LECTURE NOTES

ON

PRODUCTION TECHNOLOGY

FOR

3RD SEM Mechanical Engg.

(Scte&vt syllabus)

Prepared by

Er. GEETANJALI MARDI

Workshop supdt

MECHANICAL ENGINEERING

ORISHA SCHOOL OF MINING ENGINEERING , KEONJHAR

PRODUCTION TECHNOLOGY

Subject code:TH-1

Sem-3RD

CHAPTER -1

METAL FORMING PROCESS

CONTENT

1.1-Extrusion Defination & Classification

1.2-Explain Direct ,Indirect & Impact Extrusion Process

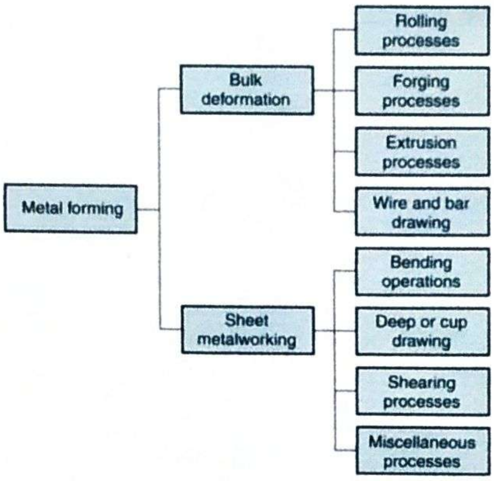
1.3-Define Rolling,Classify it

1.4-Differentiate between Cold rolling &Hot Rolling process

1.5-List the different types of rolling mills used in Rolling process

Basic Types of Metal Forming Processes

1. Bulk deformation
   - Rolling processes
   - Forging processes
   - Extrusion processes
   - Wire and bar drawing
2. Sheet metalworking
   - Bending operations
   - Deep or cup drawing
   - Shearing processes

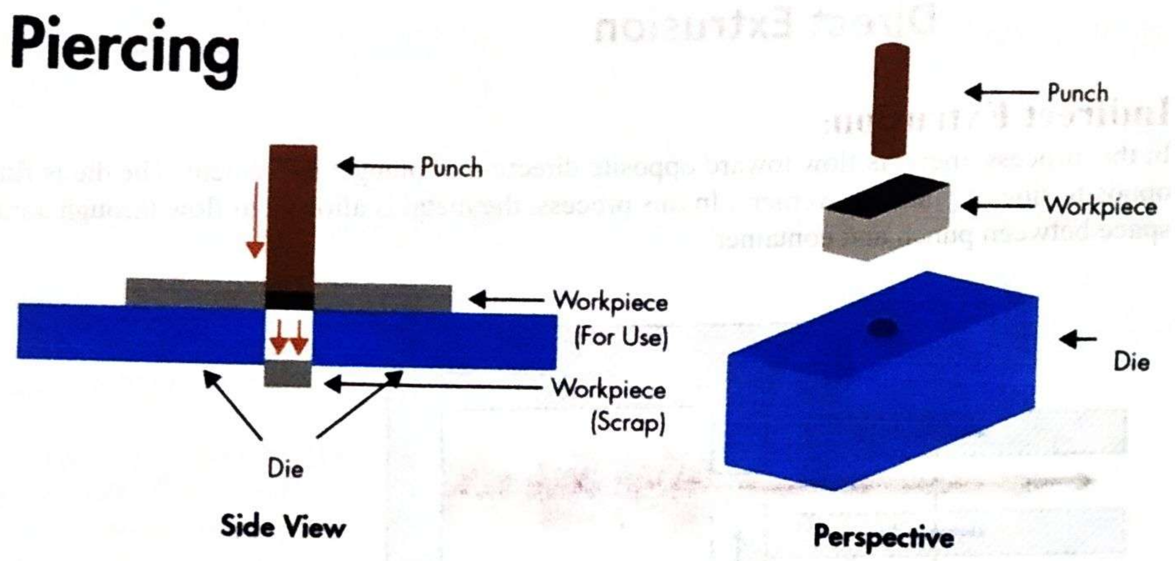


What is a billet in extrusion?

A billet, or solid block, of aluminium is **the raw material of the extrusion process**. It must be heated before it is pushed into the die and extruded to the correct shape. Under-heated billets can damage the press, or may revert to a solid state, blocking the entireA die is a female part of a complete tool for **producing work in a press**.

Punch and die is a type of cutting tool equipment used in punching and forging work, which is a metal forming process that requires high heat. This process needs a 'punch' as a pusher on the cutting workpiece, and the die is a secondary object that the punch pushes in. The punch helps the die cut the part of the workpiece that is pushed down by the punch. The cutting edge is located on the die.

A punch is a male component of the die assembly, which is directly or indirectly moved by the press ram.



1.2 Types of Extrusion:

Extrusion process can be classified into following types.

1.Direct

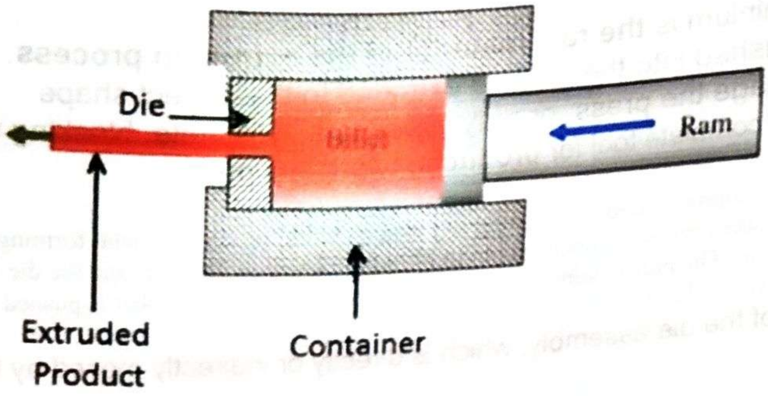
2.Indirect

3.Impact

According to the direction of flow of metal

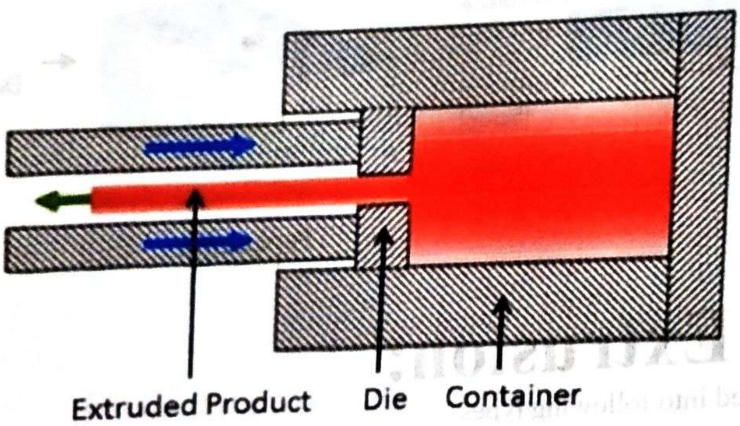
Direct Extrusion:

In this type of extrusion process, metal is forced to flow in the direction of feed of punch. The punch moves toward die during extrusion. This process required higher force due to higher friction between billet and container.



Direct Extrusion

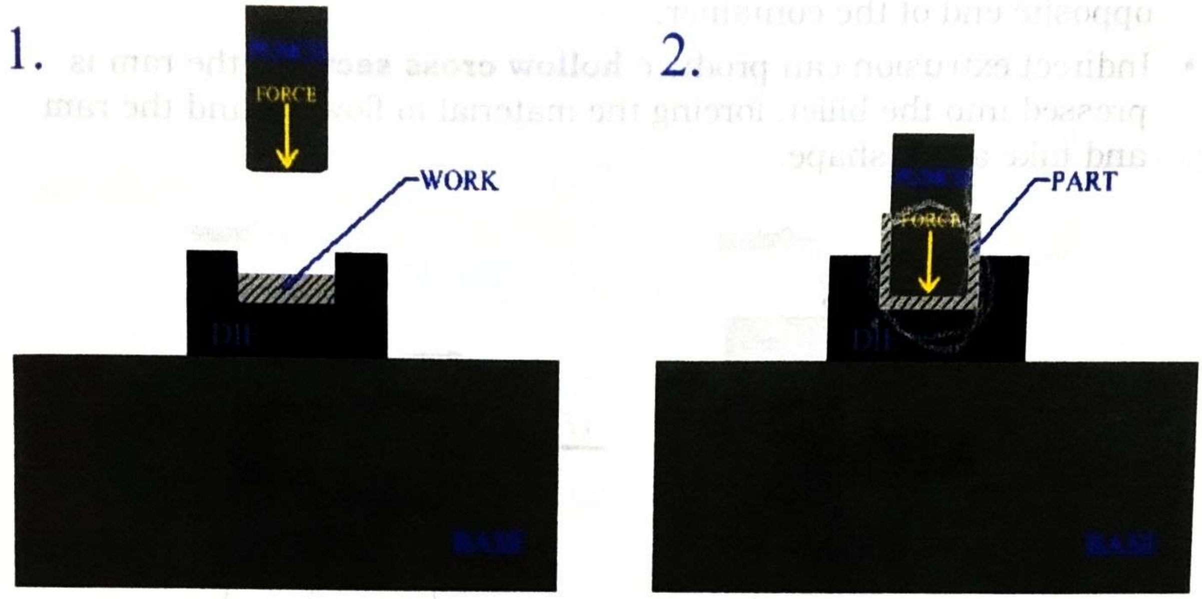
Indirect Extrusion:
In this process, metal is flow toward opposite direction of plunger movement. The die is fitted at opposite side of punch movement. In this process, the metal is allowed to flow through annular space between punch and container.



Indirect Extrusion

Hydrostatic Extrusion:
This process uses fluid to apply pressure on billet. In this process, the friction is eliminated because the billet is neither contact with cylinder wall or plunger. There is a fluid between the billet and plunger. The plunger applies force on fluid which further applied on billet. Normally vegetable oils are used as fluid. This process accomplished by leakage problem and uncontrolled speed of extrusion.

IMPACT EXTRUSION



PUNCH APPROACHES WORK AT A HIGH VELOCITY

PART IS FORMED BY THE IMPACT WITH WORK

Examples of Typical Parts Produced via Impact Extrusion

Impact extrusion allows for the efficient and cost-effective manufacturing of a wide variety of parts. The copper grounding ferrules shown below are a good example of what can be done with impact extrusion, but there are many more examples that can be found throughout a diverse range of industries and applications. See our Gallery page for more examples of parts we produce via impact extrusion and cold forming.

Copper Grounding Ferrules are a good example of parts produced with Impact Extrusion

- **Indirect extrusion** also called **backward extrusion** or **reverse extrusion**, the die is mounted to the ram rather than at the opposite end of the container.
- Indirect extrusion can produce **hollow cross section**, the ram is pressed into the billet, forcing the material to flow around the ram and take a cup shape.

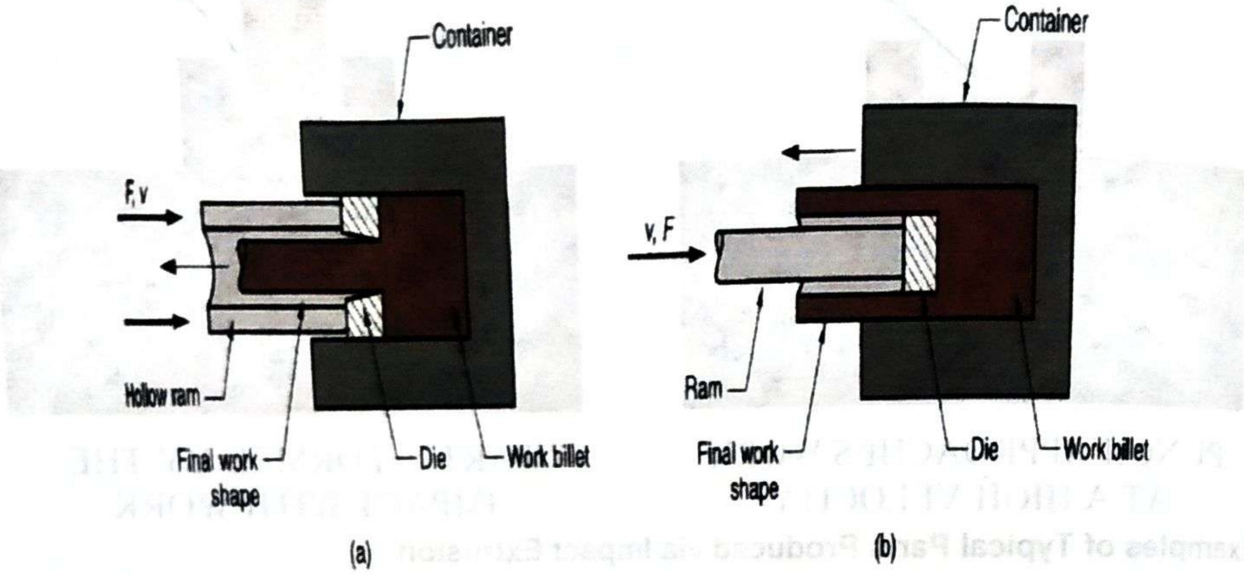
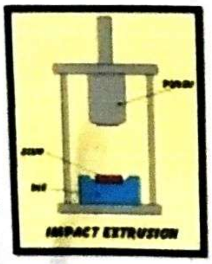


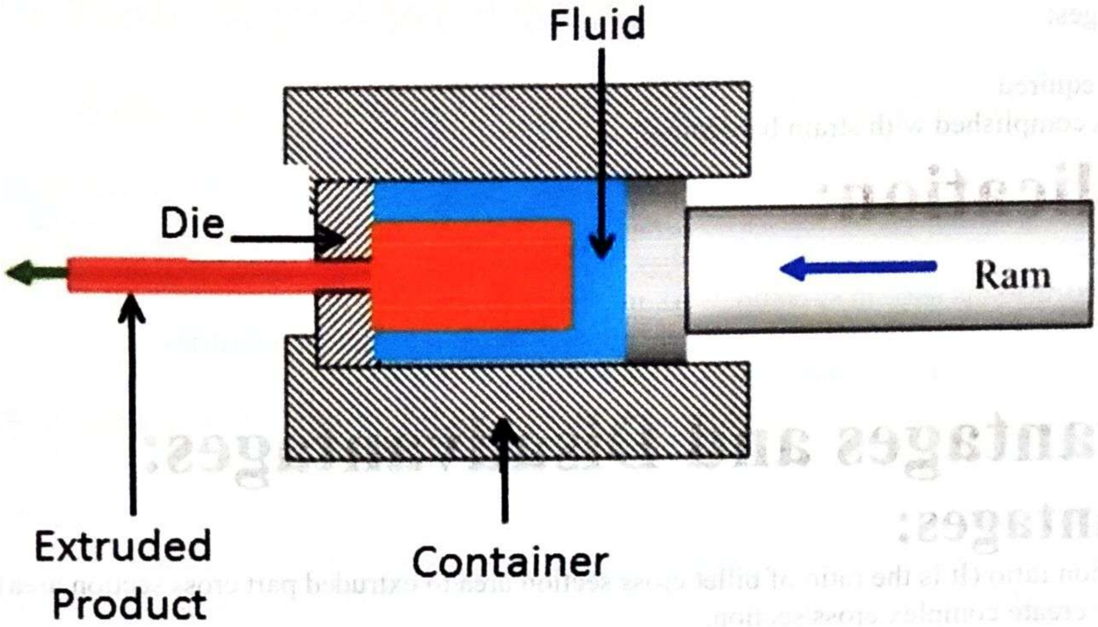
Figure 3.15: Indirect extrusion to produce (a) A solid cross section, (b) a hollow cross section

IMPACT EXTRUSION

Impact extrusion-

- A manufacturing process in which a small shot of solid material is placed in the die and is impacted by a ram, which causes cold flow in the material.
- It may be either direct or indirect extrusion and it is usually performed on a high- speed mechanical press.





Hydrostatic Extrusion

1.2 According to the working temperature

1.Hot Extrusion:

If the extrusion process takes place above recrystallization temperature which is about 50-60% of its melting temperature, the process is known as hot extrusion.

Advantages:

- Low force required compare to cold working.
- Easy to work in hot form.
- The product is free from stain hardening.

Disadvantages:

- Low surface finish due to scale formation on extruded part.
- Increase die wear.
- High maintenance required.

2.Cold Extrusion:

If the extrusion process takes place below crystallization temperature or room temperature, the process is known as cold extrusion. Aluminum cans, cylinder, collapsible tubes etc. are example of this process.

Advantages:

- High mechanical properties.
- High surface finish

- No oxidation at metal surface.

Disadvantages:

- High force required.
- Product is accomplished with strain hardening.

Application:

- Extrusion is widely used in production of tubes and hollow pipes.
- Aluminum extrusion is used in structure work in many industries.
- This process is used to produce frames, doors, window etc. in automotive industries.
- Extrusion is widely used to produce plastic objects.

Advantages and Disadvantages:

Advantages:

- High extrusion ratio (It is the ratio of billet cross section area to extruded part cross section area).
- It can easily create complex cross section.
- This working can be done with both brittle and ductile materials.
- High mechanical properties can achieved by cold extrusion.

Disadvantages:

- High initial or setup cost.
- High compressive force required.

Original Source

1.3 What is Rolling Process.

Rolling is a fabricating process in which metal is passed through a pair of rolls. Rolling has 2 main classifications. Flat rolling, in which the product is typically a sheet, or profile rolling, in which the product is typically a rod or bar. Rolling is also classified according to the recrystallization temperature of the metal

1.3. Working Principle of Rolling

The Rolling Process consists of two opposing rollers and a metal squeezing in between them. The basic consideration is that the thickness between the rollers should be less than the Metal's (Ingot) Initial Thickness. This consideration will help metal's forward motion as it passes through the gap between the Rollers. Rolling Process decreases the Thickness of Metal and Increases its Length and Breadth, Keeping Overall Volume Constant.

1.3. Terminology used In Rolling Process

The most common terminologies used in rolling are as follows:

- **Ingot:** It is the Starting Metal that is Provided Input to the Rolling Process. The Ingot is a forging terminology, where metal is taken out from the cast with various defects.
- **Bloom:** It is the first rolled product of Ingot, with a Cross-section area of more than 230 cm^2.
- **Billet:** The product is obtained by further rolling of Bloom, having an area of Cross-section greater than 1600 mm^2.
- **Slab:** It is a hot Rolled Ingot, with a Cross-section area greater than 100 cm^2 and Width>=2*thickness.

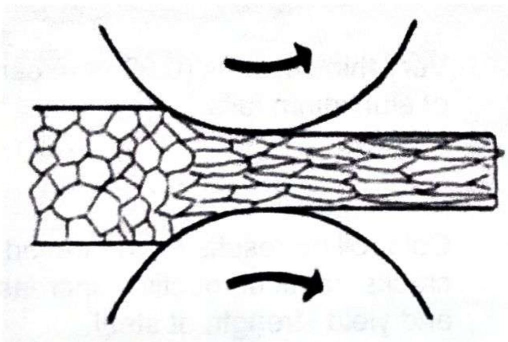
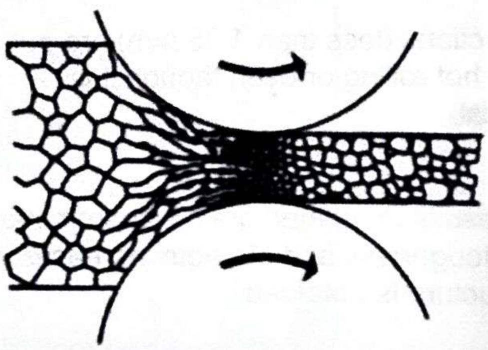
- Another classification is by **working temperature**; cold, warm, or hot extrusion.
- **Hot extrusion** involves prior heating of the billet to a temperature above its re-crystallization temperature.
- This reduces strength and increases ductility of the metal, permitting more extreme size reductions and more complex shapes to be achieved in the process.
- Additional advantages include reduction of ram force, increased ram speed, and reduction of grain flow characteristics in the final product.
- Glass is sometimes used as a lubricant in hot extrusion; in addition to reducing friction.
- **Cold extrusion** and warm extrusion are generally used to produce discrete parts, often in finished form.
- Advantages of cold extrusion include increase strength due to strain hardening, close tolerances, improved surface finish, absence of oxide layers, and high production rates.
- Cold extrusion at room temperature also eliminates the need for heating the starting billet.

1.3.1. Hot Rolling:

Hot rolling uses large pieces of metal, such as slabs or steel billets, and heats them above their recrystallization temperature. The metal pieces are then deformed between rollers creating thin cross sections. These cross sections are thinner than those formed by cold rolling processes with the same number of stages. Hot rolling also reduces the average grain size of metal but maintains an equiaxed microstructure.

1.3.1. Cold Rolling: Cold rolling is a process which passes metal through rollers at temperatures below its recrystallization temperatures. This increases the yield strength and hardness of the metal.

1.3.1 .Both hot rolling and cold rolling are used to create sheet metal. However, cold rolling produces thinner sheets. Hot rolling is also commonly used to create railroad rails, and cold rolling is often used to make beverage cans.

Cold Rolling	Hot Rolling
	

Hot Rolling	Cold Rolling
The material to be rolled is above its re-crystallization temperature.	The material to be rolled is below its re temperature.
The roll radius is larger than used in cold rolling.	The roll radius is smaller.
Heavy reduction in area of the work-piece can be obtained.	The heavy reduction area is not possib
Very thin sections (less than 1.25 mm) are not obtained by hot rolling or even though it is uneconomical.	Very thin sections (0.02 mm) can be ma of aluminium foils.
Hot rolling results in; refined grain size, removed blow holes, toughness and strength increases. A fiber-like structure is obtained.	Cold rolling results in; increased hardne cracks, reduced ductility, increased tens and yield strength of steel.
Generally hot rolled metal does not shows work hardening effect.	Cold rolled metal shows work hardenin

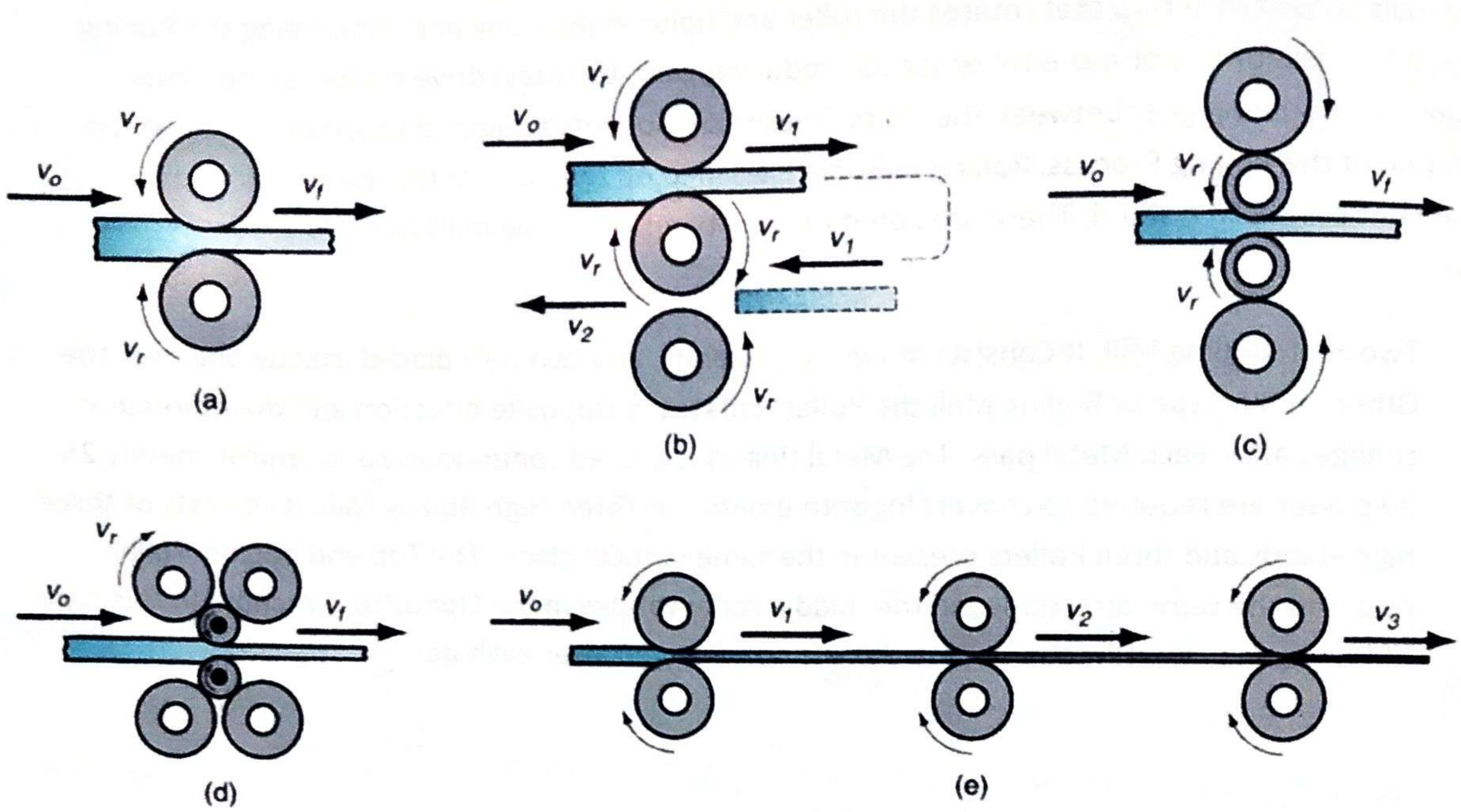
Hot Rolling	Cold Rolling
The material to be rolled is above its re-crystallization temperature.	The material to be rolled is below its recry temperature.
The roll radius is larger than used in cold rolling.	The roll radius is smaller.
Heavy reduction in area of the work-piece can be obtained.	The heavy reduction area is not possible.
Very thin sections (less than 1.25 mm) are not obtained by hot rolling or even though it is uneconomical.	Very thin sections (0.02 mm) can be mad of aluminium foils.
Hot rolling results in; refined grain size, removed blow holes, toughness and strength increases. A fiber-like structure is obtained.	Cold rolling results in; increased hardnes cracks, reduced ductility, increased tensi and yield strength of steel.
Generally hot rolled metal does not shows work hardening effect.	Cold rolled metal shows work hardening

1.5 Types of Rolling Mills

Rolling mills consist of set-up that rotates the roller and helps in initiating and completing the Rolling Process. It consists of one or more roller stands, reducing gear, the main drive motor, Stand Pinion, Flywheel, and Coupling gear between the Units. These Components equipped together to help in the Completion of the Rolling Process. Rolling mills are classified on the basis of the number and arrangement of rolls in a stand. There are commonly six types of Rolling mills that are used, they are as follows:

(i) Two-High Rolling Mill: It Consists of two High stands, and two rolls placed exactly one over the Other. In this type of Rolling Mill, the Rollers rotates in Opposite direction and their direction changes after each Metal pass. The Metal (Ingot) is passed continuously and approximately 25-30 passes are required to convert Ingot to Bloom. (ii) Three-High Rolling Mill: It consists of three high stands and three Rollers present in the same vertical plane. The Top and bottom roller rotate in the same direction, and the middle roller rotates in the Opposite Direction. In this type of Rolling mill, the Direction of the drive is not changed after each pass.

(ii) Three-High Rolling Mill: It consists of three high stands and three Rollers present in the same vertical plane. The Top and bottom roller rotate in the same direction, and the middle roller rotates in the Opposite Direction. In this type of Rolling mill, the Direction of the drive is not changed after each pass. It is more Productive and easier with respect to the two-High Rolling Mill.



vo
vr
vf
v1
v2
v3
(a)
(b)
(c)
(d)
(e)

CHAPTER-03

3.0 WELDING PROCESS

3.1Introduction of Welding

Welding is **a fabrication process whereby two or more parts are fused together by means of heat, pressure or both forming a join as the parts cool.**

Welding is a process of joining two metal pieces by the application of heat. Welding is the least expensive process and widely used now a days in fabrication. Welding joints different metals with the help of a number of processes in which heat is supplied either electrically o by mean of a gas torch. Different welding processes are used in the manufacturing of Auto mobiles bodies, structural work, tanks, and general machine repair work. In the industries , welding is used in refineries and pipe line fabrication. It may be called a secondary manufacturing process.

3.2 SAFETY PRECAUTIONS IN WELDING,SAFETY EQUIPMENTS

Various welding equipment are

1. Welding Machine
2. Welding electrodes
3. Filler metals
4. Electrode holder

Safety Equipment that is very essential for the safe working

1. Welding Helmet
2. Welding apron or Jacket
3. Welding Gloves
4. Safety Glasses
5. Mask or Respirator
6. Earplugs
7. Shoes

3.2 Applications of welding

3.3 Classification of welding processes:

There are about 35 different welding and brazing process and several solderin methods, in use by the industry today. There are various ways of classifying th welding for example, they may be classified on the basis of source of heat(flame ,arc etc.)

In general various welding processes are classified as follows.

1: Gas Welding

(a): Air Acetylene

(b): Oxy Acetylene

(c): Oxy Hydrogen Welding

(a): Carbon Arc welding
(b); Plasma Arc welding
(c): Shield Metal Arc Welding
(d): T.I.G. (Tungsten Inert Gas Welding)
(e): M.I.G. (Metal Inert Gas Welding)

(a): Spot welding
(b): Seam welding
(c): Projection welding
(d): Resistance Butt welding
(e): Flash Butt welding

:

(a): Cold welding
(b): Diffusion welding
(c): Forge welding
(d): Fabrication welding
(e): Hot pressure welding
(f): Roll welding

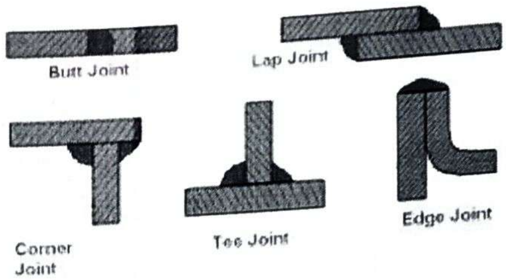
(a): Thermit welding
(b): Atomic welding

(a): Electric Beam Welding
(b): Laser Beam Welding

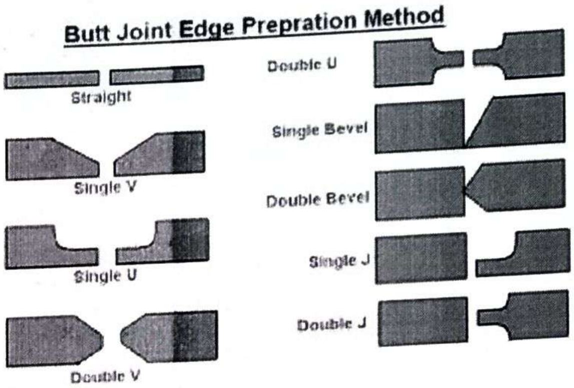
Welding Joints

Different types of welding joints are classified as Butt, Lap , Corner, Tee and edge joints which are shown in figure

Welding Joints



Butt Joint Edge Prepration Method



or performing the welding process we have several welding equipments that helps in the joining process.

COMMON MATERIALS that can be welded:steel and stainless steel , cast iron ,copper,brass,alluminium,magnesium alloys...etc

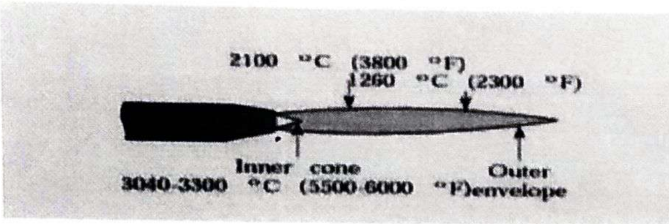
GAS WELDING

Gas welding is **a process in which two or more parts of the metal are mixed or united using heat transmitted by the heat produced by the reaction of oxygen and fuel gas**. Gas welding is also called oxy-fuel welding. This is called oxy-fuel welding because oxygen is used along with the burning fuel in this process. In this process, heat receives combustion of fuel gases. When a fuel gas such as acetylene (C2H2) is mixed with oxygen and ignites to produce temperatures in the range 3100 ° Celsius.

- The second one is oxy
-

3.3 TYPES OF FLAME

3.3 Neutral flame



In this gas welding flame, oxygen and acetylene are released at a one-to-one ratio. That is, an equal amount of oxygen and acetylene is released. It absorbs additional oxygen from the air as it provides complete combustion. A neutral flame is fine, clear, and well-defined. It is generally preferred for welding. it produces a luminous cone indicating the completion of the flame.

Neutral flames are used to weld both ferrous and nonferrous metals such as mild steel, cast iron, copper, stainless steel, aluminum, etc. welder are expected to adjust to neutral before any other flame. The flame is indicated from its inner cone consisting of a luminous cone that is bluish-white. It is also known for its surroundings showing a light blue flame sheath or envelope. Neutral flame, which is also known as a balanced flame which is achieved by releasing excess acetylene. A flame with feather extension of inner cone is produce, increasing the oxygen valve will produce the flame. Immediately oxygen gas, the acetylene flame feather disappears and neutral flame remains. The inner core tip temperature is approximately 585-degree Fahrenheit, whilst, end of its outer sheath or envelope temperature drops to approximately 2300-degree Fahrenheit.

Carburizing flame

In this oxyacetylene flame, excess acetylene is supply. Its inner core has a feather edge extending beyond it, this white feather is also known as acetylene feather. This acetylene is 2x if it's twice as long as the inner cone, helping to know the amount of acetylene supply. Carburizing flame may add carbon to the welded metal of one volume. It is performed by adjusting to a neutral flame before increasing the acetylene valve. The inner core will change showing an acetylene streamer or "feather" at its end. The level of carburization flame is determined from the length of the streamer. The streamer should not be more than half the length of the inner core.

Carburizing flame is clearly recognized by three flame zones:

1. A clearly defined bluish-white inner cone

2. White immediately cone indicating the amount of excess acetylene
3. A light blue outer flare envelope.

This flare burns with a coarse rushing sound. The inner cone tip temperature is approximately 3700-degree Fahrenheit. If a carburizing flame is used for welding, carbon absorbs from the flame, causing metals to boil. This metal is not clear as it boils, obtains high carbon steel, becomes brittle, and subject to cracking.

Oxidizing flame

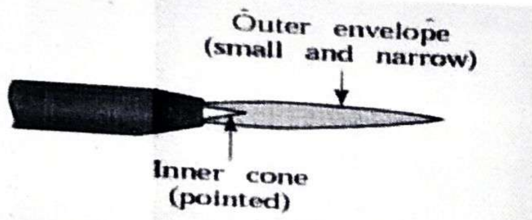
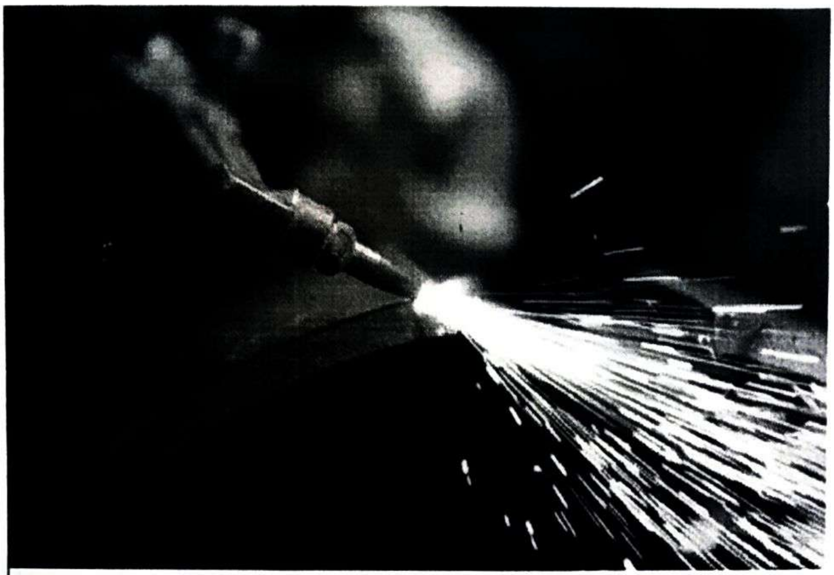


Figure3: Oxidizing Flame

this is the third oxyacetylene flame. It is obtained when oxygen is slightly more than one volume, mixed with one volume of acetylene. Just as it is done in carburizing flame, the torch is adjusted to a neutral flame. The oxygen valve will then be increased until the inner core is shortened to about one-tenth of its original length. The flame tends to be slightly purple and the inner cone is pointed if the flame is properly adjusted. This flame is also known for its clear hissing sound.

The temperature of the oxidizing flame is approximately 6300-degree Fahrenheit at its inner core tip. It is used to weld metals such as zinc, copper, manganese steel, and cast iron. Applying this flame to steel causes its molten metal to form and spark off, indicating excess oxygen is supply to the steel. It is not used for welding steel because it causes it to be porous, oxidized, and brittle.

3.3 Gas Welding:



shutterstock.com · 78886216

Principle:

Gas welding is a most important type of welding process. It is done by burning of fuel gases with the help of oxygen which forms a concentrated flame of high temperature. This flame directly strikes the weld area and melts the weld surface and filler material. The melted part of welding plates diffused in one another and create a weld joint after cooling. This welding method can be used to join most of common metals used in daily life.

Welding equipment

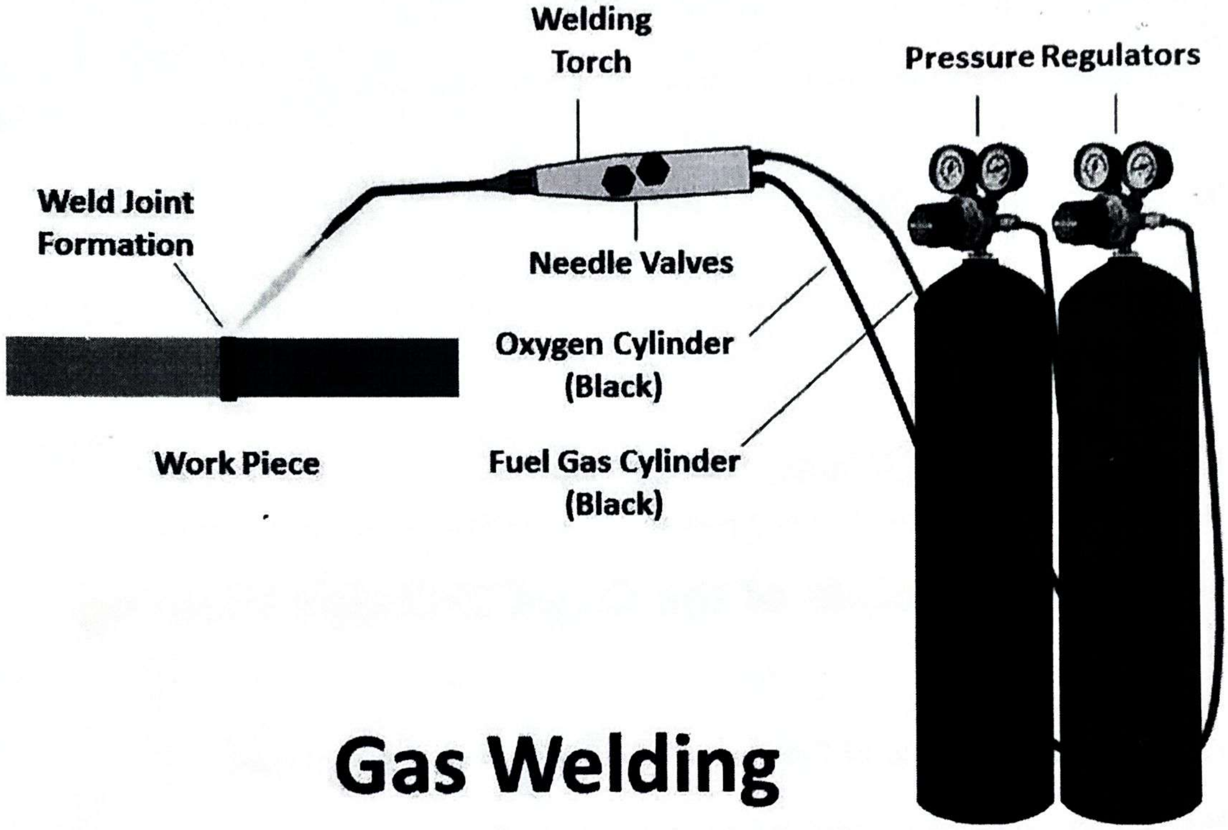
Cylinder(oxygen &acetylene),regulator,,hose pipe,control valve

Welding torch

w/p

base/work table

nozzle,,



Welding Torch:

Welding torches are most important part of gas welding. Both the fuel gas and oxygen at suitable pressure fed through hoses to the welding torch. There are valves for each gas witch control the flow of gases inside the torch. Both gases mixed there and form a flammable mixture. These gases ignite to burn at the nozzle. The fire flame flow through nozzle and strikes at welding plates. The nozzle thickness depends on the size of the welding plates and material to be welded.

Oxygen Cylinder:

For proper burning of fuel, appropriate amount of oxygen required. This oxygen supplied by a oxygen cylinder. A black line is used to indicate oxygen cylinder.

Fuel Gas Cylinder:

Gas cylinder is filled either by oxy acetylene gas, hydrogen gas, natural gas or other flammable gas. The fuel gas selection is depends on the welding material. Mostly oxy acetylene gas is used for all general purpose of welding. Normally these cylinders have Maroon line to indicate it. The fuel gases passes through it.

Pressure regulator:

Both oxygen and fuel gases are filled in cylinder at high pressure. These gases cannot use at this high pressure for welding work so a pressure regulator is used between flow. It supplies oxygen at pressure about 70 – 130 KN / M2 and gas at 7 – 103 KN / M2 to the welding torch.

Goggles and Gloves:

These are use for safety purpose of welder. It protects eyes and hand from radiation and flame of fire.

working Principle of the Oxy-C2H2 Gas Welding Process:

The working principle of the Gas Welding process is as follows.

Oxygen and acetylene gases will be drawn from their respective cylinders mixed in the torch body so that the mixture is processing certain high pressure.

When these high-pressure mixture is passing through the convergent nozzle, the pressure energy is converted into velocity energy and coming out from the nozzle at high velocity.

When the initiation for the burning of this mixture is given, the continuous flame is produced and the heat available in the flame will be used for melting and joining of the plates.

By Majo statt Senf

Chemical Reactions Involved in Gas Welding:

$C_2H_2 + O_2 \rightarrow 2CO + H_2 + heat$

$2CO + O_2 \rightarrow 2CO_2 + heat$

$H_2 + 1/2\ O_2 \rightarrow H_2O + heat$

For complete combustion of one unit Volume of acetylene, 2.5 units of volumes of oxygen are required.

Note:

Out of **2.5 units,1 unit volume of oxygen** is obtained from the **Oxygen cylinder** and **1.5 units of volume of oxygen** are obtained from the **atmosphere**.

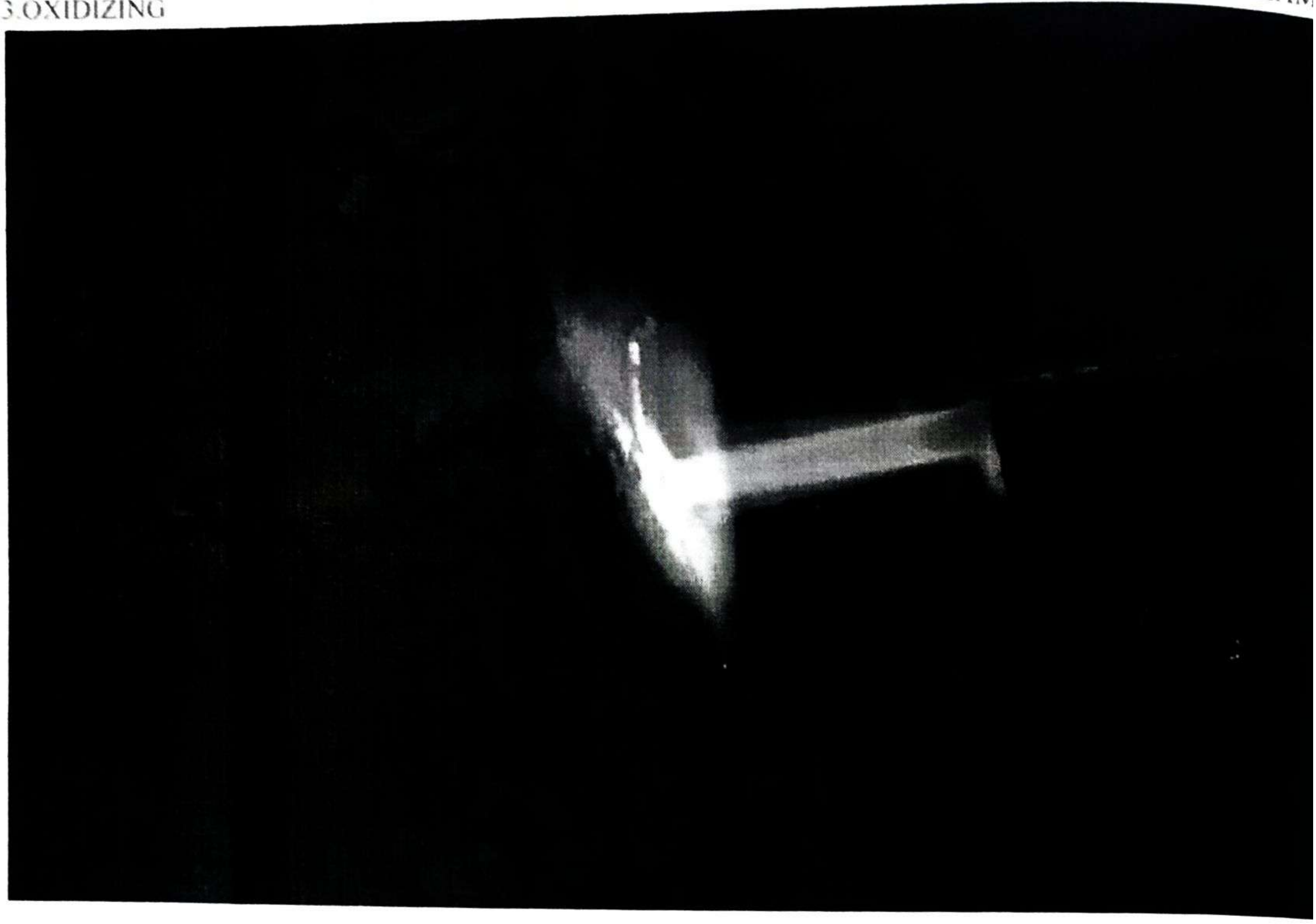
Based on the amount of oxygen taken from the oxygen cylinder, the flame produced in oxyacetylene gas welding is divided into three types.

Types of Flames in Oxy-Acetylene Gas Welding:

1.NEUTRAL FLAME

2.CARBURIZING FLAME

3.OXIDIZING FLAM



Application:

- It is used to join thin metal plates.
- It can used to join both ferrous and non-ferrous metals.
- Gas welding mostly used in fabrication of sheet metal.
- It is widely used in automobile and aircraft industries.

Advantages and Disadvantages:

Advantages:

- It is easy to operate and dose not required high skill operator.
- Equipment cost is low compare to other welding processes like **MIG**, **TIG** etc.
- It can be used at site.
- Equipment's are more portable than other type of welding.
- It can also be used as gas cutting.

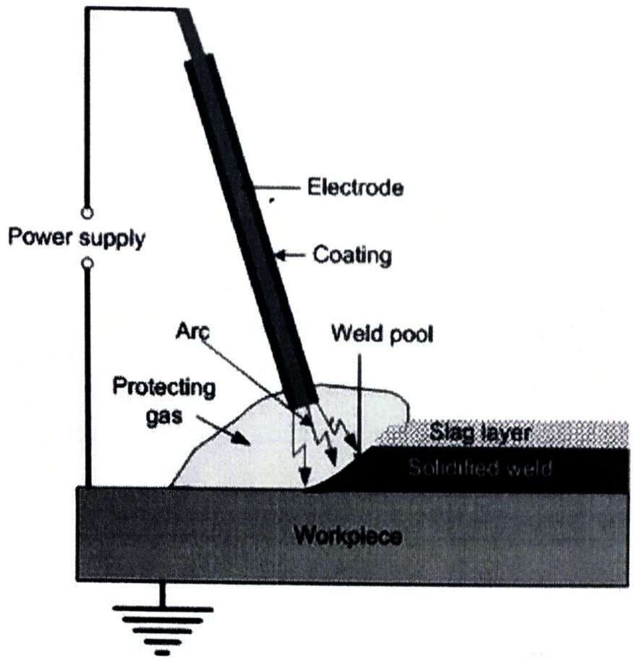
Disadvantages:

- It provides low surface finish. This process needs a finishing operation after welding.
- Gas welding have large heat affected zone which can cause change in mechanical properties of parent material.
- Higher safety issue due to naked flame of high temperature.

- It is Suitable only for soft and thin sheets.
- Slow metal joining rate.
- No shielding area which causes more welding defects.

This is all about gas welding principle, equipment's, working, application, advantages and disadvantages. If you have any query regarding this article, ask by commenting. If you like this article, don't forget to share it on social networks. Subscribe our website for more interesting articles. Thanks for reading it.

3.4 ARC WELDING DEFINITION AND PROCESS TYPES



Defination:Arc welding is one of many fusion welding processes used to join metals. It uses an electric arc to create intense heat to melt and join metals. A power source generates an electric arc between a consumable or non-consumable electrode and base metal. Arc welders can use either direct current (DC) or alternating current (AC).

HOW DOES IT WORK?

Arc welding works by using an electric arc from an AC or DC power source to generate a staggering heat around 6,500 degrees Fahrenheit at the tip, to melt the base metals, and to create a pool of molten metal and join the two pieces.

The arc is formed between the work piece and the electrode, which is moved along the line of the joint either mechanically or manually. The electrode can either be a rod that carried the current between the tip and the work piece, or it can be a rod or wire that conducts current as well as melts and supplies filler metal to the joint.

Metal tends to react chemically to elements in the air such as oxygen and nitrogen when heated to extreme temperatures by the arc. This creates oxides and nitrides, which ruin the strength of the weld. Therefore, a protective shielding gas, slag, or vapor needs to be used to lessen the contact of the molten metal with the air. After the piece has cooled, the molten metal is able to solidify to create a metallurgical bond.

CONSUMABLE ELECTRODE METHODS

METAL INSERT GAS WELDING (MIG) AND METAL ACTIVE GAS WELDING (MAG)

This form of arc welding is also known as Gas Metal Arc Welding (GMAW). MIG uses a shielding gas such as argon, carbon dioxide, or helium to protect the base metals from being destroyed from contamination.

SHIELDED METAL ARC WELDING (SMAW)

This form of welding is also known as stick welding or manual metal arc welding. In this process, the arc is placed between the metal rod that is electrode flux coated and the work segment to melt it and form a weld pool. The electrode flux coating on the metal rod is melted to form a gas, which shields the weld pool from the air. This process does not use pressure and the filler metal is formed by the electrode. This process works best for ferrous metals because they can be welded in all positions. Ferrous metals are alloys that are made up mostly of iron and contain carbon.

FLUX-CORED ARC WELDING (FCAW)

This form of welding can be used as a substitute for SMAW. FCAW uses the gas formed by the flux to shield the work piece from contamination. This enables the operator to weld outdoors even if it is windy. It works by using a constantly fed consumable flux cored electrode and a continual voltage power supply in order to generate a constant arc length. This form of welding is great for general repairs and shipbuilding because it works well with thicker joints.

SUBMERGED ARC WELDING (SAW)

SAW involves the formation of an arc between a constantly fed consumable electrode or wire, and the work piece. This process creates a cover of fusible flux, which generates a protective gas to shield the work area. The process becomes conductive when molted and generates a current path amongst the electrode and work piece. The flux is great because it prevents spatter and sparks while simultaneously quelling fumes and ultraviolet radiation.

ELECTRO-SLAG WELDING (ESW)

ESW is a welding process that uses heat which is generated by an electric current moving between the consumable electrode and the workpiece. This creates a molten slag, which covers the weld surface. The molten slag's resistance to the passage of the electric current creates heat for melting the wire and plate edges. The metal solidifies as it is hit with water. This is a vertical process that is used to weld thick plates that are above 25 mm in a single pass.

ARC STUD WELDING (SW)

SW joins a metal stud such as a nut or fastener, to a metal work piece by heating both parts with an arc of electricity.

NON-CONSUMABLE ELECTRODE METHODS

TUNGSTEN INERT GAS WELDING (TIG)

This process is also referred to as Gas Tungsten Arc Welding (GTAW). TIG uses a non-consumable tungsten electrode to generate an electric arc. The arc also works as a shield of gas to protect the weld from the air, which can cause oxidation. This is a favored method for welding aluminum.

PLASMA ARC WELDING (PAW)

This method uses an electric arc between a non-consumable electrode and a base metal. The electrode is placed in a torch and the plasma forming gas is separated from the shielding gas, which produces narrow and deep welds

ARC WELD ADVANTAGES

Arc welding provides a plethora of advantages compared to other types of welding. These advantages include:

- **Low cost.** This is an affordable technique because the cost of equipment is low. It also requires less equipment due to the lack of gas.
- **Portability.** The materials in this technique are easy to transport.
- **Used on unclean metals**. Arc welding can be performed on dirty metals.
- **Work in any environment.** A lot of arc processes use shielding gas so work can only be done in one place. With arc welding, there is no need for shielding gas so work can happen regardless of weather conditions.

ARC WELD DISADVANTAGES

While there are many great benefits to arc welding, there are also some shortcomings. These disadvantages include:

- **Cost.** While cost is considered an advantage, it is also a disadvantage because it produces more metal waste than other methods, resulting in higher project costs.
- **Requires a high level of skill and training.** Not all operators have a **high level of training and skills**.

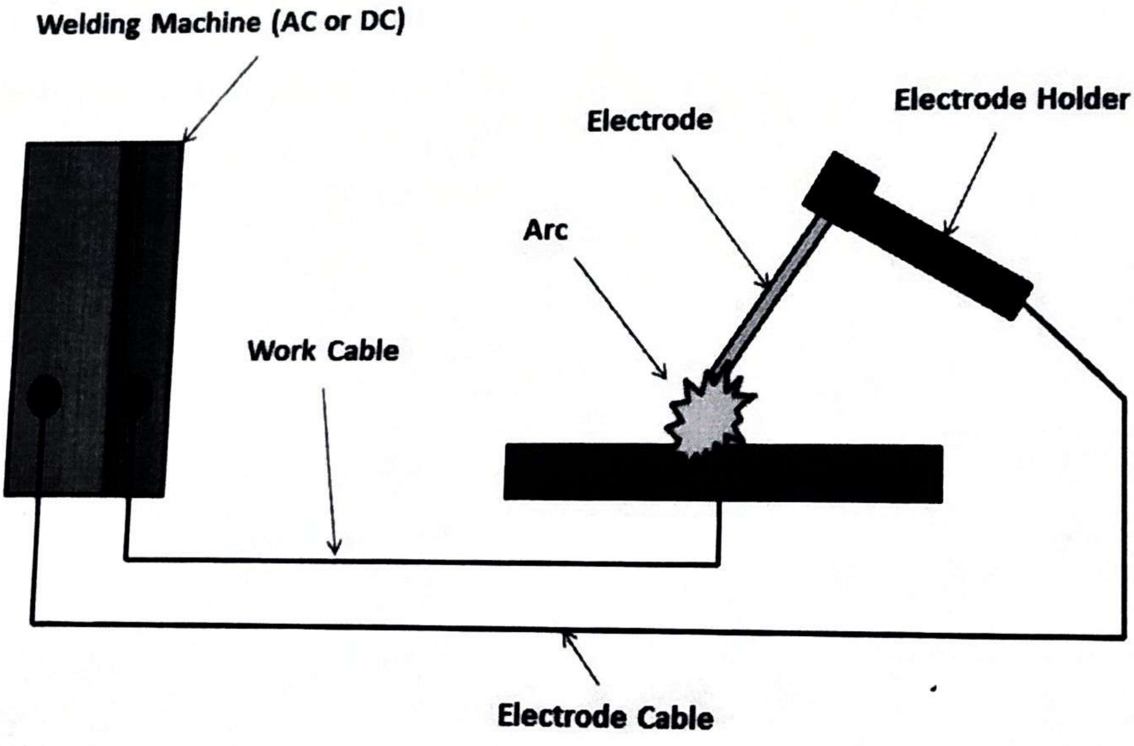
Thin metal. Arc welding does not work well on certain thin **What is TIG Welding : Principle, Working, Equipment's, Applications, Advantages and Disadvantages**

- metals

Meaning of Electric Arc Welding:

The arc welding is a fusion welding process in which the heat required to fuse the metal is obtained from an electric arc between the base metal and an electrode.

The electric arc is produced when two conductors are touches together and then separated by a small gap of 2 to 4 mm, such that the current continues to flow, through the air. The temperature produced by the electric arc is about 4000°C to 6000°C.



Basic Arc Welding Circuit Diagram

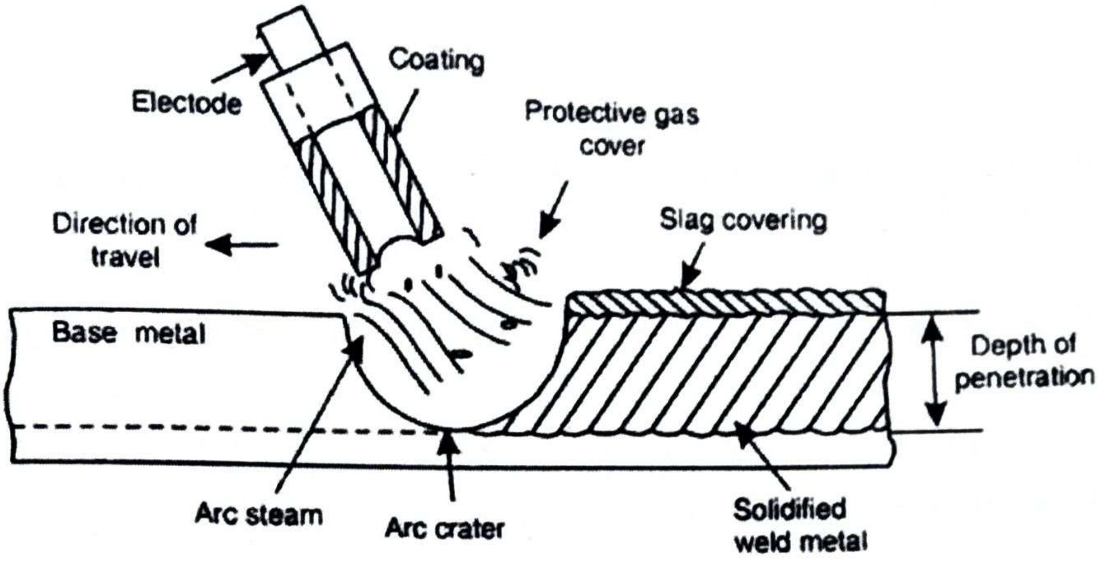


Fig. 7.14. Cut away view of the arc welding with a coated electrode.

A metal electrode is used which supplies the filler metal. The electrode may be flux coated or bare. In case of bare electrode, extra flux material is supplied. Both direct current (D.C.) and alternating current (A.C.) are used for arc welding.

The alternating current for arc is obtained from a step down transformer. The transformer receives current from the main supply at 220 to 440 volts and step down to required voltage i.e., 80 to 100 volts. The direct current for arc is usually obtained from a generator driven by either an electric motor, or patrol or diesel engine.

An open circuit voltage (for striking of arc) in case of D.C. welding is 60 to 80 volts while a closed circuit voltage (for maintaining the arc) is 15 to 25 volts.

Procedure of Electric Arc Welding:

First of all, metal pieces to be weld are thoroughly cleaned to remove the dust, dirt, grease, oil, etc. Then the work piece should be firmly held in suitable fixtures. Insert a suitable electrode in the electrode holder at an angle of 60 to 80° with the work piece.

Select the proper current and polarity. The spot are marked by the arc at the places where welding is to be done. The welding is done by making contact of the electrode with the work and then separating the electrode to a proper distance to produce an arc.

When the arc is obtained, intense heat so produced, melts the work below the arc, and forming a molten metal pool. A small depression is formed in the work and the molten metal is deposited around the edge of this depression. It is called arc crator. The slag is brushed off easily after the joint has cooled. After welding is over, the electrode holder should be taken out quickly to break the arc and the supply of current is switched off.

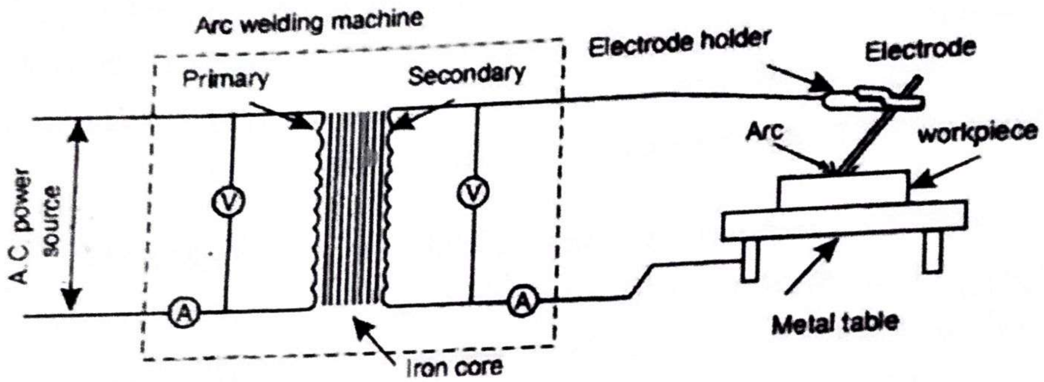


Fig. 7.15. The arc welding setup.

Electric Current for Welding:

Both D.C. (direct current) and A.C. (alternating current) are used to produce an arc in electric arc welding. Both have their own advantages and applications.

The D.C. welding machine obtains their power from an A.C. motor or diesel/petrol generator or from a solid state rectifier.

The capacities of D.C. machine are:

Current:

Up to 600 amperes.

Open Circuit Voltage:

50 to 90 volts, (to produce arc).

Closed Circuit Voltage:

18 to 25 volts, (to maintain arc).

The A.C. welding machine has a step down transformer which receives current from main A.C. supply. This transformer step down the voltage from 220 V-440V to normal open circuit voltage of 80 to 100 volts. The current range available up to 400 amperes in the steps of 50 ampere.

The capacities of A.C. welding machine are:

Current Range:

Up to 400 ampere in steps of 50 ampere.

Input Voltage:

220V- 440V

Actual Required Voltage:

80 – 100 volts.

Frequency:

50/60 HZ.

Significance of Polarity:

When D.C. current is used for welding, the following two types of polarity are available:

(i) Straight or positive polarity.

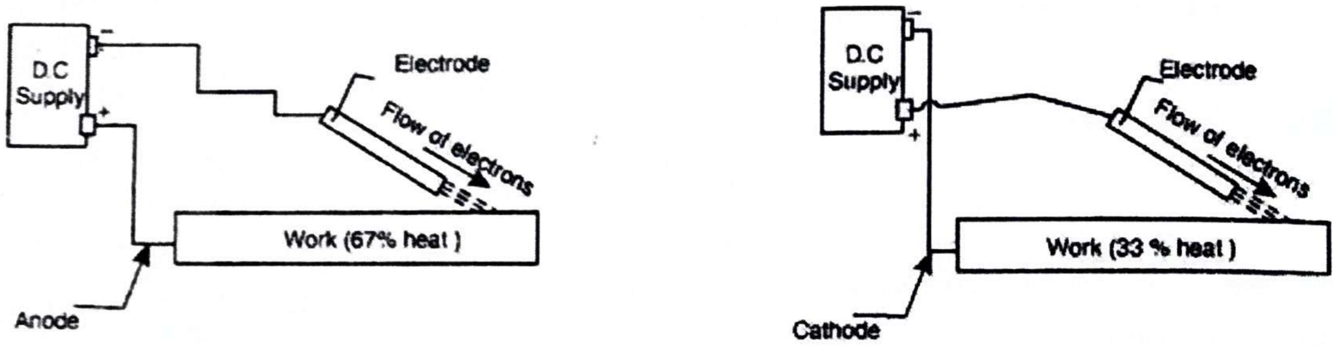
(ii) Reverse or negative polarity.

When the work is made positive and electrode as negative then polarity is called straight or positive polarity, as shown in Fig. 7.16 (a).

In straight polarity, about 67% of heat is distributed at the work (positive terminal) and 33% on the electrode (negative terminal). The straight polarity is used where more heat is required at the work. The ferrous metal such as mild şteel, with faster speed and sound weld, uses this polarity.

(a) Straight polarity.

(b) Reverse polarity



(*a*) Straight polarity. (*b*) Reverse polarity

Fig. 7.16. Polarity for D.C. Arc Welding.

On the other hand, when the work is made negative and electrode as positive then polarity is known as reverse or negative polarity, as shown in Fig. 7.16 (b).

In reverse polarity, about 67% of heat is liberated at the electrode (positive terminal) and 33% on the work (negative terminal).

The reverse polarity is used where less heat is required at the work as in case of thin sheet metal weld. The non-ferrous metals such as aluminum, brass, and bronze nickel are welded with reverse polarity.

Equipments Required for Electric Arc Welding:

The various equipments required for electric arc welding are:

1. Welding Machine:

The welding machine used can be A.C. or D.C. welding machine. The A.C. welding machine has a step-down transformer to reduce the input voltage of 220- 440V to 80-100V. The D.C. welding machine consists of an A.C. motor-generator set or diesel/petrol engine-generator set or a transformer-rectifier welding set.

A.C. machine usually works with 50 hertz or 60 hertz power supply. The efficiency of A.C. welding transformer varies from 80% to 85%. The energy consumed per Kg. of deposited metal is 3 to 4 kWh for A.C. welding while 6 to 10 kWh for D.C. welding. A.C. welding machine usually work with low power factor of 0.3 to 0.4, while motor in D.C. welding has a power factor of 0.6 to 0.7. The following table 7.9 shows the voltage and current used for welding machine.

Table.7.9. Voltage and Current for Welding Machine.

Current (Amp.)	Voltage (volts)
50 to 100	15
100 to 250	20
200 to 250	25
250 to 350	30
350 to 500	35
Over 500	40

2. Electrode Holders:

The function of electrode holder is to hold the electrode at desired angle. These are available in different sizes, according to the ampere rating from 50 to 500 amperes.

3. Cables or Leads:

The function of cables or leads is to carry the current from machine to the work. These are flexible and made of copper or aluminum. The cables are made of 900 to 2000 very fine wires twisted together so as to provide flexibility and greater strength.

The wires are insulated by a rubber covering, a reinforced fibre covering and further with a heavy rubber coating.

4. Cable Connectors and Lugs:

The functions of cable connectors are to make a connection between machine switches and welding electrode holder. Mechanical type connectors are used; as they can he assembled and removed very easily. Connectors are designed according to the current capacity of the cables used.

5. Chipping Hammer:
The function of chipping hammer is to remove the slag after the weld metal has solidified. It has chisel shape and is pointed at one end.

6. Wire Brush, Power Wire Wheel:
The function of wire brush is to remove the slag particles after chipping by chipping hammer. Sometimes, if available a power wire wheel is used in place manual wire brush.

7. Protective Clothing:

The functions of protective clothings used are to protect the hands and clothes of the welder from the heat, spark, ultraviolet and infrared rays. Protective clothing used are leather apron, cap, leather hand gloves, leather sleeves, etc. The high ankle leather shoes must be wear by the welder.

9. Screen or Face Shield:
The function of screen and face shield is to protect the eyes and face of the welder from the harmful ultraviolet and infrared radiations produced during welding. The shielding may be achieved from head helmet or hand helmet.

Edge Preparation of a Joint:
The efficiency and quality of welded joint also depends upon the correct preparation of the edges of the plates to be welded. It is necessary to remove all scales, rust, grease, paint, etc. from the surface before welding.

The cleaning of the surface should be carried out mechanically by wire brush or power wire wheel, and then chemically by carbon tetrachloride. Proper shape to the edges of the plate should be given to produce a proper joint.

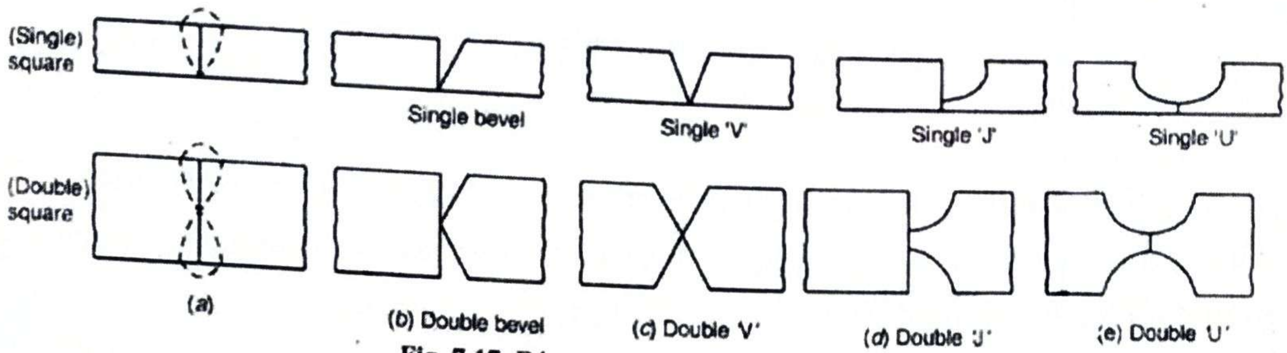


Fig. 7.17. Edge preparation for butt welding.

Arc Welding Electrodes:

Arc welding electrodes can be classified into two broad categories:

1. Non-Consumable electrodes.

2. Consumable electrodes.

1. Non-Consumable Electrodes:

These electrodes do not consumed during the welding operation, hence they named, non-consumable electrodes. They are generally made of carbon, graphite or tungsten. Carbon electrodes are softer while tungsten and graphite electrodes are hard and brittle.

Carbon and graphite electrodes can be used only for D.C. welding, while tungston electrodes can be used for both D.C. and A.C. welding. The filler material is added separately when these types of electrodes are used. Since, the electrodes do not consumed, the arc obtained is stable.

2. Consumable Electrodes:

These electrodes get melted during welding operation, and supply the filler material. They are generally made with similar composition as the metal to be welded.

The arc length can be maintained by moving the electrode towards or away from the work.

The consumable electrodes may be of following two types:

(i) Bare Electrodes:

These are available in the form of continuous wire or rods. They must be used only with straight polarity in D.C. welding. Bare electrodes do not provide any shielding to the molten metal pool from atmospheric oxygen and nitrogen.

Hence, the welds obtained by these electrodes are of lower strength, lower ductility and lower resistance to corrosion. They find limited use in minor repair and poor quality work. They used to weld wrought iron and mild steel. In modern practice they are not used or rarely used. They are also known as plain electrodes.

(ii) Coated Electrodes:

These are sometimes also called as conventional electrodes. A coating (thin layer) of flux material is applied all-round the welding rod, and hence termed as coated electrode. The flux, during welding, provides a shielding to the molten metal zone from the atmospheric oxygen and nitrogen. This flux also prevents formation of oxides and nitrides. Flux chemically react with the oxides present in the metal and forms a low melting temperature fusible slag.

The slag is float on the top of the weld and can easily be brushed off after solidification of weld. The quality of weld produced by coated electrode is much better as compared to that of bare electrodes.

Depending on the coating factor or thickness of flux coating, coated electrodes are divided in three groups:

(a) Lightly coated electrodes.

(b) Medium coated electrodes.

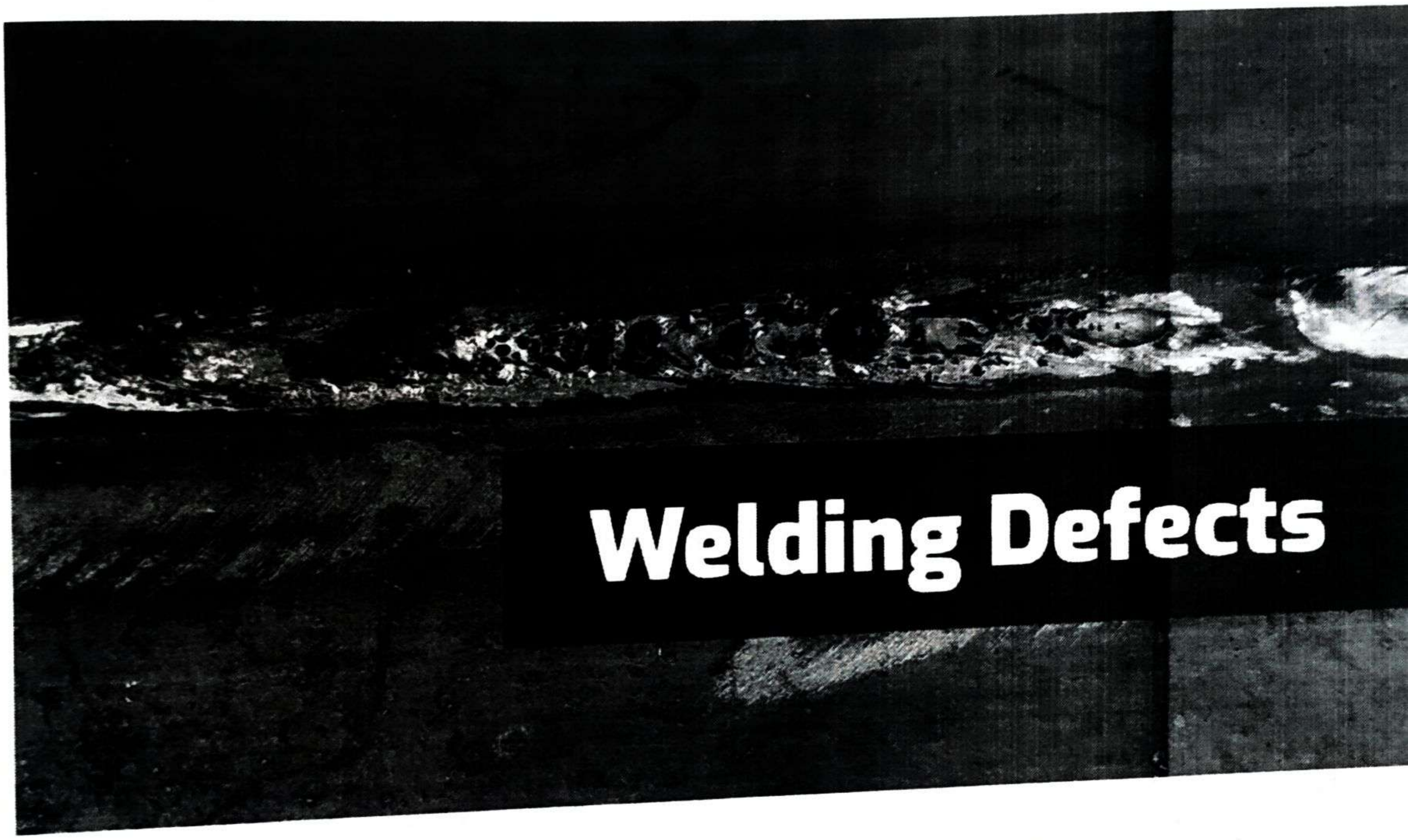
(c) Heavily coated electrodes.

A comparison of three types of coated electrodes is given in the Table

Table 7.10. Comparison of Coated electrodes.

S. No.	Basis	Light Coated	Medium Coated	Heavily Coated
1.	Flux coating	Less than 1mm	1 to 1.5mm	1.5 to 3mm
2.	Coating Factor	1.25	1.45	1.6– 2.2
3.	Weight of coating	5 to 10%	10 to 15%	15 to 30%
4.	Weld quality	Poor	improved	Best.

3.6 Demonstrate of welding defects & various types of joints & end preparation. Job: Preparation of lap joint by arc welding rod. Job: Preparation of Tee joint by arc welding



When weld defects form in a weld they can weaken the joint. In some cases, this results in complete failure of the weldment.

In serious cases, there can be severe consequences to a failing weld. So, you need to understand the various defects.

What Is A Weld Defect?

Welding Defects can be defined as the irregularities formed in the given weld metal due to wrong welding process or incorrect welding patterns, etc. The defect may differ from the desired weld bead shape, size, and intended quality. Welding defects may occur either outside or inside the weld metal. Some of the defects may be allowed if the defects are under permissible limits but other defects such as cracks are never accepted.

13 Common Types Of Weld Defects

There are many types of welding defects, but in general, the most common weld defects are:

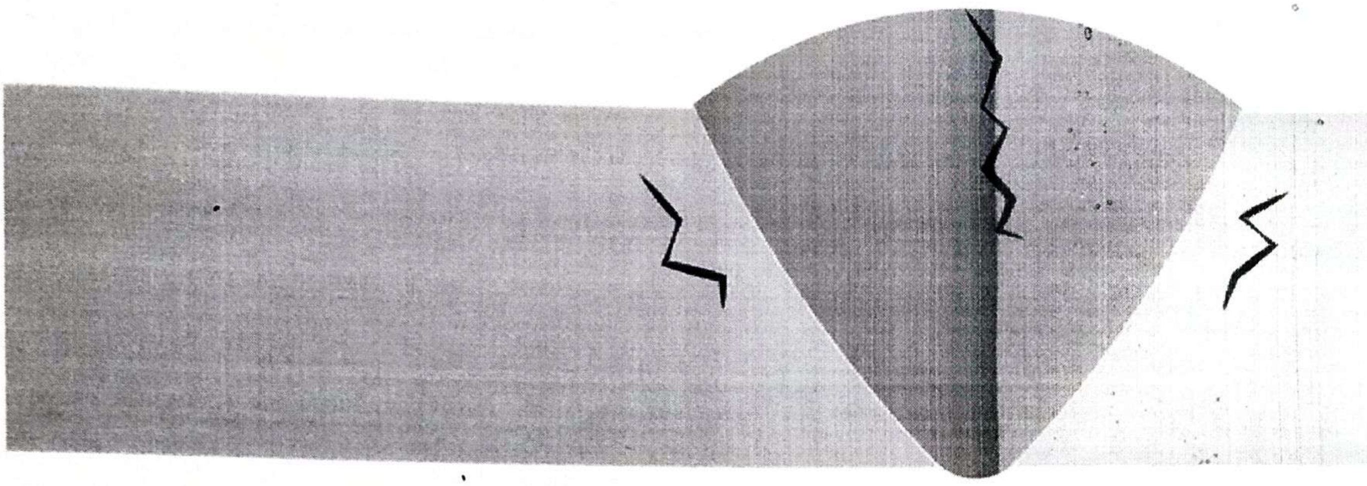
1. Cracks
2. Inclusions
3. Lack of fusion
4. Porosity
5. Undercut
6. Poor penetration
7. Burn through
8. Under-fill
9. Excess reinforcement
10. Spatter
11. Over-roll/Overlap
12. Whiskers
13. Mechanical damage

Irregular welds include too wide or too narrow, those with an excessively convex or concave surface, and those with coarse, irregular ripples. These characteristics may be caused by poor torch manipulation, a speed of travel that is too slow, current that is too high or low, improper arc voltage, improper stick out, or improper shielding gas.

But when a particular defect occurs, you want to know which parameter needs adjusting so you can fix it. Therefore, a list by defect type, along with how to correct the problem, is helpful.

1. Cracks

Cracks



We may as well start with one of the most obvious and serious defects in a weld – cracks. These weaken a weld, and even worse, cracks tend to grow at a rapid rate making the problem worse.

So, it goes without saying you do not want any cracks in your welds. But it can be a challenge, and there are three main types of cracks:

- Longitudinal cracks run along, or are parallel, to the length of the weld.
- Transverse cracks run across the width of a bead.
- Crater cracks usually occur at the end of a weld when the arc is terminated. They are often star-shaped and form when a dent or "crater" is formed at the end of a weld.

Cracks can further be categorized as hot or cold cracks.

Welds can be heated to over 10,000°C, and hot cracks occur as the weld cools and transitions from the liquid to the solid phase. Hot cracks tend to occur when the wrong alloy filler material is used.

Cold cracks occur after the weld has cooled. They can occur hours or days after the joint is made. This defect usually occurs when welding steel and is often caused by deformities in the base metal.

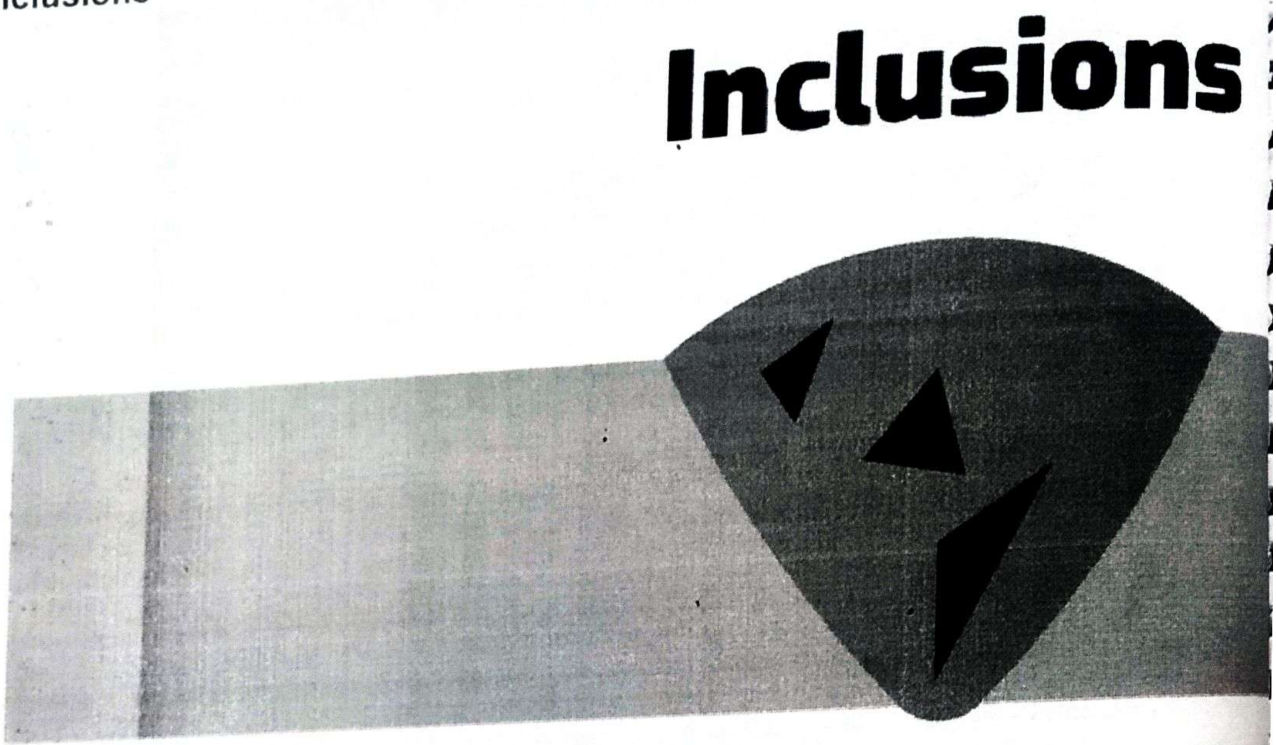
You can read more in detail about weld cracks here.

How To prevent cracks

- Use the correct alloy filler material for the metal being welded.
- Avoid welding high sulfur and carbon steel.
- Preheat your joint.

- Ensure the joint is filled and avoid a convex-shaped bead.
- Use sound, defect-free base metal.
- Avoid low currents coupled with high travel speeds.
- Do not use hydrogen shielding gas with ferrous metals.
- Keep a good depth to width ratio for your joint.
- Avoid craters at weld termination by placing adequate filler material when ending a bead.
- Allow for expansion and contraction of a weld joint during the weld and cool down.

2. Inclusions



Impurities can become trapped inside a weld, and these are referred to as inclusions. Contaminants trapped inside a weld dramatically weaken the joint.
Slag often forms when flux is used, such as brazing and stick, flux-cored, and submerged arc welding. The slag must be allowed to float to the top of the puddle and not become trapped inside the bead. That means the molten pool should not be allowed to cool too fast.

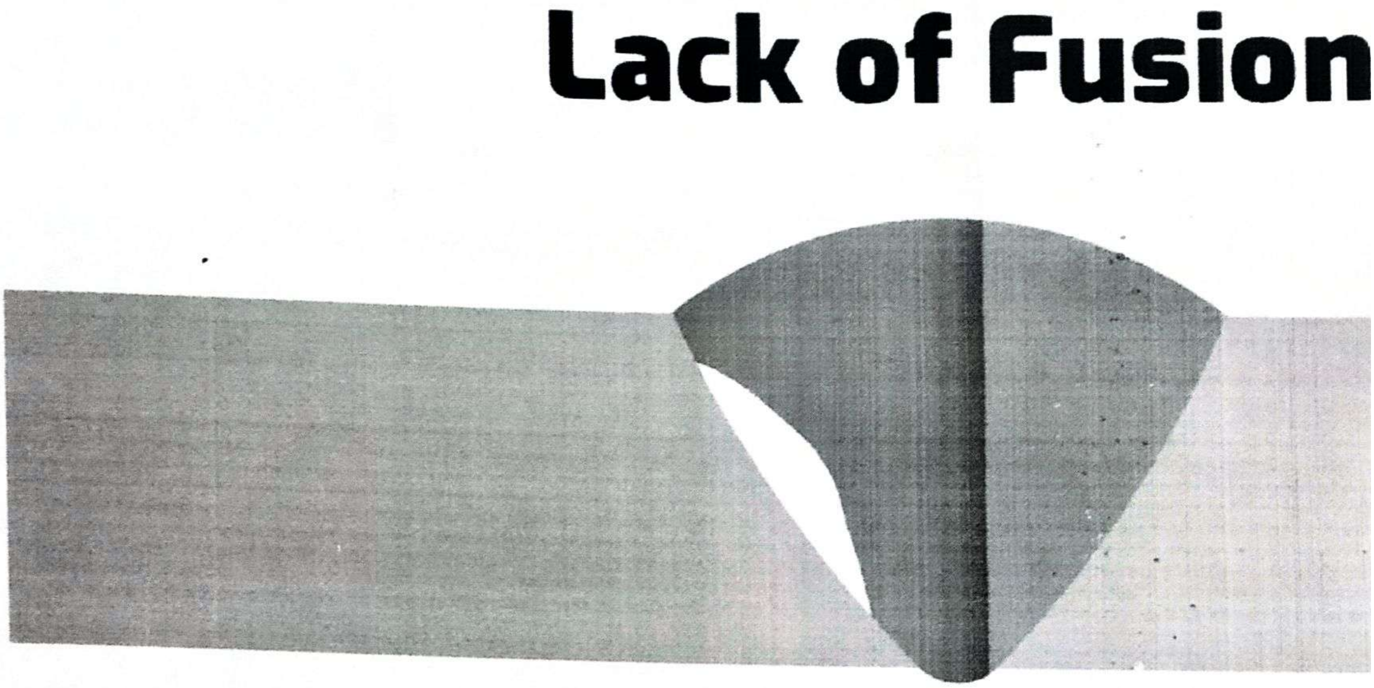
But it can occur with MIG welding as well. Bits of rust and even tungsten can be counted as slag and can cause contamination in your welds. So, MIG and TIG welding is not immune to inclusions.

How To prevent inclusions in your welds

- Prep and clean the base metal well.
- Avoid low amperage settings (prevent the weld pool from cooling too fast).
- Keep a proper torch speed (the welding and slag pools should not mix).
- Maintain a proper torch angle.

- Clean slag from previous welds between passes.

3. Lack Of Fusion



It may seem obvious, but the filler material must be well bonded to the base metal on both sides and to welds underneath during multiple passes.

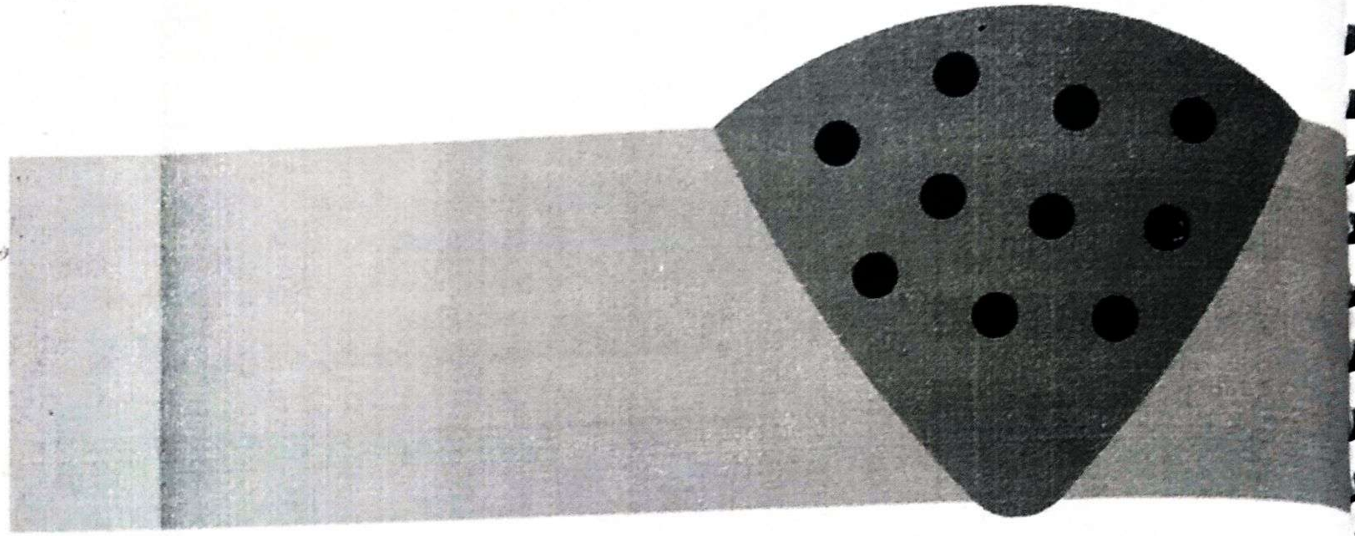
If there are voids, gaps, or poor adhesion, the joint will be structurally impaired.

How to prevent a lack of fusion

- Clean your base metal well and remove all impurities.
- Use the correct size electrode.
- Select the right electrode alloy for the metal being welded.
- Don't move the torch too fast.
- Prevent the arc from getting too short.
- Keep the amperage high enough for the job.

4. Porosity

Porosity



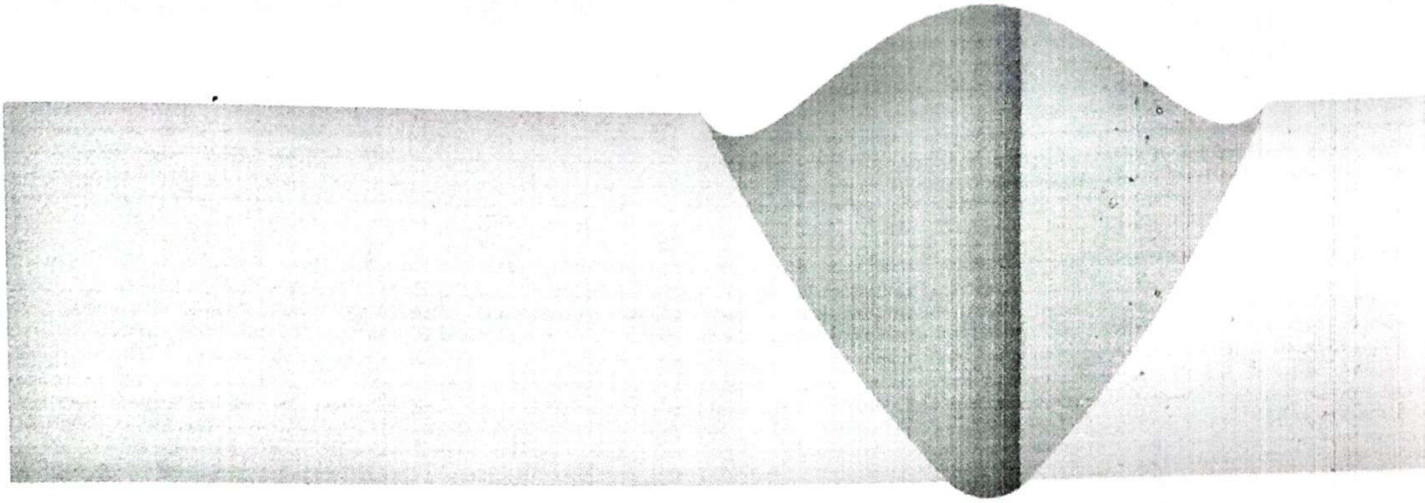
Weld porosity (also known as wormhole weld) is where gas bubbles accumulate and get trapped inside a weld. This is also said to be porous. A cross-section of a porous weld bead will resemble a sponge with all the air bubbles trapped inside.
As you weld, gases like steam, hydrogen, and carbon dioxide can be generated, and they normally bubble out of the molten bead. But if the gas bubbles are trapped, they can weaken your joint, and the work is ruined.

How to Avoid porous welds

- Properly clean and prepare the base metal.
- Make sure the joint is dry.
- If used, set your shielding gas flow correctly (too low or high can create issues).
- Keep the amperage from getting too high (i.e., too "hot").
- Use the correct electrode alloy for the job.
- Ensure the electrode coating is not damaged if it has one.
- Move your torch slow enough to keep a molten puddle, allowing the gas to bubble out.
- Avoid a long arc.
- Use low hydrogen electrodes.

5. Undercut

Under Cut



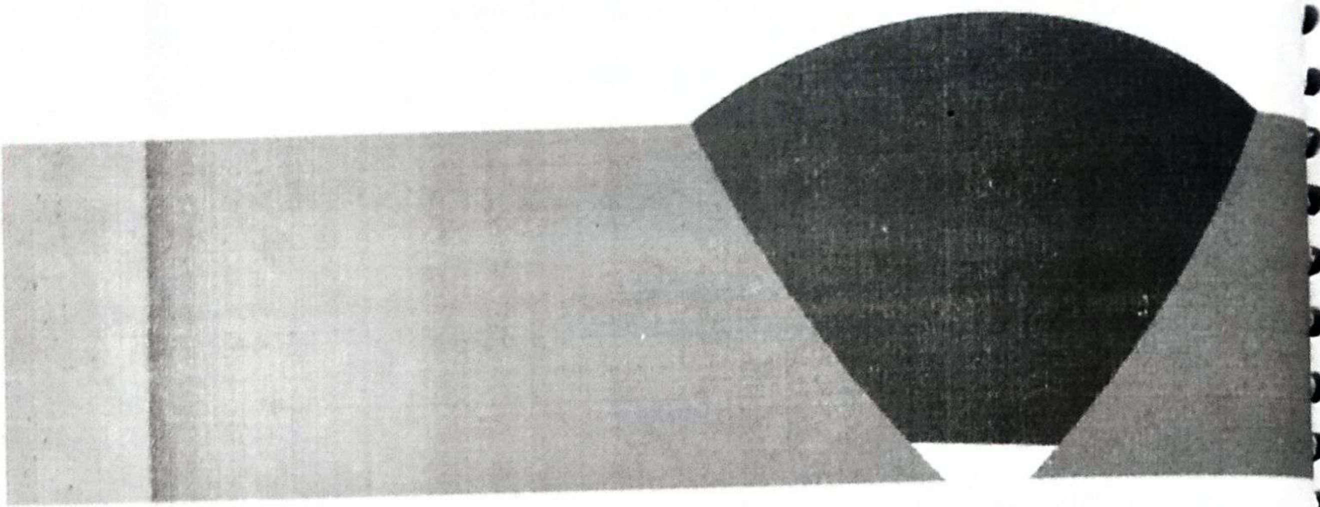
When the welding process results in spots or sections being less than the original base metal, the defect is referred to as an undercut. This will often appear as a "notch" at the edge of a weld, either on the top or bottom of the weld.
A loss in thickness reduces the strength of the weldment and makes the joint susceptible to fatigue. This defect is often the result of too high a current or moving the torch too fast.

How to prevent undercutting

- Do not move the torch too quickly.
- Use the proper amperage and avoid too high a setting.
- Keep the torch at the correct angle (and angle the heat to thicker areas when possible).
- Use a correctly sized electrode.
- Keep a shorter arc.
- Ensure you have the right shielding gas flowing at the correct rate.
- Use proper welding techniques.
- Employ multiple passes.

6. Poor Penetration

Poor Penetrati



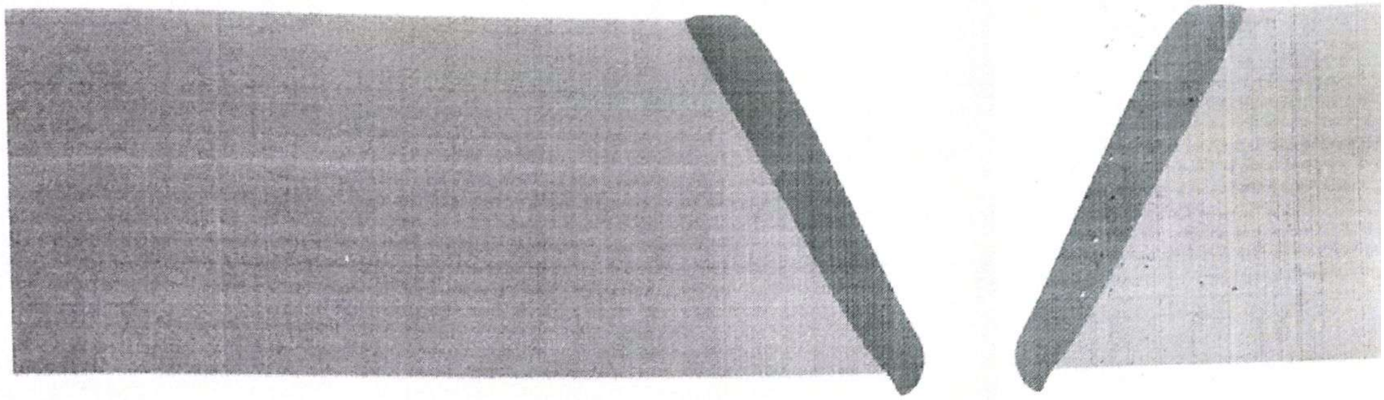
When the bead does not fill a butt joint all the way to the bottom, the weld achieves poor penetration. It is also referred to sometimes as incomplete penetration. Whatever you call it, this form of defect also compromises the integrity of a joint.

How to get good penetration

- Use a properly sized electrode for the weld (avoid an oversized electrode).
- Don't move the puddle too fast.
- Prepare V grooves for butt joints with 60 to 70 degree sloped sides.
- Align the workpieces, so there are no large or irregular gaps to fill.
- Keep your amperage, or heat, at an optimum setting and avoid too low a current setting.

7. Burn Through

Burn Through



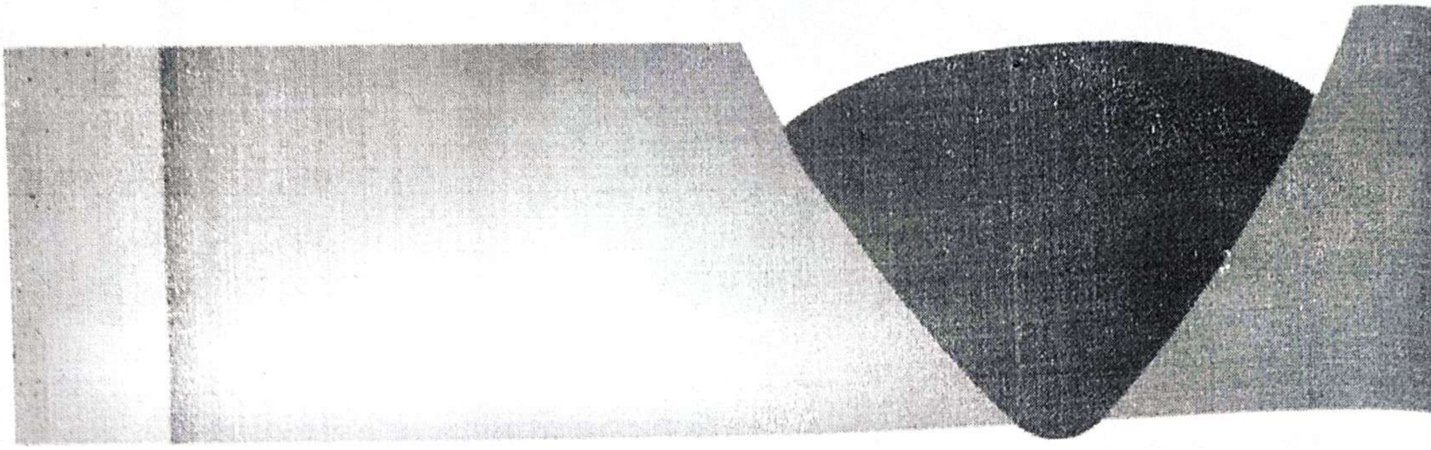
If too much heat is applied during the weld, you can actually blow a hole through the metal. This defect is referred to as burn through, but sometimes it is also called melt through. Of course, creating a hole defeats the purpose of a weld and destroys the joint.
This type of defect is usually encountered with thin stock, material less than 1/4 inch thick. But it can occur with thicker stock if your welder settings are too high, if the gap between pieces is large, and/or you are moving the torch too slow.

How To prevent burn through

- Do not let the current get too high.
- Avoid excessive gaps between plates.
- Ensure your travel speed is not too slow.
- Stay away from large bevel angles.
- Ensure the nose is not too small.
- Use the correct wire size; too small accentuates the problem.
- Provide adequate metal hold-down and/or clamping.

8. Under-Fill

Under Filled



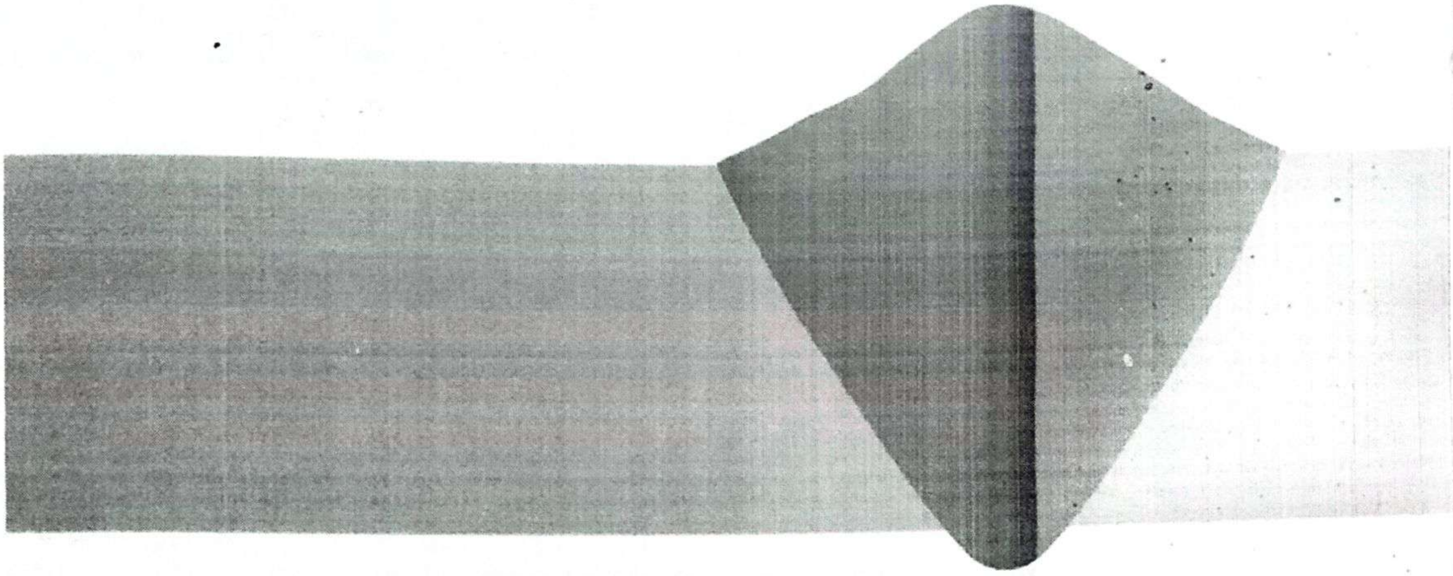
When the weld bead sits below the surface of the base metal, the weld is said to be under-filled. The bead itself is thinner than the base metal, which weakens the joint. This condition often appears as a "rut" that runs the length of the bead and is sometimes called a convex joint.

How to Prevent under-filled welds

- Avoid moving too fast.
- Use the right current setting.
- Use the correct size electrode/filler wire.

9. Excess Reinforcement

Excess Reinforcem



In contrast to an underfilled joint, a defect results when there is too much filler material in the joint. This is known as excess reinforcement or a "high" crown. Project specifications and codes often regulate what is considered too high.

At times, excess reinforcement may even come out the bottom of the joint. This is sometimes referred to as excess penetration.

Other variations of the defect include narrow, steep-sided beads caused by an insufficient coating of flux on your feed wire or low voltage.

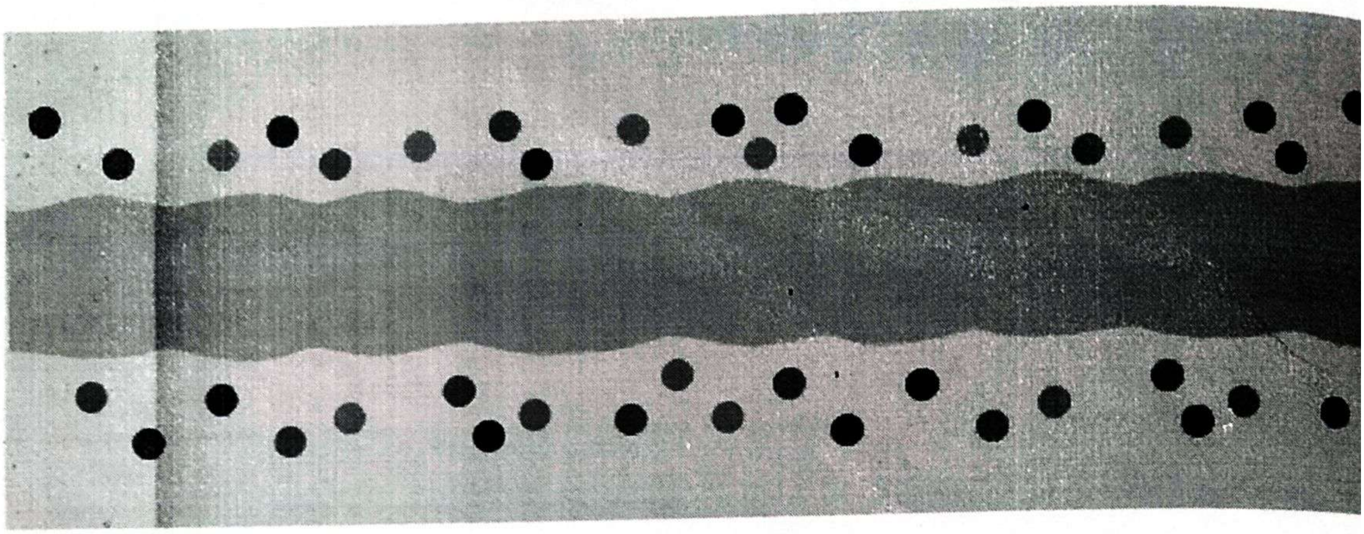
Also, when excess reinforcement is uneven and ragged, it may be called "mountain range" reinforcement, and this is caused by excess flux on the feed wire or fast/uneven travel speed.

How To Avoid excess reinforcement

- Keep the torch moving at a proper speed. Too slow, and excess filler will be placed. Too fast, and the bead becomes erratic.
- Set your amperage correctly and avoid excess heat.
- Adjust your voltage so that it is not too low.
- Align the pieces so that the gap is not too large.

10. Spatter

Spatter



While usually not a threat to structural integrity, spatter can be considered a defect. The aesthetics of a weld are sometimes as important as the weld's strength. But nothing makes welded pieces look sloppy, like spatter stuck all over the surrounding metal.

Spatter frequently occurs with MIG welders but can occur with other welding processes, too.

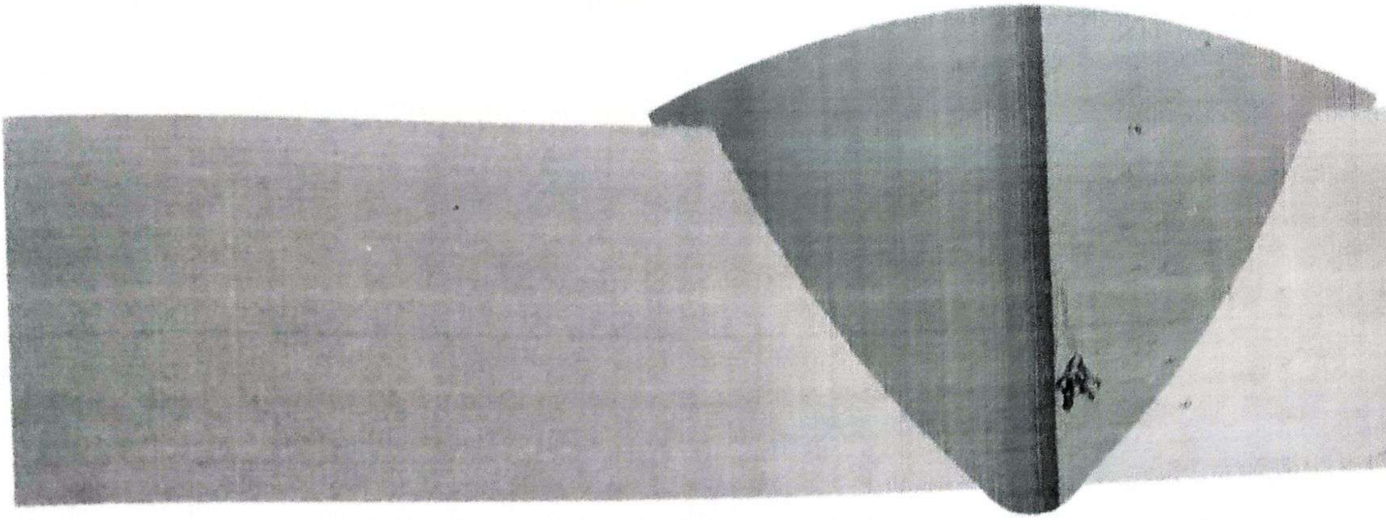
How to reduce spatter

While you can never eliminate all spatter, there a few things you can do to minimize it:

- Clean the base metal well.
- Use the correct amperage, and avoid "hot" settings.
- Use the correct voltage, and avoid low settings.
- Ensure the polarity is set correctly.
- Keep a short arc.
- Increase the electrode angle.
- Check the feed wire to ensure it is unimpeded.

11. Over-Roll/Overlap

Overlap



When the filler material at the weld's toe covers the base metal without bonding, an over-roll or overlap defect occurs.

How to Prevent Overlap

If you want to avoid this condition:

- Avoid letting your travel speed get too slow.
- Keep the correct torch angle.
- Do not use oversized electrodes.
- Set the correct amperage, avoid a high setting.

12. Whiskers

When MIG welding, whiskers are short lengths of electrode wire sticking through the weld on the root side of the joint. They are caused by pushing the electrode wire past the leading edge of the weld pool.

These protruding wires look bad, but they can also cause problems. For starters, whiskers are considered inclusions and weaken the joint. In pipes, they can even inhibit the flow or even break off inside and cause equipment damage downline.

Whiskers can be prevented by

- Reducing your wire-feed speed.
- Keep an optimum travel speed, avoid going too fast.
- Increase the wire stick-out distance.

- Weaving the torch.

13. Mechanical Damage

Once the perfect bead is installed, you are not out of the woods. Damage can be caused by chipping hammers, grinders, and other tools. Not surprisingly, the term used for this type of defect is mechanical damage.

Common sense guides you to prevent mechanical damage with cautions like:

- When removing slag or cleaning a joint, do not get too aggressive
- Avoid heavy hammer blows
- Do not let other large pieces of metal impact or grind over your welds

Wrapping It Up

As you can see from our shortened list of common defects (yes, there are more we could have discussed), there are good reasons why welders need to learn certain fundamentals. Defects usually occur when one of these basics is not followed. The cornerstones included:

- Prepare the base metal to ensure it is clean and contaminant-free
- Position the pieces correctly for the type of weld to be performed with no large gaps
- Create V grooves at the proper angle when needed
- Set both the amperage and the voltage correctly
- Maintain a proper arc length
- Move the torch at an optimum speed
- Use a correctly sized electrode
- Ensure your feed wire is not impeded
- Find and keep the right torch angle
- Properly weave the electrode when necessary
- Avoid mechanical damage to the parent metal and finished bead

Knowing how to identify the various defects and correct them makes your joints stronger and more presentable. It also makes you a better welder.

All these potential defects may seem overwhelming and impossible to avoid at first. But keep welding. It takes patience and lots of practice to become a great welder.

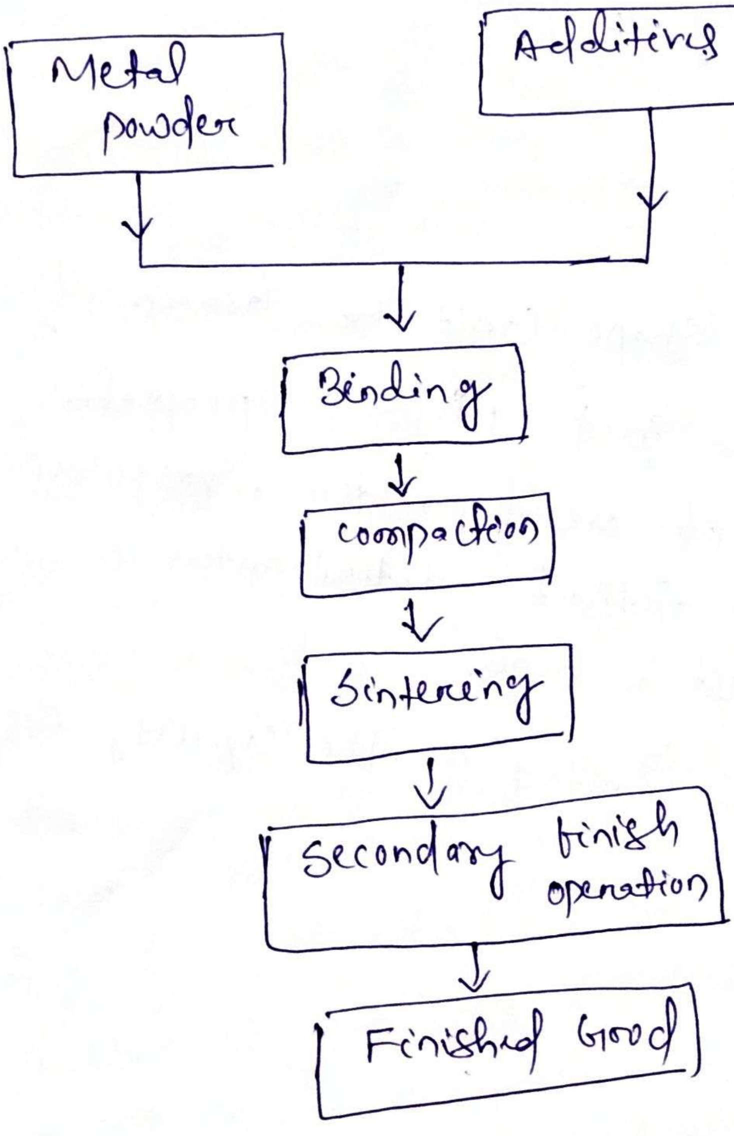
POWDER METALLURGY

CHAPTER- 04

Introduction:

It is one type of technique which is used to produce the fine metal powder & making the object from the individual component or alloyed component at proper temperature & pressure.

Flow chart:



Advantages of powder Metallurgy:

(i) surface finish is good.

(ii) Machining process are eliminated.

(iii) Uniformity of the Structure.

(iv) No material is Waste.

(v) High production rate.

(vi) product cost is cheaper

(vii) Skill operator is not required.

(viii) Longer life of the product.

(ix) Accuracy is good.

Disadvantages:

(i) complecated shape can't be formed.

(ii) Don't have good physical properties.

(iii) Manufacture of metal powder is expensive & storage is difficult without deterioration

(iv) Equipment cost is high.

(v) The size is limited by the capacity of press.

(vi)

Methods of powder metallurgy for producing component. ②

It involves 4 steps

1. powder preparation
2. Mixing & Blending
3. Compacting
4. Sintering. (Heating)

1. powder preparation:

- Crushing - brittle material.
- Atomizing - low melting pt metals, & alloys like tin, zinc, brass, lead, Al, etc.
- Milling
- Machining.

In this step metal powder is produced or formed by using different PM Technique. (Crushing, atomization, grinding)

2. Blending / Mixing

The blending & Mixing of the powder are necessary for uniformity of the product. Lubricants are added to the blending / Mixing of powder before mixing.

This Lubricant minimizes the friction, wear.

- Different metal powders are mixed in correct composition to get the finished product.

The blending & Mixing of the powder are necessary for uniformity of the product. The lubricants are added to the blending of powder before mixing the lubricant minimize the wear, to reduce the friction.

-> The different powder in correct compositions are thoroughly mixed with wet or in

Compaction / compression:

In this step metal powders are compressed by applying external forces. It is necessary for strengthen the metal powder. The object which is formed after compaction is called as green ~~compal~~ product.

(4) Sintering:

In this process the compressed metal powders are heated up to the melting pt to get the desired product & this product is considered as the final product.

(5) secondary finishing operation:

After sintering if some maching operation is required then. It is called as 2ndary finishing operation.

Application of powder metallurgy.

- To produce a porous product
- used for production of cutting tools, wire drawing dies & deep drawing dies.
- parts of cars, aircrafts, gas turbine, etc.
- parts of vacuum cleaners, refrigerators, parts of sewing m/cs
- production of electrical & magnetic part
- Automobile parts components such as piston rings, cam-shaft sprockets
- components of timing devices, such as clock, type writer, calculator etc.
- precision gauges, dies punching tools

Finishing operation:

When the desired specifications are not achieved by previous operations. Sintering must be followed by other finishing operations.

Some of the finishing operations are,

(1) Sizing (at the time on sintering → it involves, shaping the components in die set.)

(2) Coining – → to reduce the porosity → repressing the sintered component in die
→ increase additional strength & density on component.

(3) Machining → Removing excess material, in form an chips.

(4) Infiltration → To reduce porosity, & increase physical properties.
(Filling of pores on sintered product with molten metal whose melting pt is less than metal with pores.

(5) Heat treatment
↓
process in controlled heating & cooling.

→ It refines grain structure & improve the strength & hardness.

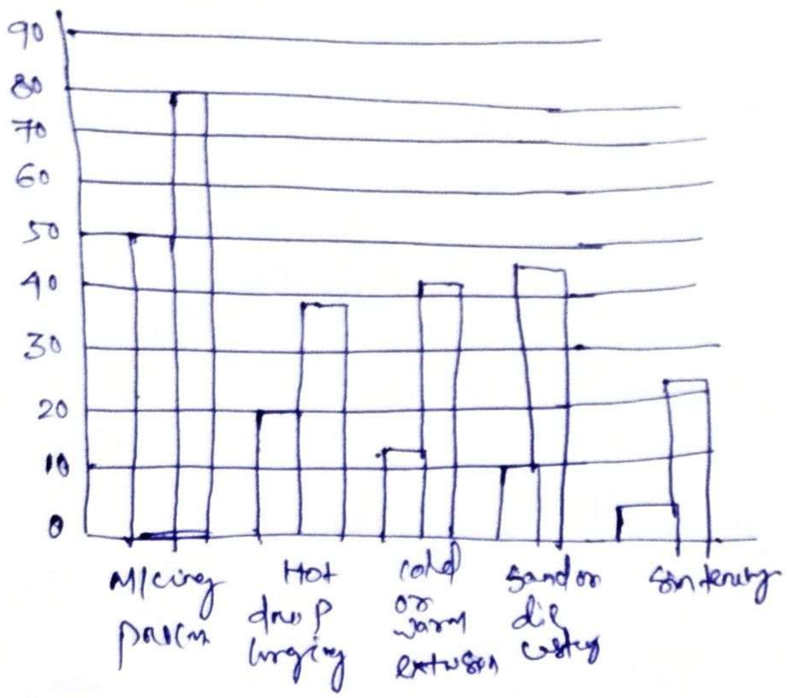
→ It must carried out in a controlled atmosphere to prevent oxidation on internal structure.
(Where the concentration of CO_2, O_2, N_2 temp & humidity are regulated (then the atmosphere ...)

ECONOMICS OF POWDER METALLURGY

(1) Lower energy consumption in this process.

(2) Superior utilisation of the starting raw material.

Follow the graph



1st □ - Material wastage

2nd. Energy consumption per kg finish product.

Product size & Weight

→ Material utilization is high in powder metallurgy (95% of raw material

→ production of small & light parts (material cost is relatively small % ~~the~~ of total manufacturing cost

→ 1000 ton.

Product Geometry:

→ Best for making "prismatic" shapes with virtually unlimited shape complexity in two dimentions.

→ large production

→ capital cost is high for processing equipments (press, furnace

(95% or the original raw material) can be utilized as compa

to other manufacturing process.

CHAPTER - 5

: PRESS WORK :

5.1 Introduction, Describe press works : blanking, piercing, and trimming

5.2 List various types of die & punch

5.3 Explain simple, compound & progressive dies

5.4 Adv & Disadv of Different dies.

Introduction: It is defined as a manufacturing process by which various components are made from sheet metal.

-> This process is also termed as cold stamping.

-> The M/C used for press working operation is called as press.

press working operations:

1. cutting operations
2. Forming operations

1. In cutting operations the work piece is stressed by its ultimate strength. The stresses caused in the metal the applied forces will be shear stress.

This cutting operations includes.

(a) Blanking (b) punching (c) Notching
(d) perforating (e) Trimming (f) Shaving
(g) Slitting (h) Lancing

(2.) Forming operations: In forming operations, the stresses are below the ultimate strength of the metal, in this operation, there is no cutting of the metal but only the contour of the w/p is changed to get the desired prod

Advantages:

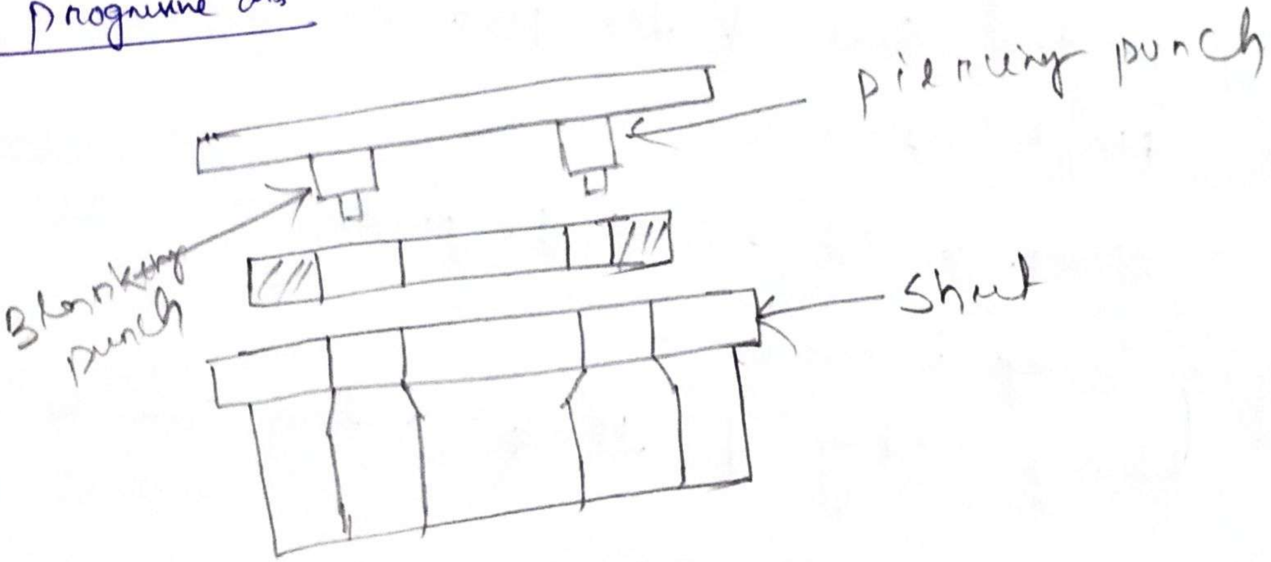
- It requires mini space for operation
- Good dimensional accuracy
- Good surface finish
- Residual stress is absent
- High production rate.
-

Disadvantages:

- Limited size of the product
- High cost
- Complex shape can't be produced
- Scrap is more
- Heavy casting & thick section can't be done.

→ The sheet metal is placed on the lower block & ram descents so that the plate is brought cutting & the punched.

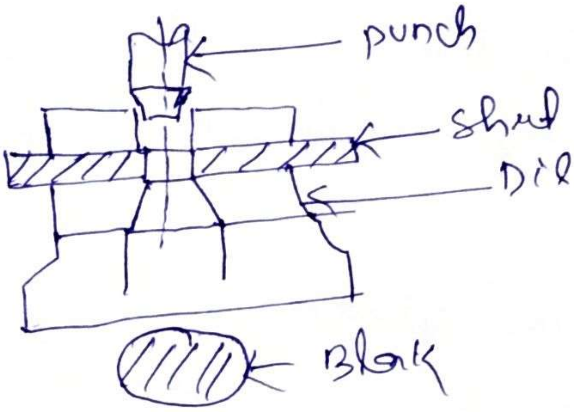
③ <u>Progressive dies:</u>



① Simple die!

It is the simplest type of Die which consists of a single die & punch

-> In simple die only one operation is performed at each stroke of the punch.



Compound die:

In a compound die two or more cutting operations can be performed at a single stroke of the punch

-> The punch & the cutting tool are bolted to the Ram.

-> The spring loaded stripper plate is inside the Die.

Die & punch:

Die - Female part on a complete tool for producing work in a press.

punch - A punch is a male component on the die assembly. Which is directly or indirectly moved by the press ram.

Classification on die! (According to the types of press operation.

Cutting dies & forming dies.

Blanking, piercing dies

bending, drawing.

2.) to the method on operation:

(1) Simple die.
(2) Compound die
(3) In a combination die.

Simple: only one operation is performed for each stroke of the press ram.

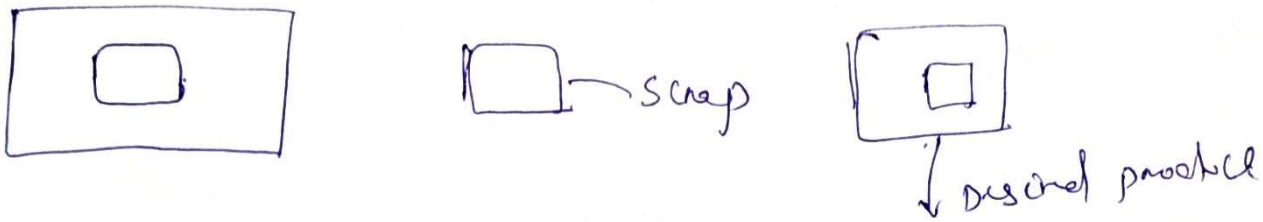
Compound: two or more cutting operations are performed at one station of the press. in every stroke of the ram.

(Blanking & piercing operation)

(1) Progressive dies! two or more operations simultaneously at different stations

punching or Piercing

It is a cutting operation by which various shaped holes are made in sheet metal. punching is similar to blanking except that in punching, the hole is desired product. The material punched out from the hole being.



Trimming!

Trimming is the removal of excess metal from a stamped part to allow the part to reach the finished stage

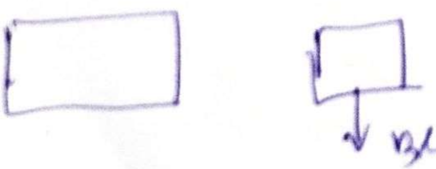
-)

The forming operations includes.

1. Bending
2. Drawing
3. Squeezing

Punch & die combination will be used as tools

<u>Blanking.</u> Blanking is the operation of cutting a blank
Shape from Sheet metal. The product punched out
is called as "blank" the required product of the
operation the hole & the metal left behind is
discarded as waste. & process is called as Blanking.



Blank
(Required product)

CHAPTER-06

JIGS AND FIXTURE

6.1 Define Jigs & Fixtures

Jig: Jigs are the work holding device which holds, supports & locate the work piece & guide tools to perform a specific operation.

→ Jig is situated on the column of M/C

Fixture: Fixture are the work holding device which holds, supports & locate the work piece but not guide the cutting tool to perform a specific operations.

→ Fixture is on the table of the M/C.

6.2 Difference between Jigs & Fixture

Jigs	Fixture
→ Jig is a device primarily used to guide the cutter to repeatedly move at predefined locations on the w/p.	→ Fixture is a device used to rigidly grip, support & locate the w/p maintain intended orientation.
→ Jigs can also hold, support & locate the w/p	→ It doesn't guide the cutter to move to a particular location.
→ A Jig is usually lighter in weight. Sometimes Jigs are held only by hand without clamping.	→ Fixture is commonly heavier & robust as it is required to sustain the cutting force & vibration. It is clamped firmly with work table.
→ Less skill is required to operate this device. (easy to use.	→ Skill operator is required to operate this device
→ Jigs is used in drilling, boring, reaming etc.	→ Fixture is employed in Milling, planing, shaping, slotting, etc

6.2 Advantages of Using Jigs & Fixture:

-> Reduces total production time.

-> Increases the accuracy.

-> Easy clamping & de clamping of component.

-> No need of high skilled workers to operate.

-> It eliminate the setting time require before machining.

6.3 State the principle of Locations:

The principle used to Locate the Work piece with respect to the position of Jigs & fixture to perform properly.

-> This method is used to restrict DOF of Work piece.

->

Locators:

The device which restrict the movement of Work piece called as Locators.

-> It maintain the position of W/P & to restrict the cutting forces

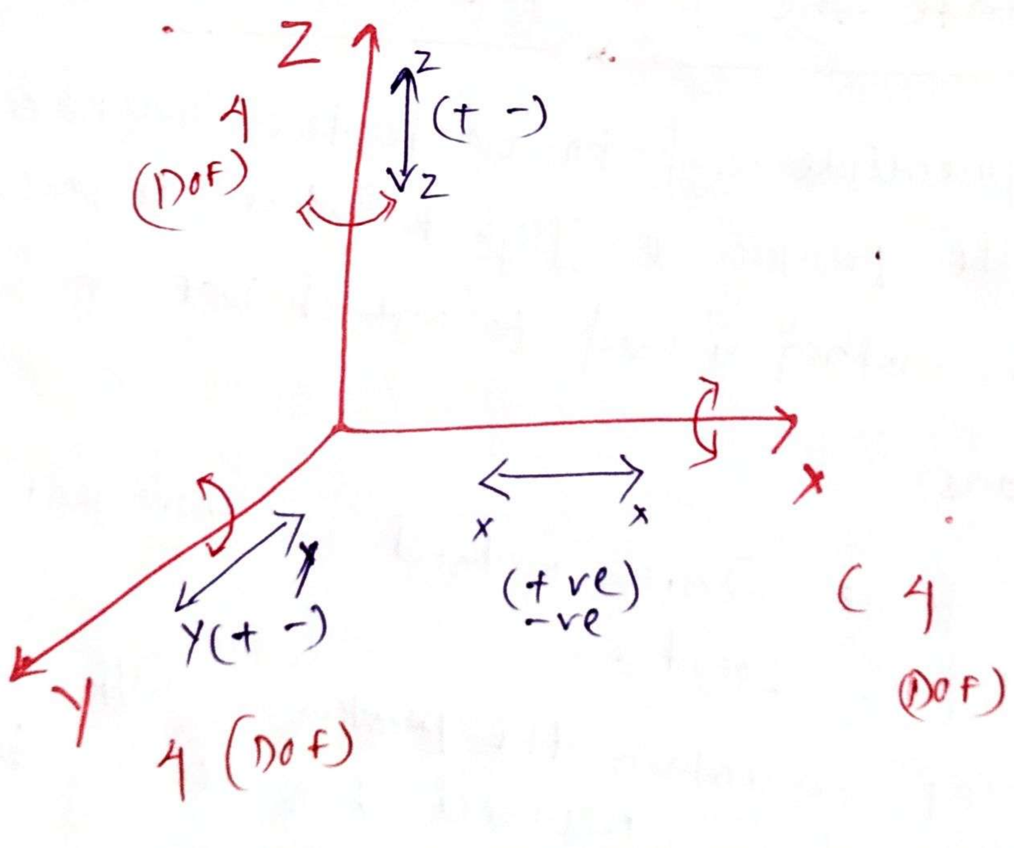
6.4 3-2-1 principle of Location

(Six point principle)

The 3-2-1 principle of location (six point location principle) is used to constrain the movement of workpiece along the three axes i.e. XX, YY, & ZZ.

→ This is achieved by providing six locating points,

- 3 pins in base plate
- 2 pins in vertical plane
- 1 pin in a plane which is ⊥ar to 1st two planes



Six point Location of a Rectangular block

Considering the six degrees of Freedom of a Rectangular block as shown in Figure (a). It is made to rest on several points on the Jig body.

(bottom surface) X-Y surface - 3 pin (Locators) C

→ This will restrict the movement along

① Z-axis

② rotation w.r.t X-axis & Y-axis

Side surface (X-Z) (2 pin) (Locator)
which will restrict motion

① along Y axis & its

② rotation w.r.t Z axis.

Surface (Y-Z) (01 pin) Locator:

It Restrict the other remaining free movements

Types of Jig:

(1) Template Jig

(2) plate Jig

(3) channel Jig

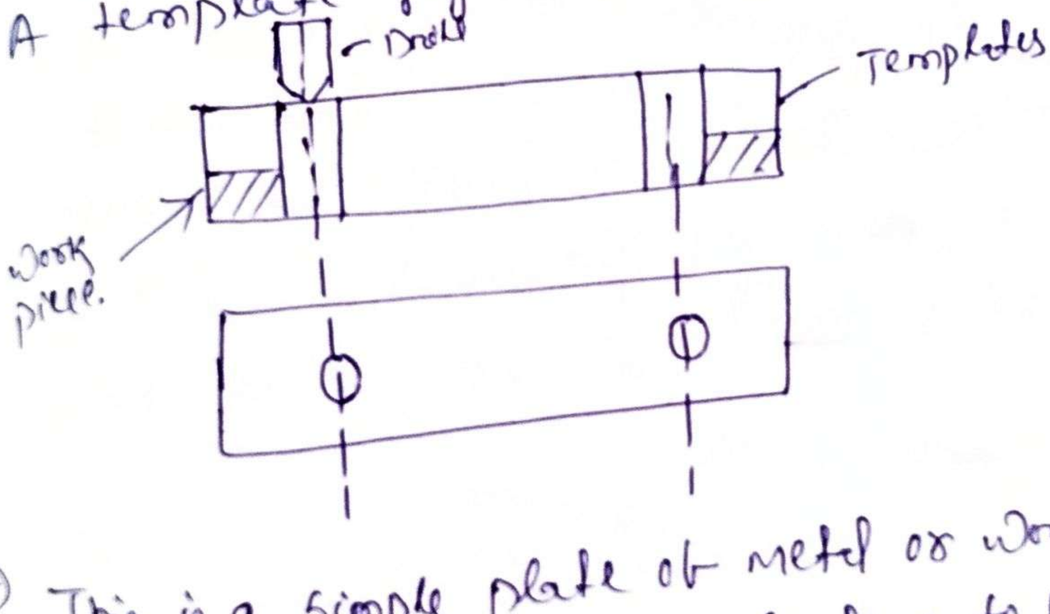
(4) Leaf Jig

(5) Ring Jig

(6) Box Jig

(1) Template Jig:

A template Jig is the simplest ~~of~~ ~~all~~ Jig



→ This is a simple plate of metal or wood which has holes at correct locations to be made in the w/p.

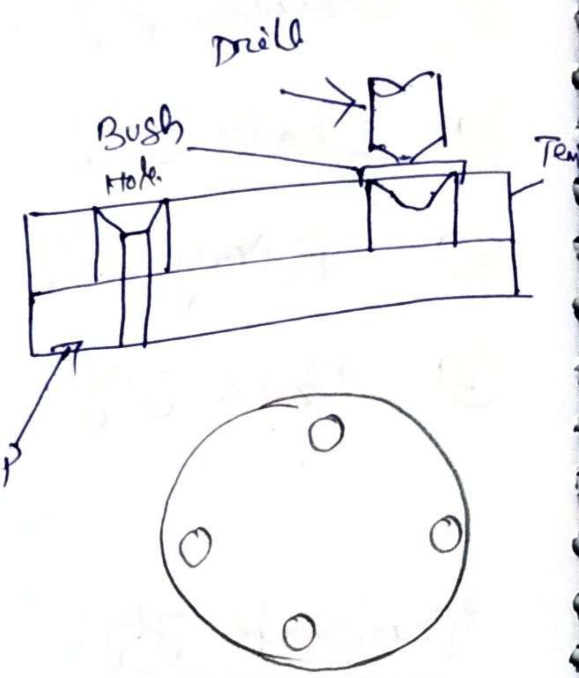
→ Size of template jig is same as that of W/P.

→ plate serves as template which is fixed & overlapped with the W/P & drilling is done quickly.

→ used for small production & very much cheap.

→

plate jig:



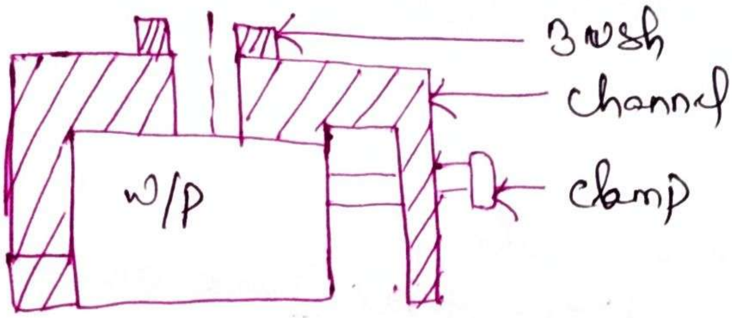
→ Instead of simple holes, drill bushes are provided in this jig for accurately guiding the tool.

→ used for drilling accurately spaced holes on larger jobs

→ Mass production.

(Bush prevent the enlargement of holes) channel jig

It is a simple type of jig having a channel like cross-section.

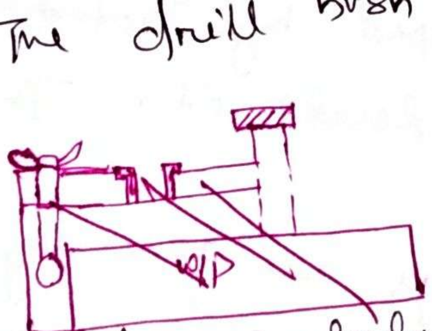


-) The component is fitted within the channel & is located & clamped by rotating the knurled knob. The tool is guided through bush.

-) very cheaper

Leaf jig:

-) It has a leaf or a plate hinged on the body & the leaf may be swing open or closed on the work for loading or unloading purpose. The work is located by the buttons & clamped by set screw. The drill bush guide the tool.



-) used for easy loading & unloading purpose to reduce the excess time.

Ring jig:

It is employed to drill holes on circular flange parts. The work is securely clamped on the drill body & the holes are drilled by guiding the tool through drill bushes.

Box jig:

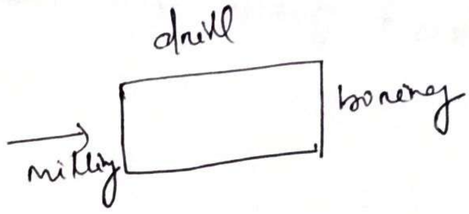
Its construction is like a box within which the component is located by the button, Here the work is clamped by rotating the cam handle which also locate it. The drill bush guides the tool.

The box jigs are generally employed to drill a number of holes on a component from different angles.

N/B
open type: (w/p irregular)

Box jig: (When we want to perform at the different different side

Legs ✓
open f removing parts
Work on different planes of the w/p are possible.



FIXTURE TYPES:

1. Turning Fixture (Holding purpose)
2. Shaping Fixture
3. Grinding Fixture
4. planning Fixture
5. Drilling Fixture.

Fixture: It is a work holding device which hold, supports & Locate the w/p. but it does't guide the cutting tool

→ Larger than jig.

(1) plate Fixture

(2) vice jaw Fixture

(3) Profile Fixture

(1)

It is the simplest form. Normal plate, on which no. of clamps are provided, to hold the w/p

(2) vice jaw fixtures.