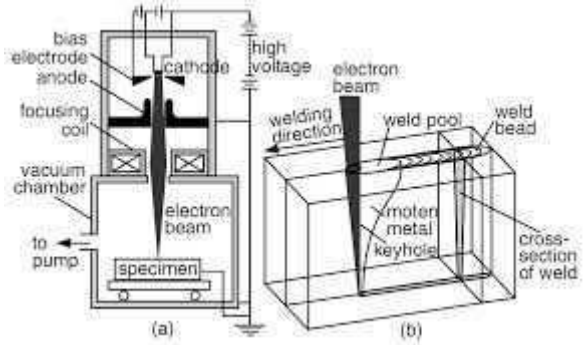
1.Wide variety of metals can be welded.
2.Thermal damage is minimum.
3.Weld metal is purified.
4.Good ductility and mechanical properties.
5.Welds are vaccum tight.
6.filler metal is not used.
7.No effect on heat treated components.

Limitations.
1.Low welding Speed.
2.Limited to thickness of 1.5mm.
3.Materials like Mg cannot be welded.

APPLICATIONS

Radio Engineering and Microelectronics.

6. Explain the method of electron beam welding and given their applications (16)



Electron Beam Welding (EBW)

Fusion welding process in which heat for welding is provided by a highly-focused, high-intensity stream of electrons striking work surface

Electron beam gun operates at:

High voltage (e.g., 10 to 150 kV typical) to accelerate electrons Beam currents are low (measured in milliamps)

Power in EBW not exceptional, but power density is

Working

The Kinetic energy of the electrons is converted into intense heat energy when the electrons are absorbed by the metal piece over a small area of the weld, producing deep penetration weld with a depth/width ratio as high as 15. This results in a narrow, almost parallel weld with very little distortion and a small width of the heat affected zone. There is no possibility of contamination by atmospheric gases because process is carried out in vaccum.

Advantages

High-quality welds, deep and narrow profiles

Limited heat affected zone, low thermal distortion High welding speeds

No flux or shielding gases needed

Disadvantages

High equipment cost

Precise joint preparation & alignment required Vacuum chamber required

Safety concern: EBW generates x-rays

Comparison: LBW vs. EBW

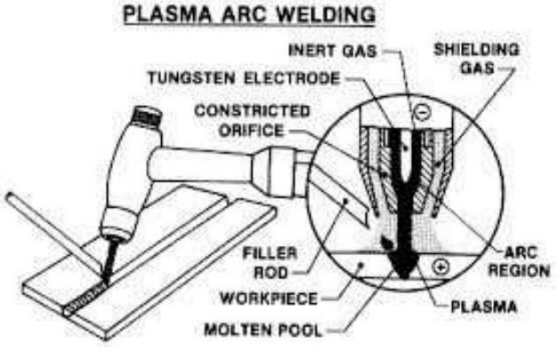
No vacuum chamber required for LBW No x-rays emitted in LBW

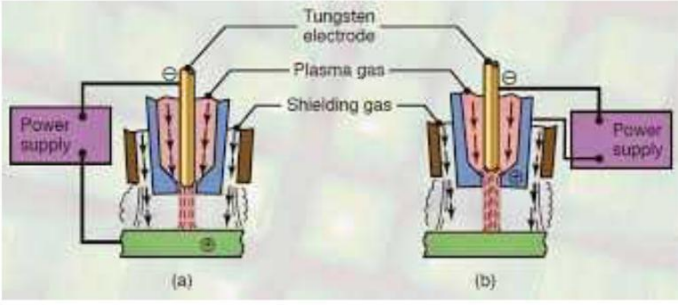
Laser beams can be focused and directed by optical lenses and mirrors

LBW not capable of the deep welds and high depth-to-width ratios of EBW

Maximum LBW depth = ~ 19 mm (3/4 in), whereas EBW depths = 50 mm (2 in)

7. Describe plasma Arc welding and give their applications (NOV/DEC 2011) (16)





Principle:

Plasma Arc welding is a constricted arc process. The arc is constrained with the help of a water cooled small diameter nozzle which squeezes the arc, increases its pressure, temperature and heat intensely and thus improves stability, arc shape and heat transfer, characteristics

There are two methods of Plasma Arc Welding

1.Transferred Arc
2.Non- Transferred Arc.

1.Transfered Arc

Here the electrical circuit is between the tungsten electode and the work piece. Work piece acts as anode and the tungsten electrode as cathode. The arc is transferred from the electrode to the work piece and hence the term transferred. Here the arc force is directed away from the plasma torch and into the work piece, hence capable of heating the work piece to a higher temperature.

2.NON-Transferred Arc.

In Non-transferreed type, power is directly connected with the electrode and the torch of nozzle. The electrode carries the same current. Thus ,ionizing a high velocity gas that is strewing towards the workpiece. The main advantage of this type is that the spot moves inside the wall and heat the incoming gas and outer layer remains cool. This type of plasma has low thermal efficiency.

Advantages

1.Ensures arc stability.
2.Produces less thermal distortion 3.The process is readily automated.

Disadvantages.

1.Excessive noise is produced.
2.Equipment is complicated and expensive.
3.Large amount of ultraviolet and infrared rays are emitted.

8. Explain Thermit welding and given their applications (16)

FW process in which heat for coalescence is produced by superheated molten metal from the chemical reaction of thermite

Thermite = mixture of Al and Fe3O4 fine powders that produce an exothermic reaction when ignited

Also used for incendiary bombs

Filler metal obtained from liquid metal

Process used for joining, but has more in common with casting than welding

Fig: Thermit welding: (1) Thermit ignited; (2) crucible tapped, superheated metal flows into mold; (3) metal solidifies to produce weld joint.

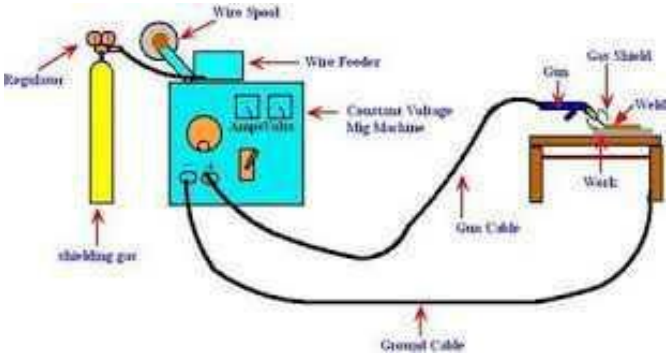
Applications

joining of railroad rails

Repair of cracks in large steel castings and forgings

Weld surface is often smooth enough that no finishing is required

9. Explain TIG and MIG welding in detail.



Inert Gas Welding

For materials such as Al or Ti which quickly form oxide layers, a method to place an inert atmosphere around the weld puddle had to be developed

Metal Inert Gas (MIG)

- Uses a consumable electrode (filler wire made of the base metal)
- Inert gas is typically Argon

Gas Tungsten Arc Welding (GTAW)

Uses a non-consumable tungsten electrode and an inert gas for arc shielding

Melting point of tungst en = 3410 C (6170 F)

A.k.a. Tungsten Inert G as (TIG) welding

In Europe, called "WIG welding"

Used with or without a filler metal

When filler metal used, it is added to weld pool from separate r od or wire Applications: aluminum and stainless steel most common

Advantages

High quality welds for suitable applications No spatter because no filler metal through arc

Little or no post-weld cleaning because no flux

Disadvantages

Generally slower and m ore costly than consumable electrode AW processes

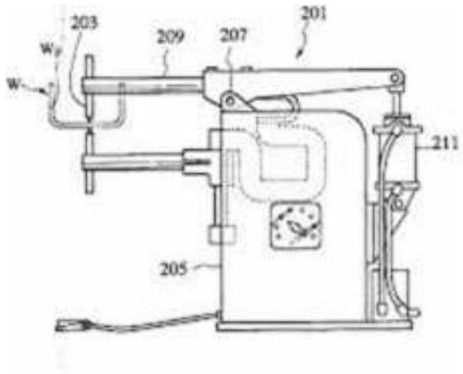
10. What is resistance welding; Me ntion the various types of Resistance welding . Explain in details about spot welding.

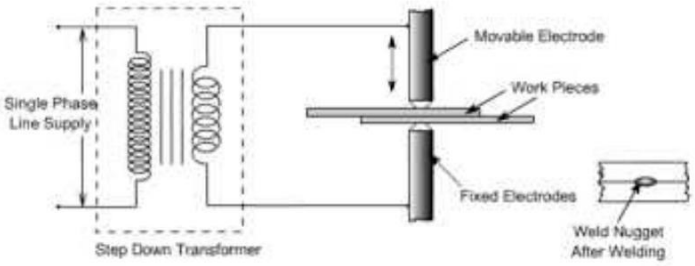
Resistance Welding (RW)

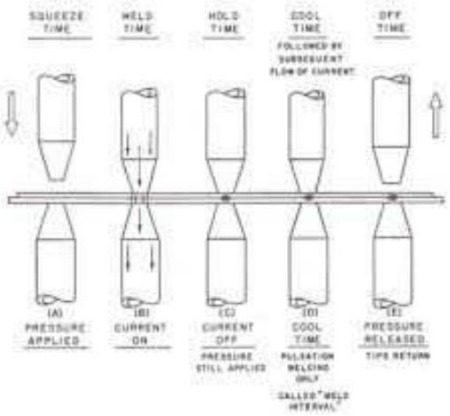
A group of fusion weldin g processes that use a combination of heat and pressure to accomplish coalescence

Heat generated by electrical resistance to current flow at junction to be welded

Principal RW process is resistance spot welding (RSW







Components in Resistance Spot Welding

Parts to be welded (usually sheet metal)

Two opposing electrod es

Means of applying pressure to squeeze parts between electrodes

Power supply from wh ich a controlled current can be applied for a specifie time duration