Rolling Module 4

- Process of deforming plastically metal by passing it between the rolls.
- It is subjected to high compressive stress.

3 types of Rolling :-

(i) Hot rolling
(ii) cold rolling
(iii) Powder rolling

Hot rolling

- used at working above recrystallization Temp. of metal.
- used for reduction of cross sectional area at a large scale.
- Rails, rods, bars.

cold rolling

- used at working. Below recrystallization Temp. of metal.
- Employed for finishing the metal to given specification and surface quality.
- sheets, strips, foils with good finishing surface and mechanical strength.

Powder Rolling

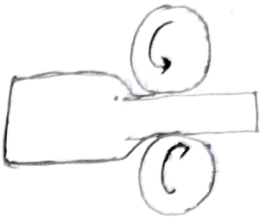
- metal powder is introduced between rolls and turned into "green strip" sintered to high density.
- It produces a very tough sheet with fine grain size.

Rolling mills

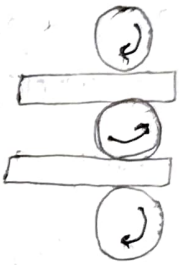
- Rolling mills consist of rolls, bearings, a housing for containing these parts and a drive for applying power to the rolls and controlling these speeds.

Types of mills :-

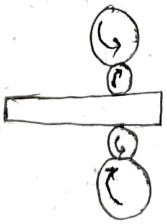
(i) Two-high mills
consist of two rollers
rotate in opposite direction



(ii) Three High mills
consist of three rollers
The first and third roller - same direction
second - opposite direct^{n}
Requires less motive power.

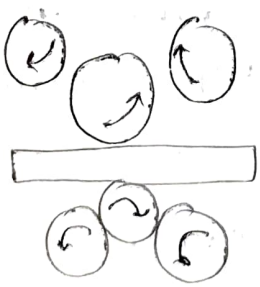


(iii) Four High mills
two big backup rollers and two working rollers are used.
used for both Hot & cold rolling.



used for large quantity of similar workpiece.

(iv) Cluster Rolling mills



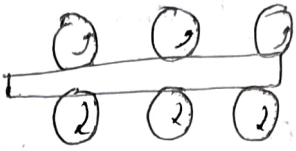
- Having more than four rollers.
- Two working rollers and four backup rollers.
- Mostly used in cold rolling.

* continuous Rolling mill

In this Process, Rollers are arranged in sequence / series and material is passed through each rolling mill.

Fast Process.

less time is required for handling material.



upper and lower rollers rotates in opposite direction.

Rolled Products (Ingot - raw workpiece)

- Slab - rectangular cross section 10" x 1.5"
- Plate - Product with a thickness > 6mm
- Sheet - Thickness < 6mm and width > 600mm
- strip - thickness < 6mm & width < 600.mm
- Bloom - First breakdown Product of ingot cross section 36 in^2
- Billet - Further reduction of bloom by rolling A = 1.5 in x 1.5 in
- Foil - Thickness is very small 0.002 in.

Rolling defects

- CRACKING - Due to excessive mechanical working
- FINS - occurs on the surface of workpiece occurs due to elevated Temp
- Non-uniform deformation - Due to careless work
  Due to unskilled work
- Formation of Scale - Due to low quality material used
  Due to low Temp. used for heating the workpiece.

Extrusion process

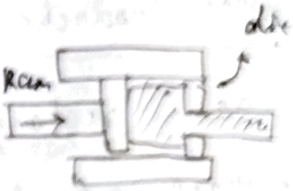
- A compression forming process in which the work piece metal is forced to flow through die opening to produce desired cross sectional area.

advantages -

(i) diff. cross sections possible
(ii) grain struct. and strength enhancement
(iii) close tolerances
(iv) No material wastage.

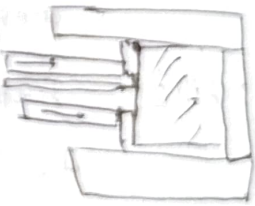
Types of extrusion :-

(i) Direct extrusion



metal is forced to flow in the direction of force. Ram moves towards die.
Requires higher force due to friction between billet and container. (die fixed)

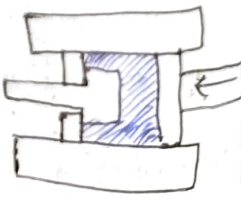
(ii) Indirect extrusion



metal is forced to flow in the opposite direction to driven ram force.
die is fixed at opposite to Punch movement. (die movement)

(iii) Hydrostatic extrusion

uses fluid to apply Pressure on billet
friction is eliminated due to no contact between billet, wall of container and Ram.
fluid bet^n billet & plunger.
Ram applies force on ~~billet~~ fluid & fluid further applies force on billet.
Normaly vegetable oils are used as fluid.



- Extrusion ratio

It is the ratio of cross sectional area of billet to the cross sectional area of extruded product.

$$\text{Ratio} = \frac{A_o}{A_f}$$

- Hollow section is formed using a mandrell.

Hot extrusion

- Performed above recrystallization Temp
- Low force is required as billet is in hot state.
- Product is free from stain hardening.

cold extrusion

- Performed below recrystallization Temp.
- High mechanical properties
- High force is required
- High surface finish.
- Product is accomplished with stain hardening.

- Extrusion Defects

(1) surface cracking

(ii) Piping - Sink hole at end of billet

(iii) centre burst - internal cracking due to excessive Tensile stress at centre.

Extrusion force

$$F = A_o k \ln(A_o/A_f)$$

A_o = area of billet
A_f = area of extruded
k = extrusion constant

Impact extrusion

- main components are Die and Punch.
- metal extruded through gap bet" punch & die
- The force used is called impact force.
- Punch moves downward direction & strikes to workpiece.
- Req. shape is produced acc. to shape of die.
- used for making tubes.

module-3

- Fabrication is a process of joining two or more metals to make a single part.
  - (I) mechanical joining
  - (II) Adhesive joining
  - (III) welding, soldering, brazing

welding Principle

involves heat & liquid metal transfer.

liquid metal deposit → cool → solid state

To remove oil substance from surface - acetone, ethyl

- filler metal → used to fill the gap between parts to be joined.

Gas welding (oxy fuel gas welding)

- Gas welding derives heat from the combustion of acetylene and oxygen mixture. The process is fusion process.
- combustion takes place in two stages

Rxn-1 - initial rxn starts when acetylene & oxygen mixture burns releasing heat & creating a small white cone

$$C_2H_2 + O_2 \longrightarrow 2CO + H_2 + 448\ kJ/mol$$

inner white core temp - 3100°C

Rxn-2 - The CO & H_2 from first rxn further reacts with atmospheric oxygen & gives outer bluish flame.

$$4CO + 2H_2 + 3O_2 \Rightarrow 4CO_2 + 2H_2O + 812\ kJ/mol$$

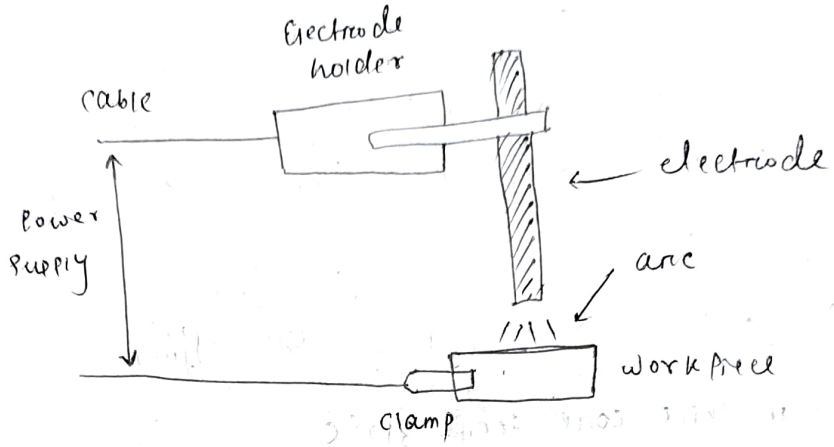
- High amount heat produced but due to distribution of large area (1200 to 2000°C)

Rxn-2 heat → used for Preheating
Rxn-1 heat → melting steel

- A neutral flame is obtained with the complete combustion of acetylene.
- when less oxygen is provided, flame known as carburizing flame.
- A reddish intermediate flame indicates the presence of excess acetylene.
- when more oxygen is provided, flame known as oxidising flame.

Arc welding Process

It is a fusion welding welding Process which uses an electric arc to Produce heat required for melting the metal. (uses also an electrode)



- electric energy converted into heat energy producing 3000°C to 7000°C

Types of electrodes :-

- consumable - steel, Cu, Al — coated / Bared
- Non-consumable - C, W, Graphite

consumable - metal arc welding

Non-consumable - carbon Arc welding.

- coading of electrodes (imp ⋆)

E 3 2 5 411 P

1st letter - E or R

solid extruded

2nd 1st digit - indicates type of coating

2nd digit - indicates weld position (F, H, V)

3rd digit - welding current cond" / polarity

4th digit - indicate UTS and YS / strength

5. Suffix -

P- deep penetration electrode
H- Hydrogen controlled electrode

After selection of electrodes, starting of arc :-

(i) scratch method
(ii) Tapping start

Arc blow:

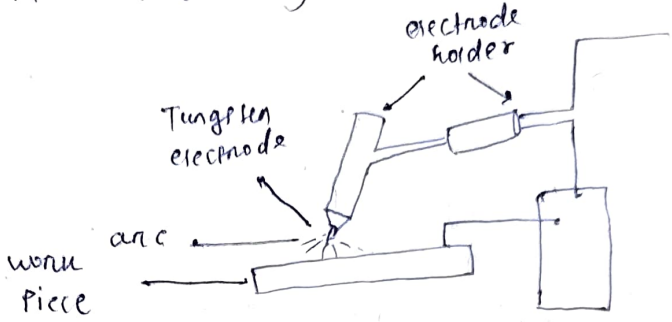
- Arc deviate from its Regular path due to unbalance magnetic field
- max arc blow cond^n is at start Point & end point.
- when electrode reaches the end of workPiece flux line moves out of base metal
- Two types - magnetic & Thermal
- Forward blow is encountered at starting point of workpiece when weirding away from workpiece connection.

Prevention:-

- Shorten arc length.
- angle the torch

Tungsten inert-gas welding (TIG)

TIG is an arc welding uses a non-consumable tungsten electrode to produce weld. The weld area and electrode are protected from from oxidation by inert shielding.



- It consists welding torch at center of which is the tungsten electrode.
- Inert gas supplied to the welding zone, surrounds tungsten electrode from atmosphere contaminated air.
- The small intense arc provided by pointed electrode is ideal for high quality and precision welding.
- TIG welding must be operated with a drooping constant current power source either DC or AC.
- Electrodes for DC welding are pure tungsten with 1 to 4% thoria to improve arc ignition.
- Argon, Argon + 2-5% H_2 and mixture of Ar and He gases are used as shielding gases in TIG welding.

Advantages

- TIG welds are more precise and have a higher general quality
- cleaner process
- No requirement of filler material.

Disadv.

- Time consuming
- more complicated
- safety issue - eye damage
- High initial cost

Metal inert gas welding (MIG)

- Same as TIG welding except a non-consumable electrode replaced by consumable electrode wire.
- arc is maintained betn consumable electrode and workpiece in a protective inert gas atmosphere. to protect from other reactive gas.
- It works on basic principle, heat generation due to electric arc.
- This heat is further used to melt consumable electrode and base plates metal which solidify together and makes a strong joint.

working :-

- suitable for thicker sheets

- MIG welding has high deposition rate and indispensable for welding of ferrous and specially non-ferrous metals like Al, Cu etc

shielding gases

- Mixture of Ar, He, N_2, O_2, Co_2
- Argon is mostly used

Electrodes :-

electrode wire are form of coils and order of 0.5 to 3.2 mm.

For steel, deoxidizer electrodes are used

Adv :-

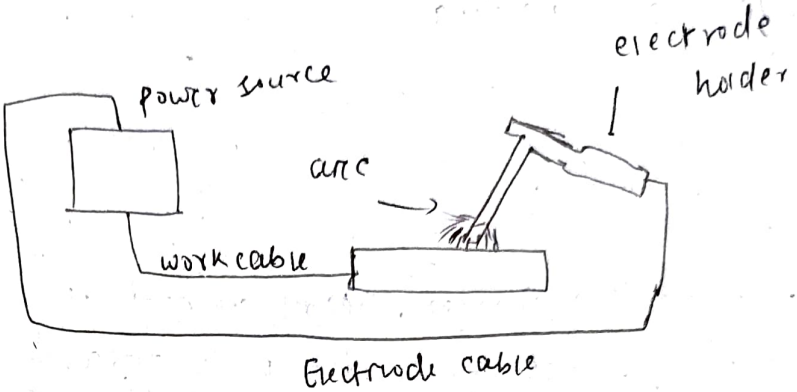
- High quality welds
- flux is not used, no entrapment of slag
- used for wide variety of metals.

Dis adv.:-

- cant be used in vertical & overhead position bcz of heat input and fluidity of weld puddle
- equipment is complex.

Shielded metal arc welding

- uses a consumable electrode consisting of filler metal rod shielded with chemical that provide flux and shielding.



- It involves striking the arc bet' covered metal consumable electrode and work piece.

Process :

(i) heat generated by the help of power source bet' base metal & consumable electrode.

(ii) This process is useful for depositing weld metal bcz it is easy to deposit the molten weld metal where it required and doesn't require separate shielding.

(iii) Commonly used for the metals which are less sensitive to metals.

(iv) DC power source used

(v) in DC welding Heat liberate at anode is greater than that of cathode side.

(viii) Polarity determines the distribution of heat generated at cathode or Anode and also melting rate of electrode.

Ex carbon arc welding

Resistance welding

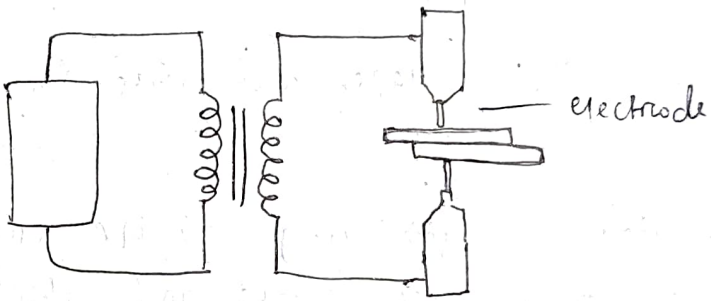
- Pressure welding Process, heavy current is passed for short time through the area of Interface.
- differ from other welding Process as no fluxes are used and rarely filler metal used
- All resistance welding operations are automatic, all Process variables are preset.
- The Heat generated during Process

$$H = i^2 R T$$ Principle

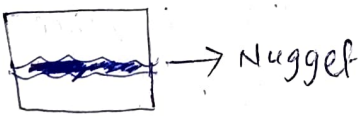
- employees the voltage of order 2 to 12 with
- employees pressure from 30 to 60 N mm^{-2} depending upon metals.
- for Ac supply - Single phase step up transformer
- for DC supply - Three phase rectifier
- Electrode materials - Pure copper & copper base alloys.
- commonly used resistance welding Process spot, seam & Projection welding.

spot welding

- Two or metal sheets held bet^ electrodes through which welding current is supplied for a definited time and also force is exerted on work piece.
- Liquid stage fusion Process In which we use heat and Pressure.
- No filler metal and copper electrodes are used. Non-consumable electrodes are used.

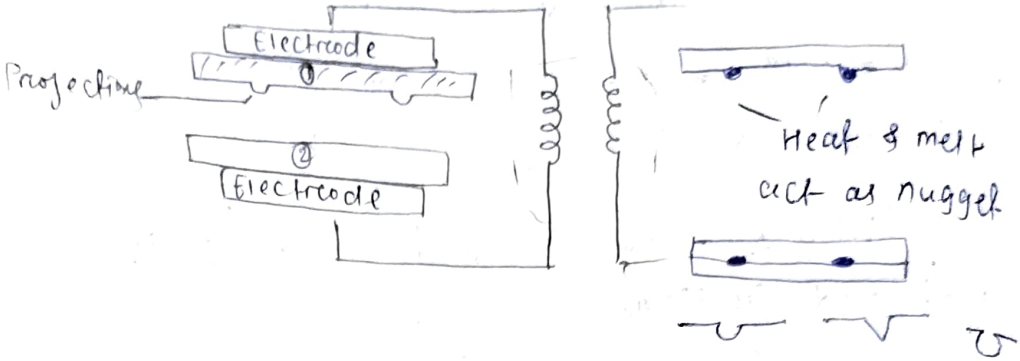


Resistance is developed due to gap bet^ two sheets and due to resistance, produces heat.



- ~~Squee~~ Squeezing cycle, at which movable electrode just slightly touches the sheet.
- weld cycle, at which molten Process starts.
- Hold cycle, at which current flowing stops and Pressure from movable electrode continues until solidification.
- off cycle, weld process completed, movable electrode removed.

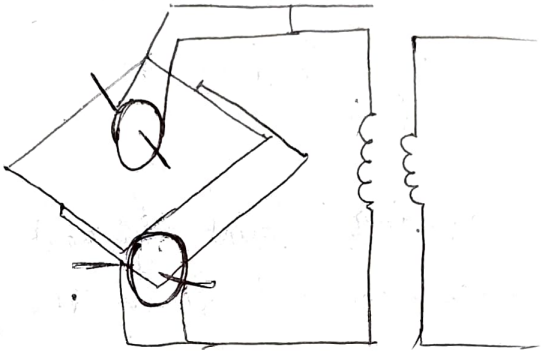
Projection welding



- Projections are little raised points which offer resistance during passage of current and generating heat at those points.
- These Projections collapse and melts due to heat.
- By applying Pressure using movable electrode leads to joint those sheets and after cooling movable electrode is removed.
- There can be one projection or more than one Projection.
- No consumables are required in Projection welding.
- The operation is performed on a Press welding machine

Seam welding

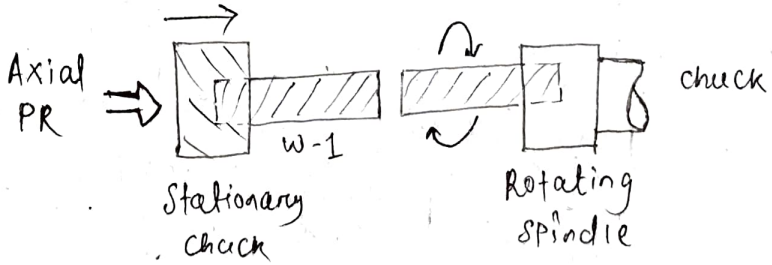
In seam welding overlapping sheets are gripped bet^ two wheels or roller disc electrodes and current is passed to obtain either continuous seam i.e. overlapping weld nuggets or intermitent seam i.e. weld nuggets are equally spaced.

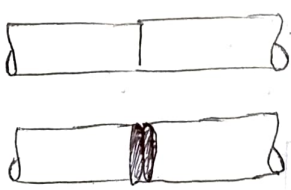


- completely mechanized Process used for making petrol tanks for automobiles, seam welded tubes, drums and other components.
- It is relatively fast method of welding

Friction welding

- Solid state welding
- No external flux, Power required.





- Friction welding is solid-state joining technique that welds workpieces by generating heat through mechanical friction in relative motion one to another.

- when both workpiece comes in contact, the rotating spindle rotates about 12000 RPM creates a very high friction with stationary chuck.

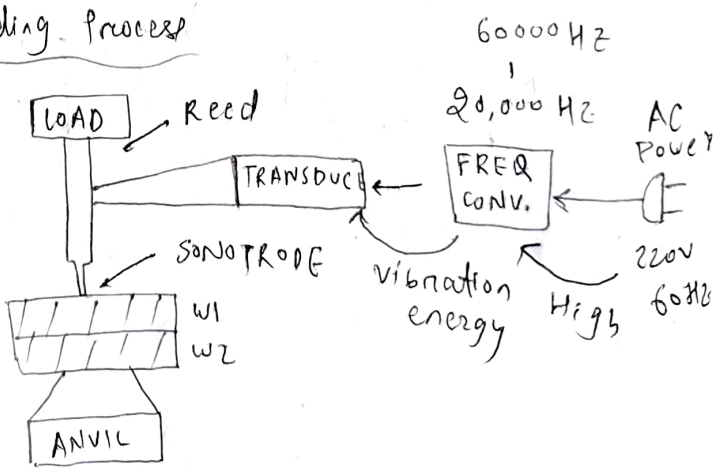
- due to friction, High amount of heat is generated between them and it results in melting of workpiece.

- Hence, the molten metal result in welding between two workpiece and after cooling the weld process is completed.

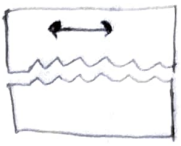
Adv.

- Not requiring a filler metal, flux and shielding gas.
- Not requiring special edge preparation.

Ultrasonic welding Process



- Solid state welding process
- No filler material
- No flux used
- No external heat used
- High freq & Pressure



- Whenever first workpiece vibrates, the peaks are frictioned betn W1 and W2 to produce heat.
- This heat converts it into plastic phase. Oxide flushes out. No Impurities Present
- Then by using feed, wood will apply Pressure vertically on W1 so that they joint together at plastic or welding phase.

Adv

- Less heat affected zone.
- Less residual stress

Disadv.

- Thickness of sheet $\leq$ 3mm
- Lap position if possible.