* GAS WELDING.

* Metal joining process: It involves joining pieces either temporarily or permanently. Depending upon mechanism of Bonding, is classified as:

i) Mechanical joining process
ii) Atomic - Bonding process.

i) Mechanical joing process: It involves temporary as well as permanent joining process. Joints obtained through bolt and screw are temporary in nature. These are used when frequent dismantling is required. Rivets are the permanent fasteners and joints can be separated only by destroying the rivet.

ii) Atomic Bonding process: Joining process involving atomic Bonding are permanent in nature. Atomic Bonding process may be further classified as:

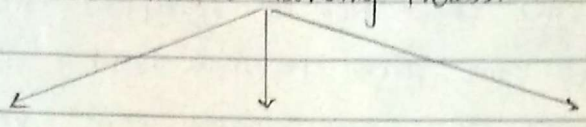
i) Adhesive Bonding: It is used to join plastics and other engineering materials. Metals and non-metals are best joined by this process. It has common application in automatic - break - shoe - lining. Commonly used adhesives are: thermo setting resins, thermoplastic resin, elastomers etc.

ii) Soldering / Brazing: Base metals are not melted and joint is obtained by means of melting filler metal. It is used in joining small assemblies.

iii) welding

* Atomic - Bonding processes can also be classified on basis of composition of joint
In Autogeneous joining, no filler material is used.
In Homogeneous joining, filler material used has same composition as that of metal.
In Heterogeneous joining, filler material used has diff. conc. than that of base metal.
Two materials which are insoluble in each other can be joined using heterogeneous joining. Iron and Silver can be joined using copper and tin.

Atomic - Bonding Process.



Autogeneous joining	Homogeneous joining	Heterogeneous joining
i) Solid state welding	i) gas welding	i) Soldering
ii) Resistance welding	ii) arc welding	ii) Brazing.
	iii) thermit welding	

* WELDING : Welding is a manufacturing process which involves joining similar metals by application of heat, with or without application of pressure and filler material. It is broadly classified into two groups :

a) Fusion welding : It involves heating of parent metal to raise its temperature to melting point, then filler material is used as a suppliment for molten pool. A homogeneous solution is formed at the joint, then it is allowed to be cooled, solidify to form a weld.

b) Forge welding : The workpiece are placed in the forge and heated within area to be joined, to condition of plasticity on the surface. Then, parts are quickly super-imposed into a complete union by power hammering or by pressing. Quality of weld depends to a great extent upon amount of heating. If ends are not heated enough, they will not stick together, and if overheated, brittle weld will be formed. At elevated temperature, ductility is increased and welding defects are eliminated.

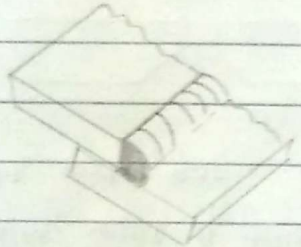
* Welding heat sources :

i) Gas flame (Gas welding)

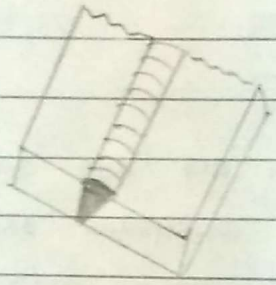
ii) electric arc (electric arc welding).

iii) Electrical resistance (Resistance welding)
iv) Exothermic reaction (Thermit welding)
v) Energy ray (Laser welding and e⁻ beam welding)
vi) Frictional energy (friction welding).

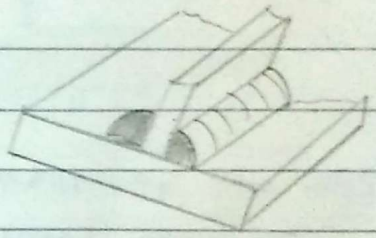
* TYPE OF JOINTS

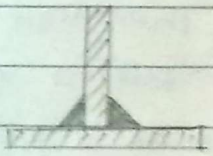


(a) Lap joint
(overlapping metals)

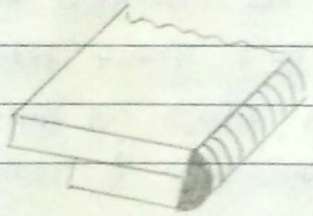


b) Butt joint

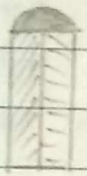




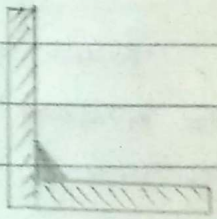
(c) T- joint.



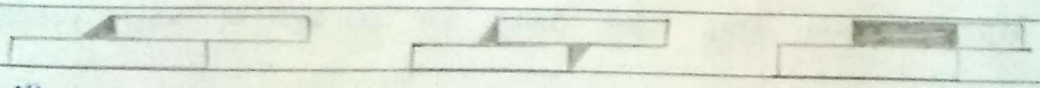
(d) edge joint.



(d) edge joint.



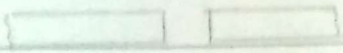
(e) corner joint



(i) Single transverse (ii) double transverse iii) parallel fillet

(f) - fillet joint

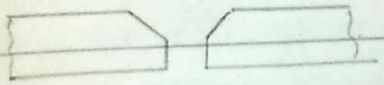
* Edge- preparation for Butt-joints



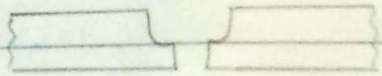
straight edge

Straight edge is shown in above fig. This type of edge is prepared when thickness of metals is small. As thickness increases, it becomes necessary to prepare edge in such a way that heat produced would be able to penetrate the entire depth. If edge preparation will not be done, joint will not be strong.

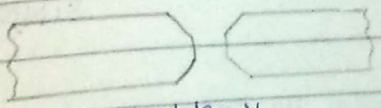
The various types of edge preparation for butt-joints are square, single V, double V, single U, double U, single bevel, double bevel etc. Straight or square weld is used for sheet about 1 to 5mm thick & single V and single U are used for 5mm-15mm thickness. The V-joint is easier to make than U-joint. But U-joint are sometimes preferred over V-joint because of less filler metal used. Double U & double V are used around 15 mm thickness. Pieces should be kept at optimum value of distance since penetration will be insufficient with small gap and with wide gap, weld pool will fall through.



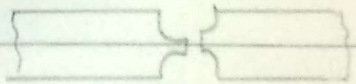
single-V



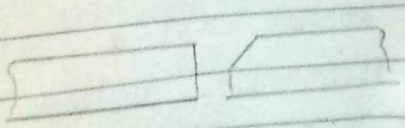
single-U.



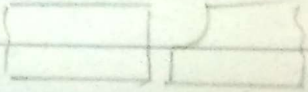
double-V



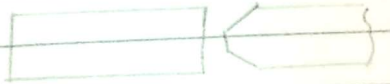
double-U.



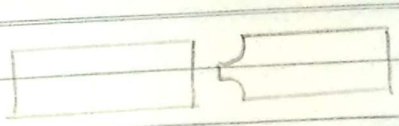
single bevel



single-J.



double bevel

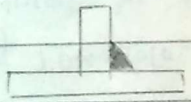
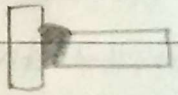
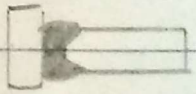
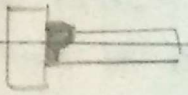
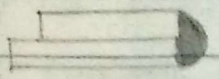
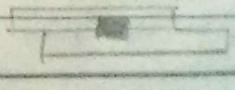


double - J.

* Cleaning of joints: The edge of metal must be clean and free from oil, grease or dirt. If they were not removed, then they would interfere and proper fusing of metals will not take place and weaker joint will be obtained. Surface oxides formed also gets entrapped in solidifying metal.

To remove oily substances, solvents such as acetone & CCl_4 should be used. But they should be evaporated before welding. Otherwise, highly poisonous gases will be formed. To remove oxides, flux are employed.

Weld Symbols.

Sl.No	weld	representation	Symbol	Sl.No.	weld	representation.	Symbol
1.	Fillet			6.	Single-bevel butt		
2.	Square - butt			7.	Double-bevel butt		
3.	Single V-butt						
4.	Double - V-butt			8.	Single-J butt		
5.	Single - U-butt			9.	Double - J-butt		
6.	Double - U-butt			10.	Edge		
				11.	Spot		

* Gas welding: It is a process in which the required heat to melt the surface is ~~surface~~ supplied by a high-temperature flame obtained by mixture of two gases. The gases are mixed in proper proportions in a welding Torch. Welding flame can be controlled by regulators present on the torch by which quantity of either gas can be regulated. The surfaces to be welded, are properly cleaned, prepared and placed near each other. The area to be joined is melted using flame, and weld is completed by supplying addition metal as metal obtained from filler rod.

* Oxy-Acetylene welding / Principle of Oxy-Acetylene welding: the heat required to melt the surfaces is produced by combination of oxygen and an inflammable gas such as acetylene, propane, butane etc. Acetylene is generally used as others are less efficient. Flame temp. is 3200°C. Gas is supplied from high pressure cylinder fitted with special regulators which reduce pressure to 0.13 - 0.5 bar. welding torch mixes the gases and flame moves through copper-nozzle. Mostly used for thickness 2mm but upto 25mm thickness plates can be welded.

* Oxy-hydrogen welding: Hydrogen is used in place of acetylene & flame temp is 1980°C. used for welding low-melting alloy.

* Depending upon the form in which Acetylene is supplied, gas welding is classified as:

i) Low-pressure gas welding: Acetylene is generated in low pressure generator by action of water on Calcium carbide and is supplied to blow pipe.

i) High-pressure gas welding: Acetylene is supplied as dissolved Acetylene in steel cylinder.

* Types of Oxy-Acetylene flames and their uses:

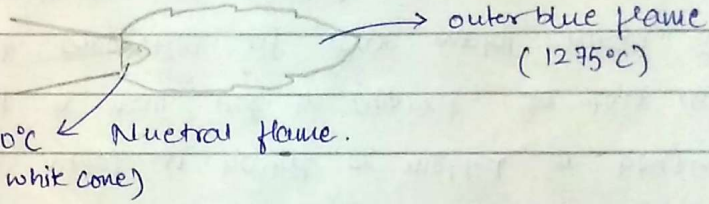
The phenomenon that occurs at the nozzle tip is combustion.

$$2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O.$$

Depending upon relative proportions of two gases, types of flames are:

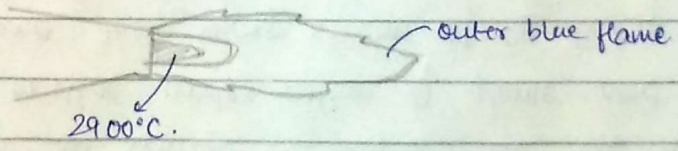
- Nuetral flame: It is obtained when equal proportions of oxygen & Acetylene are mixed in blowpipe (welding torch). Complete combustion takes place. The highest temperature is developed at inner cone.

  Apps: used for welding Aluminium, copper alloys & ferrous metals.



- Carburising flame: in this flame, acetylene quantity is more. It is a reducing flame.

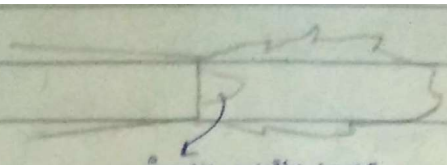
  Apps: used for welding steel at a faster rate than nuetral flame.



(b) carburising flame.

- Oxidising flame: Oxygen quantity is generally more. Inner core is v. much shortened and luminosity is reduced.

  Apps: welding Brasses & Bronzes (due to formation of oxide film which prevents vapourisation of zinc).



* Oxy Acetylene cutting

It is a chemical process in which the metal, at the portion where it is to be cut, is made to oxidise under action of flame and heated upto red heat by means of flame and then sharp stream of O_2 is made to impinge on hot surface to form iron oxide. On removing iron oxide layer, cut is obtained. (only those metals for which combustion temp is much below melting pt, can be cut. otherwise, it will melt, and sharp cut will not be obtained).

All ferrous metals can be cut.

* SOLDERING AND BRAZING.

In welding processes, Base metal is heated or melted or bought to plastic stage and then pressure may or may not be applied. In this case, metallurgical defects are introduced and properties of Base metal changes. So, to avoid these, Soldering & Brazing methods are adopted.

- Soldering: The method of joining two or more pieces of metal by means of a fusible alloy or metal is called soldering. fusible alloy is called solder.

Its classification:

i) Soft soldering: used in sheet metal works for joining those metal parts that are not subjected to high temp. and high forces. Soft solder → Tin & lead

ii) Hard soldering: used to obtain strong joint than that obtained by soft soldering. Hard solder → Silver & Zin.

The quality of weld in soldering depends upon adhesive properties of filler material.

NOTE: Soldered components have joints which are weaker as compared to brazed joints.

Procedure for soldering:

- Metal is cleaned with wire brush, chemicals and files.
- Metals are placed in joining position.
- flux is applied. Flux may be contained inside the solder.
- Joint area is heated using soldering iron, induction heating etc.
- solder is applied. It moves in the joint through capillary Action.
- after removal of heat, solder is allowed to cool & solidify.
- To remove flux residue, use warm water.

Apps: Soldering is used for sheet metal work, and joining electrical components.

Advantages:

- Joining cost is low.
- Easy & simple, cheap equipment.
- it gives +ve electrical connection.
- properties of Base metal are not Affected.

Disadvantages:

- Joints formed are weak.

* Brazing: It is process of joining two metal pieces by heating & adding a non ferrous alloy whose melting pt is above 400°C, in liquid state b/w pieces of metal & allowed to solidy on cooling.

Procedure for soldering:
Surfaces to be joined are cleaned & placed in joining position. flux is powdered & sprinkled. The surfaces & filler rod are brought to a temp. which is greater than melting temp. of filler material but lower than melting temp. of metals. Then, Brazing material is added and moves into joint by capillary Action. It is allowed to cool, solidy & joint is obtained.
Brazing material is usually Copper, Ag alloys

Apps: used for electrical items, pipes & pipe fittings etc.

Advantages:
- used to join dissimilar metals.
- Thin sections can be joined easily.
- Less skilled operator required.
- Cost is less.
- Good finish obtained.

Disadvantages: low weld strength & Not applicable to hardened steel.

Sl.	Soldering	Brazing.
i)	filler metal has melting pt < 400°C	Filler material has melting pt. > 400°C
ii)	less stable joint.	More stable joint.
iii)	joint is not affected by high T & P.	affected by high T & P.
iv)	low cost	high cost.

* Welding flux.

During welding process, when metal is heated or melted, atmospheric oxygen reacts with metal to form oxides & gases. This oxides & gases per makes the fusion of metals difficult & poor quality weld is obtained. To eliminate these, flux is added

flux is defined as "a material used to prevent, dissolve or facilitate removal of oxides & undesirable surface substances.

* function of flux coatings:

- flux reacts with oxides & impurities & form slag. Slag due to low density flow on top of weld pool. On solidification, slag is removed using chipping hammer
- helps in stabilising arc
- controls depth of penetration.
- controls rate of cooling.
- improves process efficiency
- prevents formation of Brittle weld.

* Common fluxes.

- In TIG, MIG welding, inert gas serves the purpose of flux and electron coating in SMAW acts as flux.
- Cast - Iron flux: reddish in color, consists of Iron oxide, carbonate & Bicarbonate of soda
- Steel Brazing: white flux containing chlorides. Borax used for Brazzing.
- Aluminium flux: consists NaCl, LiCl, KCl, Na_2SO_4, cryolite, chloride etc.

Fresh flux is used for good results.

* Welding defects

a) dimensional defects

It includes incorrect joint preparation, incorrect weld size. etc.

b) structural discontinuities

It includes porosity, non metallic inclusions, incomplete fusion, inadequate penetration, surface defects etc.

c) defective properties :

low yield strength, low tensile strength, low ductility, improper hardness, poor corrosion resistance.

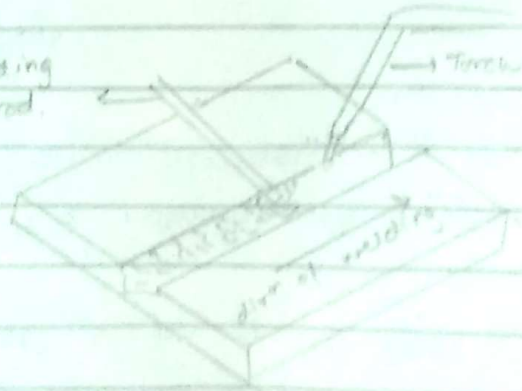
* Gas welding Techniques :

i) Backhand (Left-word) welding

ii) forehand (rightward) welding

iii) vertical welding.

i) Backhand welding : welding tip is held at 60 to 70° to plate and filler rod is inclined to 30 to 40 degrees in opposite direction. The torch tip & filler rod are moved slowly in dirⁿ towards left. Suitable for pipe & plate welding. metal upto thickness 5mm can be welded.

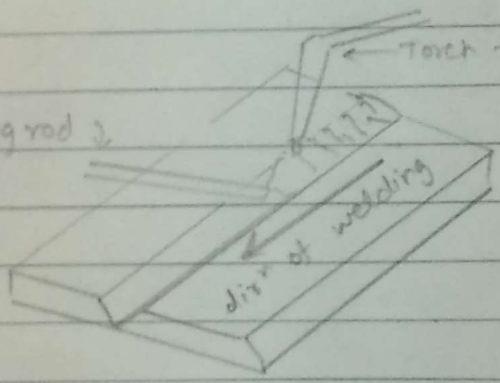


ii) forehand (rightward) welding:

the torch tip is kept at 40 to 50 degrees to the plate to be welded & filler rod at 30 to 40° angle. filler rod is moved in a straight line ⇒ & torch is moved forward & backward in a loop as weld proceeds. used for heavier sections.

Advantages:

- improvement in mechanical properties
- Operator has better vision of weld zone.
- less gas consumption, filler material used is less & cost is low.
- less welding time.



iii) vertical welding.

Sheet of any thickness can be welded. welding starts from bottom & moves till top & welding torch follows filler rod. Inclination of blow pipe is 30 to 80° & filler rod is 30°.

* Applications of welding:

- Replacing casting: many machines which were manufactured by casting are now manufactured by welding.
- Replacing riveting & Bolting: Speedy & sound joints are obtained. Jobbed structure is lighter in weight.
- ⁋ welding can also weld metals (sheets etc.) whose thickness is greater than those joined by riveting.