HOT & COLD WORKING

Q.1. What is hot working ? State its principles, advantages and disadvantages.
Ans. Mechanical working of metals above its recrystallisation temperature is known as *hot working.*
Advantages :
1. Larger deformation can be accomplished and more rapidly by hot working since the metal is in plastic state.
2. Porosity of the metal is considerably minimised.
3. Concentrated impurities, if any in the metal are disintegrated and distributed throughout the metal.
4. Grain structure of the metal is refined and physical properties improved.
Disadvantages :
1. Due to high temperature a rapid oxidation or scale formation takes place on the metal surface, leading to poor surface finish and loss of metal.
2. On account of the lost of carbon from the surface of the steel piece being worked the surface layer loses its strength, which is a disadvantage when the part is put to service.
3. This weakening of the surface layer may give rise to a latigue crack which may ultimately result in fatigue failure of the part.
4. Close tolerances cannot be maintained.
5. It involves excessive expenditure on account of high cost of tooling. This, however, is compensated by the high production rate and better quality of products.

Q.2. Describe the procedure of hot extrusion of tubes.
Ans. A common method of hot extrusion of tubes is shown in figure. It is actually a forward extrusion method using a mandrel to form the bore of the tube. First the mandrel is pushed through the centre of the billet and the die, followed by applying pressure on the billet by advancing the plunger. The metal is forced to flow through the opening between the die and the mandrel. The operation is performed quite rapidly. Most of the metals and alloys are hot extruded, although some of these are cold extruded also, for production of seamless tubes.

Q.3. Write short notes on
Ans. ***1. Hot Spinning :-***
The process consist of heating the metal to forging temperature and then forming it into the desired shape on a spinning lathe which is similar to an engine lathe. Usually shapes of circular cross-section which are symmetrical about the axis of rotation, are formed by this

process. The workpiece is shaped over a formed revolving metal holding device, called chuck, with the help of spinning tools. It very well compares with drawing of stamping in so far as the production in small quantities is concerned, since the cost of dies for such small quantities will lead to uneconomical production through the latter methods. Hot spinning is generally used for thicker plates and sheets which cannot be shaped through cold spinning. In operation it is similar to cold spinning and, therefore, the details of equipment, tools and procedure, etc., will be given later under *'cold spinning'*.

2. Hot Forging

These process basic ally consists of heating the metal to plastic state and then applying pressure to form it into different shapes and sizes. Unlike rolling, the pressure in this case is not continuous but intermittent. The hot metal piece may be compressed along its length to increase its cross-section, along its cross-section to increase its length, within a closed cavity to acquire the shape of that cavity or in different directions to bend it into different shapes. The pressure may be applied by hand hammer called hand or smith forging, by power hammers, called hammer forging, by presses (press forging) or upset forging machines.

3. Hot drawing

This process is widely used for the production of thicker walled seamless tubes and cylinders. It is usually performed in two stages. The first stage consists of drawing a cup shape out of a hot circular plate with the help of a die and a punch. The second stage consists of reheating the drawn cup and drawing is further to the desired length having the required wall thickness. The second drawing operation is performed through a number of dies, which are arranged in a descending order of their diameters, so that the reduction in wall thickness is gradual in various stages. The farther end of the drawn object is always blind, which may be cut off to produce a through hole, if required.

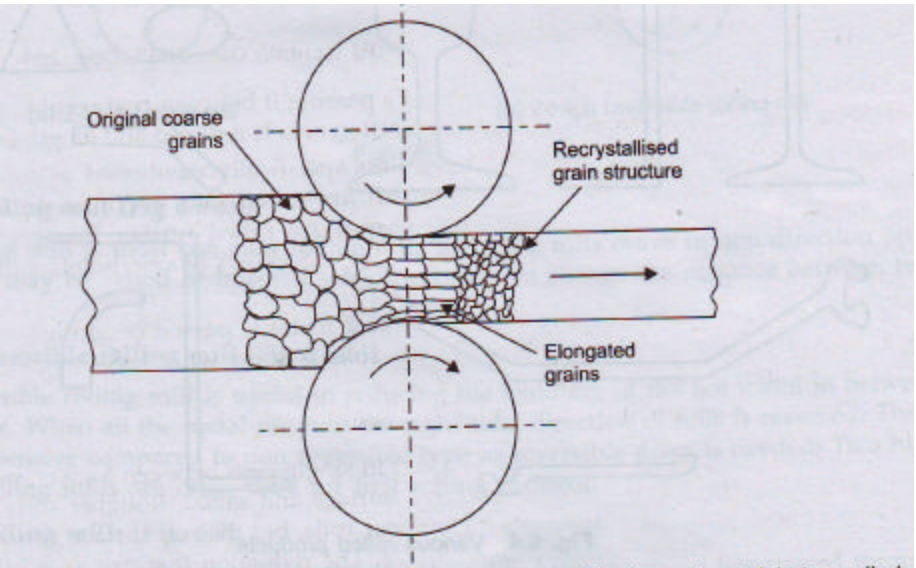
Q.4. What are the specific advantages and limitations of cold working?

Ans. ***Advantages and limitations:***

1.Better dimensional control than hot working is possible because the reduction in size is not much.
2.Surface finish of the component is better because no oxidation takes place during the process.
3.Strength and hardness of the metal are increased.
4.It is an ideal method for increasing hardness of those metals which do not respond to the heat treatment.

5.Only ductile metals can be shaped through cold working.
6.Over-working of metal results in brittleness and it has to be annealed to remove the same.
7. Subsequent heat treatment is mostly needed to remove the residual stresses set up during cold working.

Q.5. What are the main characteristics of the hot working of metals or compared with cold working process?
Ans. (1) Above the re-crystallisation temperature, the metal becomes plastic and causes the growth of grains. By hot working, the grains are broken up and their parts are deformed into small and more numerous crystals or in other words the refinement of grain occurs. Metals possess little elasticity and low load is required to shape the metal as the strength and hardness decrease at elevated temperatures.
(2)The porosity of the steel ingot can be eliminated to a greater extent.
(3)Great latitude in shape and size of form is possible due to reduction of elastic limit.
(4)A uniformity is established either by squeezing other impurities into fiber slags or distributing them throughout the mass.
(5)Directional property resulting from a fiber structure is obtained.
(6)Due to refinement of grains, mechanical properties such as toughness, ductility, elongation and reduction in area are improved.
(7)The power required to finish the part ingot is less.
(8)It can be used on most of the metals, because it is a rapid and economical process.



Hot rolling process showing Deformation & recrysttallisation of metal being rolled.

Q.6.Why forging generally preferred for those components which require high strength and resistance to shock? Explain briefly.

Ans. ***Characteristics of the Forged Parts***

(1)It refines the structure of metal by closing up the cavities and by smashing up large grain formations.
(2)Forged parts have directional properties and hence have good strength.
(3)Mechanical properties such as percentage elongation, percentage reduction of area and resistance to shock and vibration are improved.
(4)Cracks and blow holes are minimised.

Q.7. For various methods of forging known to you give the application areas.

Ans.

(1) ***Hand forging :-*** Hand forging is emplayed only to shape a small number of light forgings chiefly in repair shops.
(2) ***Hammer forgings :-*** Usually used for small item forging.
(3) ***Press forging :-*** Usually used for heavy item forging.
(4) **Machine forging :-** For medium sized and large articles requiring very heavy blows.
(5) **Drop forging :-** For mass production of identical parts.

Q.8. Define up setting, edging, drawing, piecing and punching operations as applied to not working of metals.

Ans.

Upsetting :- This is just opposite to drawing and involves increasing of the cross-sectional area usually by pressing or hammering in a direction parallel to the original ingot axis. In the process of upsetting, the shaft or rod is generally gripped in dies, and the head or flange upset either by a plain flattened ram or with further dies, shaped to give the desired contour.

Edging :-

Drawing :- Refer – (Hot drawing)

Piercing :- This process is employed for the production of seamless tubes. It offers the most economical mechanical working, process for the manufacture of seamless tubes. It consists of passing the hot rolled billet at 1100^0C. between two conical rollers and over a mandrel which helps in piercing and controlling the size of bore as the billet is forced over it.

Q.9.Define the following terms related to cold working of metals.

Ans.

(1) ***Blanking :-*** This is the operation carried out on presses and consists of cutting the outside contour of a stamping. Production of sheet-metal blanks of flat

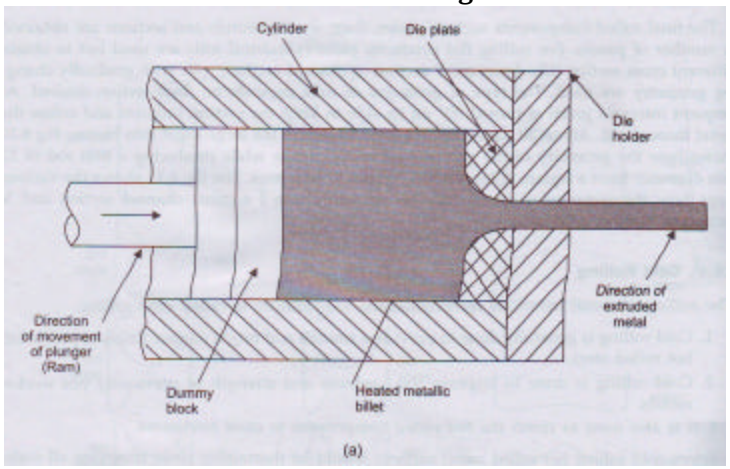
shapes requires a single-action press equipped with tools comprising a punch, a corresponding die, a stripper to keep the sheet from following the punch on its upstroke and means for aligning the sheet or strip of material and for spacing successive cuts. Cutting inside contours, i.e. holes and slots is called piercing. All these operations will be dealt in detail under the chapter of presses. However pressed-metal parts, or stampings are recommended for mass production. Stampings combine the virtues of lightness, a high degree of uniformity, and surfaces well adopted to receive protective and decorative finishes.

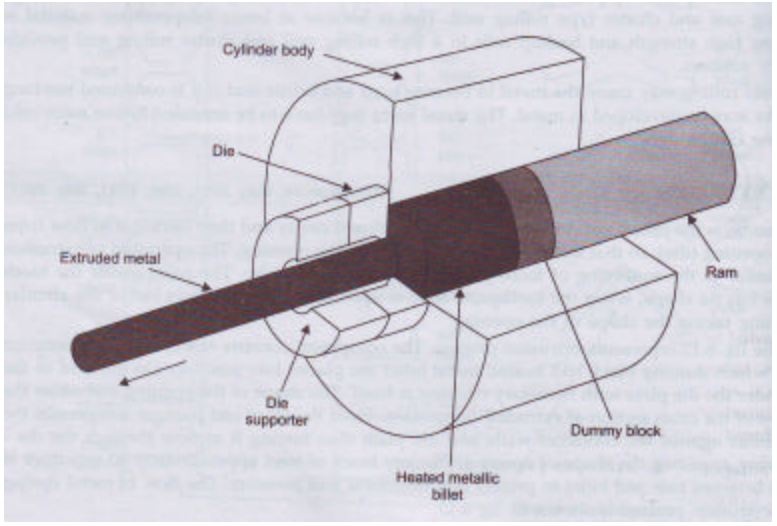
(2) ***Swaging :-*** This operation consists of applying compressive or impact forces on the metal below the recrystallisation temperature. It causes the metal to flow in the predetermined shape according to the design of the dies. Rotary swaging and cold heading are the two important processes of swaging.

(3) ***Lancing :-*** It is a special form of piercing operation in which the entire contour is not cut, the blanked material remains attached with the sheet. It is achieved by bending down one side of partially punched hole.

(4) ***Embossing :-*** It is also like a drawing or stretching operation and does not require much pressure like drawing and coining. It consists of producing, projected or raised designs in relief on a surface of sheet. It is done with the help of two mating dies. The sheet is first blanked and then little more force is applied by the punch which forces the metal against a mating die conforming to the same configuration as the punch. In this way very little metal is squeezed in the operation and the words are printed on the sheet in projected form.

Q.10. Explain extrusion process as used for production of tubes. Draw sketches for various stages in it.





Ans.

1.Tube drawing
2.Roll piercing
3.Tube manufacturing by lap welding.
4.Tube extrusion.

Roll piercing :-

It is a method of producing seamless tubes. The piercing machine used in the process consists of two tapered rolls called piercing rolls. Round heated billet of steel is passed between these rolls over a mandrel. Both the rolls rotate in the same direction. The billet is centre punched or provided with a small drilled hole at one end and heated to proper temperature. It is then pushed forward into the rolls. The rolls grip the billet and pull it further into them. The axes of the rolls are crossed, therefore they revolve the billet as well as draw it forward to force it on to the mandrel. The mandrel can also revolve in its own position. This combination of the revolving motions of the billet, and mandrel, together with the axial advancement of the billet, provide a helical rolling effect on the material. Production of a 12 meter length of upto 150 mm diameter rough tubing will take about 10 to 30 seconds through this method. If tubing of larger bore (say upto 350 mm) are to be made a second piercing operation is necessary after the first. Still larger sizes will need a third piercing operation.

The rough tubing produced as above is further subjected to rolling, reeling and sizing etc. to bring it to the correct shape and size and to provide a fine surface finish. Such tubes are produced in various metals and alloys like steel alloys, aluminum, brass and copper etc.

Q.13. What do you mean by cold working methods ? Explain any two cold working process with neat sketch.

Ans. The processes which are done on the metals by keeping the temperature below recrystallisation temperature are known as cold working processes. The force required for these processes is high as compared to hot working processes. Cold working processes are also applied for soft materials otherwise the work piece will crack. In cold working processes strength & hardness is increased but grain structure is distorted.

Q.14. Write short notes on

1.Hot spinning *(described earlier)*

2.Hot drawing *(described earlier)*

3.Roll piercing *(described earlier)*

Q.15. Explain principle of rolling showing its effect on granular structure.

Ans. The process of rolling basically consists of passing the hot ingot through two rolls rotating in opposite direction at a uniform peripheral speed. The space between the rolls is adjusted to conform to the desired thickness of the rolled section, and the same is always less than the thickness of the ingot to reduce its crosssection and increase its length.

The process is illustrated in figure, which shows the changes that take place in the grain structure of the metal as it passes through the rolls. As a result of squeezing the grains are elongated in the direction of rolling and the velocity of material at exit is higher than that at the entry. After crossing the stress zone the grains start refining. But this is the case only in hot rolling. In cold rolling they tend to retain the shape acquired by them during rolling.

Q.16.Describe the types of rolling mills. Explain their arrangements, specific uses in detail.

Ans. The different types of rolling mills are described below:

1)Two high mill-

It consists of two heavy horizontal rolls, placed exactly one over the other. The rolls are supported on bearings housed in sturdy upright side frames, called stands. The space between the rolls can be adjusted by raising or lowering the upper roll. The position of the lower roll is fixed. Both the rolls rotate in opposite directions to one another, as shown in figure. Their direction of rotation is fixed and cannot be reversed. Thus, the work can be rolled by feeding from one direction only. There is another type of two high mill which incorporates a drive mechanism that can reverse the workpiece continuously through back-and-forth passes between the rolls. This type of rolling mill is known as a two-high
reversing mill. They are normally employed for the initial rolling of an ingot.

2)Three high rolling mills-

It consists of three horizontal rolls, positioned directly one rotation of the upper and lower rolls are the same, but the intermediate roll rotates in a direction opposite to both of these. All the three rolls continuously revolve in the same fixed directions and are never reversed. The work piece is fed in one direction between the upper and middle rolls and in the reverse direction between the middle and lower rolls. Many pieces may be passed through the rolls simultaneously. This results in a higher rates of production than the two-high mill. This mill may be used for blooming, billet rolling or finish rolling.

3)Four-high rolling mills-

It consists four horizontal rolls, two of smaller diameter and two of larger diameter, arranged directly one over the other as shown in figure. The larger diameter rolls are called back-up rolls and their main function is to prevent the deflection of the smaller rolls, which otherwise would result in thickening of rolled plates or sheets at the centre. The smaller rolls are known as working rolls and they are the rolls which concentrate the total rolling pressure over the metal. These mills are generally used for subsequent rolling of slabs. The common products of these mills are hot or cold rolled sheets and plates.

4)Cluster mill-

It consists of two working rolls of smaller diameter and four or more back-up rolls of larger diameter. The arrangement of rolls for this mill is shown in figure. The number of back-up rolls may go up as high as 20 or more, depending upon the amount of support needed for the working rolls during the operation. This type of mill is generally used for cold rolling.

5)Continuous rolling mills-

It consists of a number of nonreversing two-high mills arranged one after the other, so that the material can be passed through all of each successively. The millstand rotate at a faster speed than that of the preceding rolls in order to accommodate the increasing length of the metal piece being rolled. This arrangement facility facilitates a very rapid production, because the component passes continuously from one stand to the other until it reaches the final pass. But it is suitable for mass production work only, because for smaller quantities quick changes of set-up will be required and they will consume a lot of time and labour. As the speed of rolls on each successive stand varies it is necessary that their respective surface speeds should be properly calculated and adjusted.

Q.17.Write short notes on

1)Cold spinning
2)Roll bending
Ans. ***Cold Spinning -***
The process is similar to hot spinning, described earlier. The metal is pressed on to the surface of a wooden or metallic form, called chuck, attached to the lathe spindle. An adapter fitted in the barrel of the tailstock holds the work against the form. The tools used, called spinning tools, are provided with blunt edges and are supported on the tool rest fitted on the cross slide, as shown in figure.
Aluminum and other soft metals are best suited for cold spinning. A few commonly used spun articles out of Aluminum and its alloys are processing kettles, cooking utensils, liquid containers and light reflectors etc.
Various other ductile metals, particularly non-ferrous ones, are quite successfully spun into various typical shapes. The thickness of the metal is reduced during spinning, and proper allowance should be made for this in the blank to be cut. At the end of the operation the unwanted material is trimmed off to bring the product to required size. The form or chuck may be in single piece or composed of many sections attached together, depending upon the possibility of the spun part from it. Where the space of the part does not permit its removal from chuck, off centre chuck are used.
This process of spinning is generally used for:
1.Limited production.
2.Keeping the tool costs low.
3.Production such peculiar shapes which are difficult to be produced through other forming methods.
2) Roll bending -
It is also s kind of roll forming operation through which metal sheets and bent into cylindrical shapes. The roll bending machines carries three rolls; two being fixed and the third adjustable. Diameter of all the same. By adjusting the position of the adjustable roll the plates or sheets can be bent in different curvatures.

Q.18. Define cold bending.
Ans. It is employed for bending into desired shapes various stock materials like rods, wires, bars, pipes, tubes and various structural shapes. Formed dies are used for bending these articles and the operation is usually performed in many stages. Well designed fixtures are also used where mass bending of such components is required.
Q.20. Sketch and describe the types of rolls used in rolling mills.
Ans. The rolls used in rolling mills essentially consists of three parts, namely body, neck, and wabbler. The main rolling operation is performed by the body. It is

therefore made to have different shapes on its periphery, according to the desired shapes of the rolled products, such as smooth for flat and grooved for other sections. The rolls vary in diameters from a few centimeters to about 1.5 meters. The extent to which the reduction in cross-section can be made in a single pass depends upon the weight and size of the rolls. The neck is that part of the roll on which it rotates in the bearing. The wabbler is the starshaped construction at both ends of the roll which engages the hollow cylinder to connect it to the driving shaft to receive power. The advantage of providing the wabblers is that the main body of the roll is not directly connected with the driving shaft. Thus, in case of too heavy loading, if there is any damage, it will occur only in the wabbler, which is a much weaker section, and the main body will remain absolutely free from it. The rolls are generally made from cast or forged steel or cast iron.

Q.21. Describe the process of cold spinning stating its advantages and specific uses.

Ans. ***Advantages of cold spinning***

(1) This is very cheap process.
(2) It does not require much investment.
(3) The production of in cylindrical shape by spinning is less economical.

Specific uses of cold spinning:

Cold-spinning process is frequently used in the making of bells on musical instruments and also for light fixtures, kitchen-ware, reflectors, funnels, and large processing kettles.

Q.22. What is continuous rolling mill? What are its advantages?

Ans. This consists of several stands of two high mills arranged one after the other. As the metal comes out of one set of rolls, it enters second, third and so on and finally comes out in required size and shape. The speed of every stage goes on increasing in comparison to preceding roll in order to accommodate the increasing length of the metal and thereby making it a continuous process. The operation is thus very fast and space requirement for mill is less. The production is economical and at the same time mass production is possible.

Q.23. Write short notes on

Ans. Cold rolling:

Cold rolling is generally employed for providing a smooth and bright surface finish to the previously hot rolled steel. It is also used to finish the hot rolled components to close tolerances and improve their toughness and hardness. The items generally subjected to cold rolling for this purpose are bars, rods, sheet plates,

strips and wires etc. Before being put to cold rolling the hot rolled articles are cleaned through pickling and other operations. The same types of rolling mills, described earlier in connection with hot rolling, are used in cold rolling. In order to obtain a smooth surface finish the roll surfaces are polished and scratches, if any, removed. The part being rolled is usually annealed and pickled before the final pass is made, so as to bring it to accurate size and obtain a perfectly clean surface.

Q.24.What is hot working? What are the common hot working processes?

Ans. The principal hot working processes generally applied to various metals, are the following:

1.Hot rolling.
2.Hot forging.
3.Hot spinning.
4.Hot extrusion.
5.Welded pipe and tube manufacturing.
6.Roll piercing.
7.Hot drawing.

Q.25.Explain the following cold working process.

Ans. Cold hobbing:

It is a process for producing cavities of various shades in a blank of soft metal by pressing a hardened steel form into it. This form is known as a hob. The operation may require several pressings and annealings in between. Hydraulic presses are used for providing the required pressure. The main advantages of this process is the economical production of identical cavities in large number. Moulds for plastic moulding can be produced through this method.

Q.26. What principles are involved in hot rolling? Explain.

Q.27. What is hot extrusion? In how many ways it can be performed?

Ans. The process of extrusion consists of compressing a metal inside a chamber to force it out through a small opening called die. Any plastic material can be extruded successfully. Most of the presses used for extruding metals are hydraulically operated horizontal presses. A large number of extruded shapes are in common use such as tubes, rods, structural shapes and lead covered cables