Chapter Five: Cold Working of Metal

5.1. Introduction

Cold working of a metal is carried out below its recrystallisation temperature. Although normal room temperatures are ordinarily used for cold working of various types of steel, temperatures up to the recrystallisation range are sometimes used. In cold working, recovery processes are not effective.

5.2 Purpose Of Cold Working

The common purpose of cold working is given as under

1. Cold working is employed to obtain better surface finish on parts.
2. It is commonly applied to obtain increased mechanical properties.
3. It is widely applied as a forming process of making steel products using pressing and spinning.
4. It is used to obtain thinner material.

5.3 Precautions Fallowed in Cold Working

Cold working leads to crack formation and propagation if performed in excess and it should therefore be avoided. Residual stresses developed due to inhomogeneous deformation cause warping or distortion when the part is released from the tooling and during subsequent machining. Magnitude and distribution of residual stresses should therefore be controlled.

5.4 Characteristics of Cold Working

The main characteristics of cold working are given as under.

1. Cold working involves plastic deformation of a metal, which results in strain hardening.
2. It usually involves working at ordinary (room) temperatures, but, for high melting point metals, e.g., tungsten, the cold working may be carried out at a red heat.
3. The stress required for deformation increases rapidly with the amount of deformation.
4. The amount of deformation, which can be performed without introducing other treatment, is limited.
5. Cold rolling process generally distorts grain structure.
6. Good surface finish is obtained in cold rolling.
7. The upper temperature limit for cold working is the maximum temperature at which strain hardening is retained. Since cold working takes place below the recrystallisation temperature, it produces strain hardening.
8. Excessive cold working gives rise to the formation and propagation of cracks in the metal.
9. The loss of ductility during cold working has a useful side effect in machining.
10. With less ductility, the chips break more readily and facilitate the cutting operation.
11. Heating is sometimes required.
12. Directional properties can be easily imparted.
13. Spring back is a common phenomenon present in cold-working processes.

14. For relatively ductile metals, cold working is often more economical than hot working.

There is some increase and some decrease in properties of the cold worked part, which are given as under.

❖ Cold working process increases:

- Ultimate tensile strength
- Yield strength
- Hardness
- Fatigue strength
- Residual stresses

❖ Cold working processes decreases:

- Percentage elongation
- Reduction of area
- Impact strength
- Resistance to corrosion
- Ductility

5.4 Limitations of Cold Working

1. The cold worked process possesses less ductility.
2. Imparted directional properties may be detrimental
3. Strain hardening occurs.
4. Metal surfaces must be clean and scale free before cold working.
5. Hot worked metal has to be pickled in acid to remove scale, etc.
6. Higher forces are required for deformation than those in hot working.
7. More powerful and heavier equipments are required for cold working.

5.5 Advantages of Cold Working

1. In cold working processes, smooth surface finish can be easily produced.
2. Accurate dimensions of parts can be maintained.
3. Strength and hardness of the metal are increased but ductility decreased.
4. Since the working is done in cold state, no oxide would form on the surface and Consequently good surface finish is obtained.
5. Cold working increases the strength and hardness of the material due to the strain hardening which would be beneficial in some situations.
6. There is no possibility of decarburization of the surface.
7. Better dimensional accuracy is achieved.
8. It is far easier to handle cold parts and it is also economical for smaller sizes.

5.6 Disadvantages of Cold Working

1. Some materials, which are brittle, cannot be cold worked easily.
2. Since the material has higher yield strength at lower temperatures, the amount of deformation that can be given to is limited by the capability of the presses or hammers used.
3. A distortion of the grain structure is created.
4. Since the material gets strain hardened, the maximum amount of deformation that can be given is limited. Any further deformation can be given after annealing.
5. Internal stresses are set up which remain in the metal unless they are removed by proper heat-treatment.

5.7 Comparison of Hot Working With Cold Working

S.No.	Hot Working	Cold Working
1	Hot working is carried out above the recrystallisation temperature and below the melting point. Hence the deformation of metal and recovery take place simultaneously.	Cold working is carried out below the recrystallisation temperature. As such, there is no appreciable recovery.
2	No internal or residual stresses are set-up in the metal in hot working.	In this process internal or residual stresses are set-up in the metal.
3	It helps in irradiating irregularities in metal composition breaking up the non metallic impurities in to tiny fragments and dispersing them through out the metal and thus facilitate uniformity of composition in the metal	It results in loss of uniformity of metal composition and thus affects the metal properties.
4	Close tolerance can not be maintained	Better tolerance can be easily maintained.
5	Surface finish of this process is comparatively not good.	Surface finish of this process is better.

S.No.	Hot Working	Cold Working
6	It results in improvements of properties like impact strength and elongation.	It results in improvements of properties like impact strength and elongation.
7	Due to re-crystallisation and recovery no or very negligible hardening of metal takes place.	Since this is done below re-crystallisation temperature the metal gets work hardened.
8	Due to higher deformation temperatures, the stress required for deformation is much less.	The stress required to cause deformation is much higher.
9	Hot working refines metal grains resulting in improved mechanical properties.	Most of the cold working processes lead to distortion of grains.
10	If cracks and blow boles are present in the metal, they are finished through hot working.	In cold working the existing cracks propagate and new cracks may develop.
11	If properly performed, it does not affect UTS, hardness, corrosion resistance, yield strength and fatigue strength of the metal.	It improves UTS, hardness, yield strength but reduces the corrosion resistance of strength of the metal.

16.8 Cold Working Processes

Commonly employed cold working processes are:

1. Rolling
2. Extrusion
3. Wire drawing
4. Forging
5. Sheet metal operations
   a) Shearing etc.
      i. Piercing
      ii. Blanking
      iii. Cutting
      iv. Parting
      v. Punching

vi. Notching
vii. Slitting
viii. Nibbling
ix. Lancing
x. Trimming

b) Bending
c) Drawing
d) Pressing and deep drawing
e) Squeezing
   i. Embossing
   ii. Coining

6. Cold spinning
7. Shot peening