



# SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Coimbatore-35



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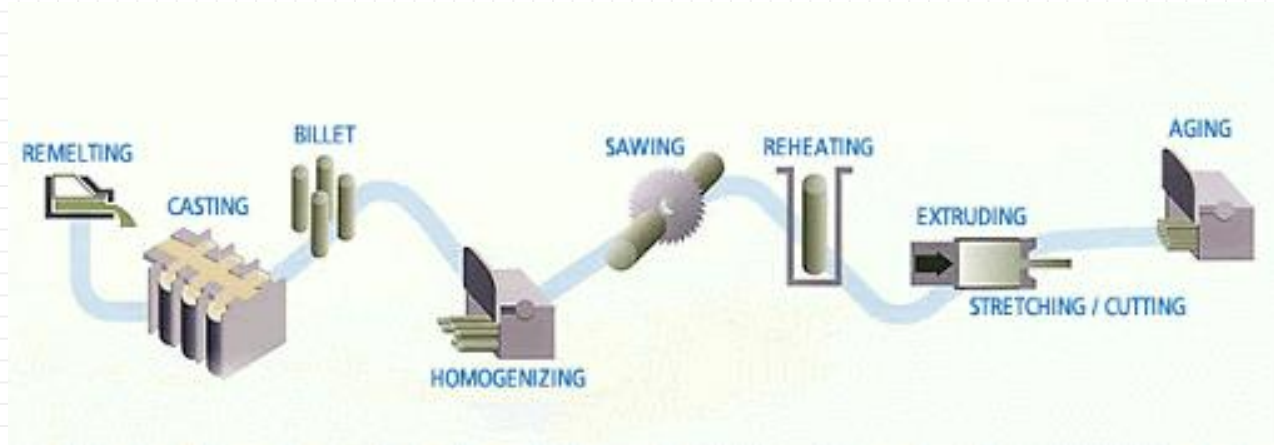
## 19MET202 – MANUFACTURING TECHNOLOGY

Prepared by Mr Gowtham M, AP/Mech



# MET, UNIT-2, LESSON-5

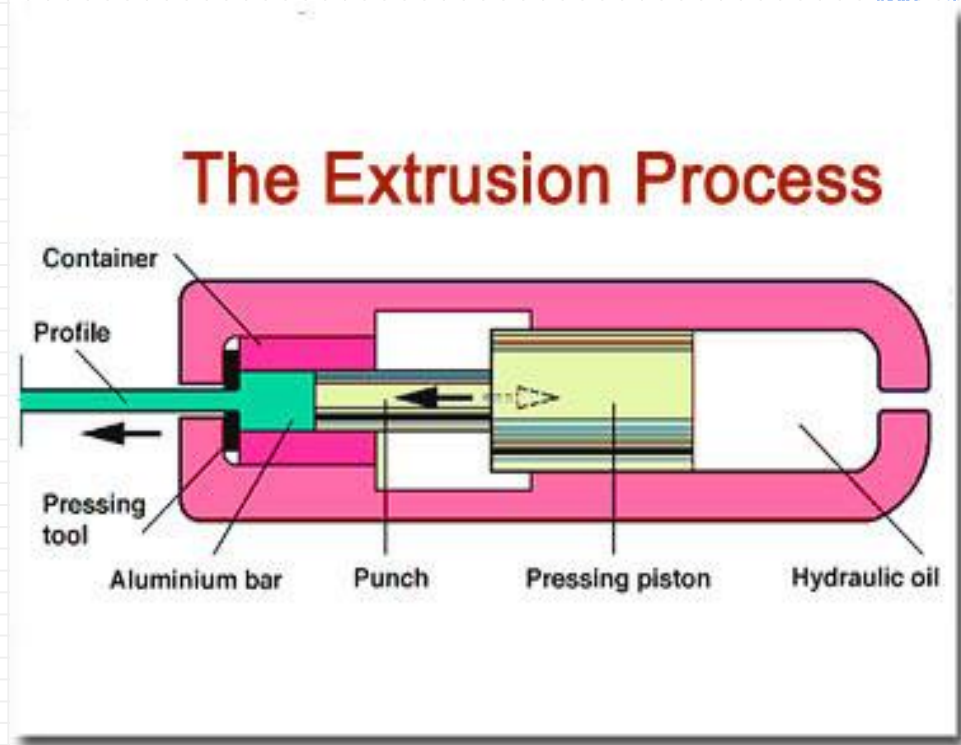
## EXTRUSION DIRECT AND INDIRECT



<http://www.malco.co.jp/en/02/02-b.html>

# EXTRUSION

- Extrusion is the process by which a block/billet of metal is reduced in cross section by forcing it to flow through a die orifice under high pressure.
- In general, extrusion is used to produce cylindrical bars or hollow tubes or for the starting stock for drawn rod, cold extrusion or forged products

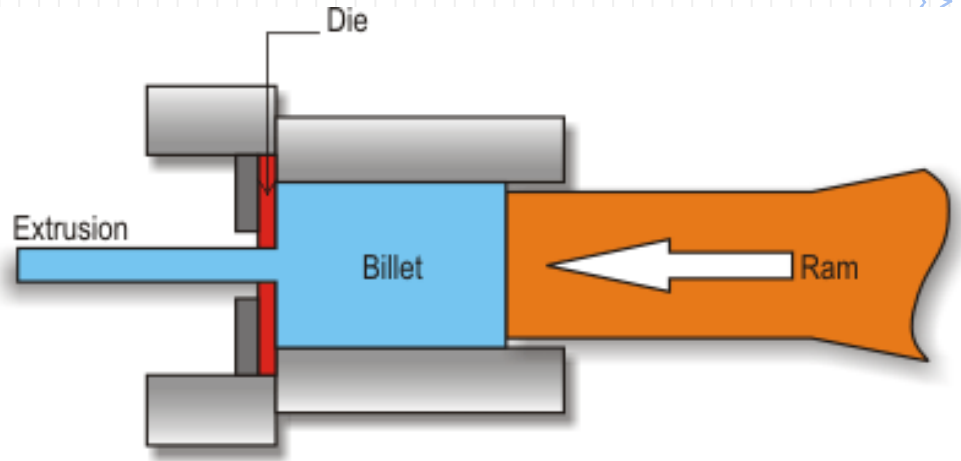


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# EXTRUSION

□ The reaction of extrusion billet with the container and die results in high compressive stresses which are effective in reducing cracking of materials during primary breakdown from the ingot.

□ This helps to increase the utilization of extrusion in the working of metals that are difficult to form like stainless steels, nickel-based alloys, and other high temperature materials.

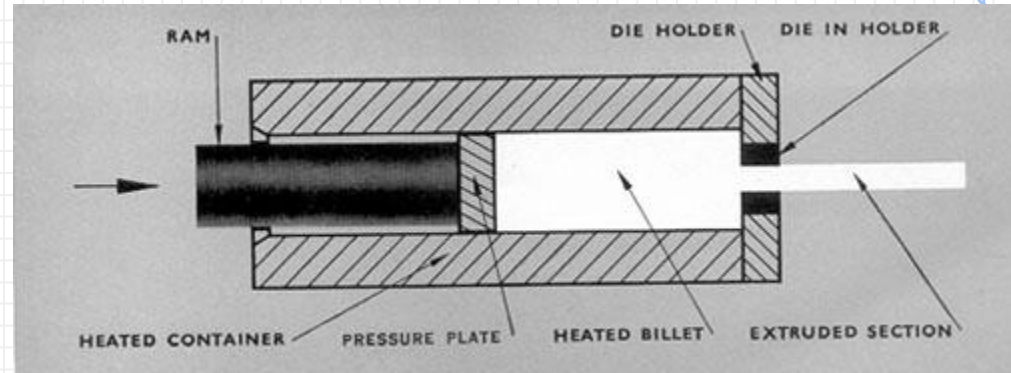


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<https://tinyurl.com/y3yt23jn>

# EXTRUSION

- Similar to forging, lower ram force and a fine grained re-crystallized structure are possible in hot extrusion.
- However, better surface finish and higher strengths (strain hardened metals) are provided by cold extrusion.



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# EXTRUSION PRODUCTS

□ Typical parts produced by extrusion are trim parts used in automotive and construction application, window frame members, railings, aircraft structural parts.

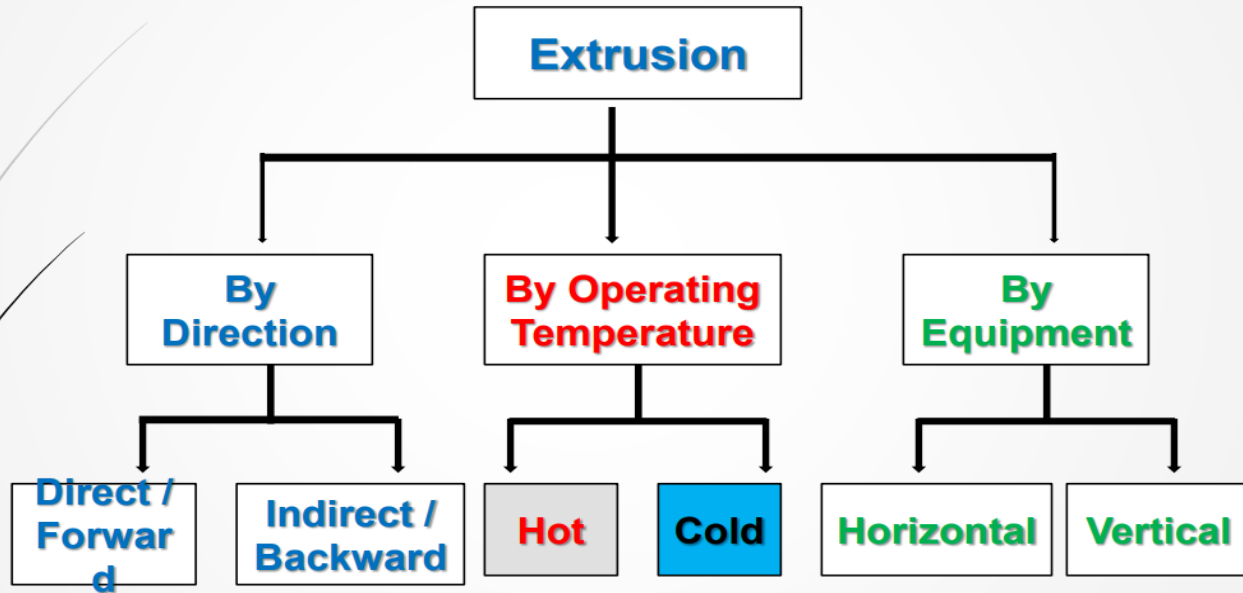
□ Example: Aluminium extrusion are used in commercial and domestic buildings for window and door frame systems, prefabricated houses/building structures, roofing and exterior cladding, curtain walling, shop fronts, etc.

□ Furthermore, extrusions are also used in transport for airframes, road and rail vehicles and in marine applications.



<https://tinyurl.com/y5359sm8>

# TYPES OF EXTRUSION



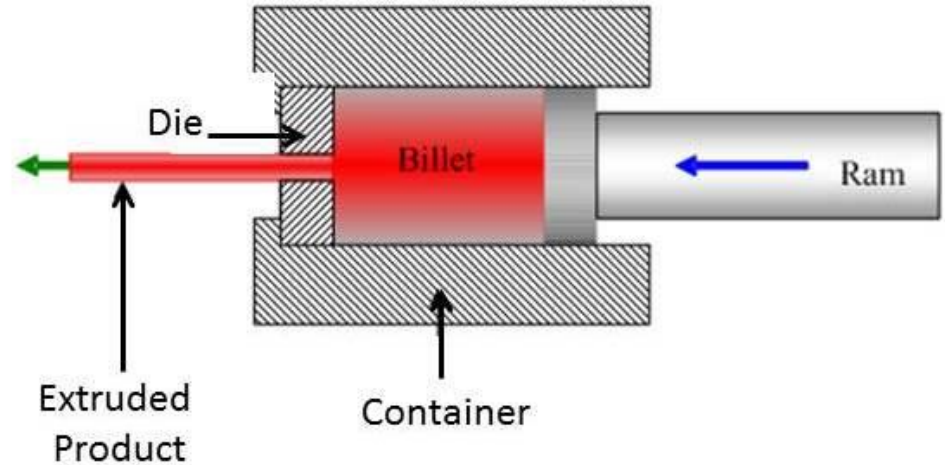
<https://tinurl.com/v6aoanmh>

# DIRECT EXTRUSION

Direct Extrusion: □ The metal billet is placed in a container and driven through the die by the ram.

□ The dummy block or pressure plate, is placed at the end of the ram in contact with the billet.

□ Friction is at the die and container wall requires higher pressure than indirect extrusion.



**Direct Extrusion**

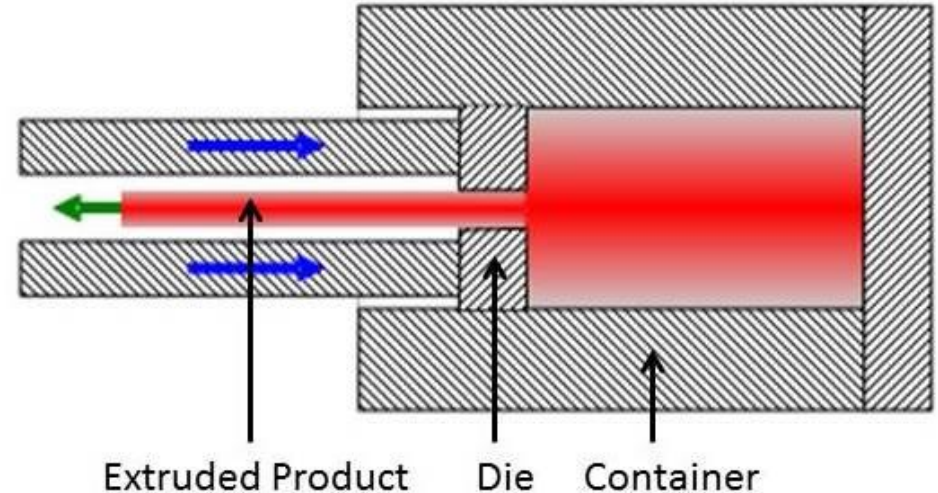
<https://tinyurl.com/y63fropc>



# INDIRECT EXTRUSION

## Indirect Extrusion:

- The hollow ram containing the die is kept stationary and the container with the billet is caused to move.
- Friction at the die only (no relative movement at the container wall) requires roughly constant pressure. Hollow ram limits the applied load.



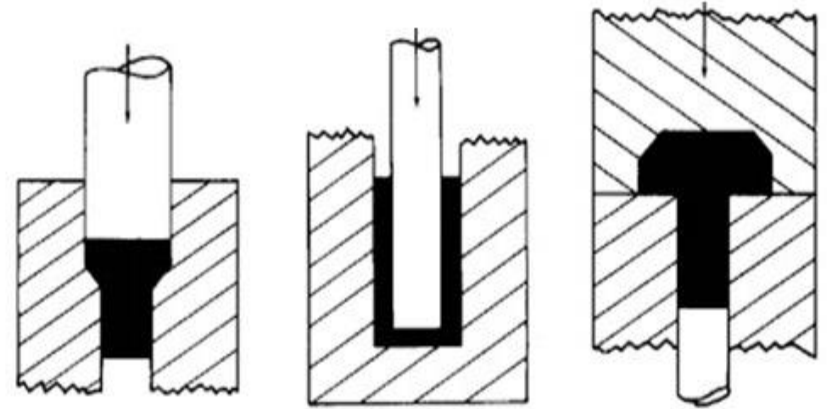
## Indirect Extrusion

<https://tinyurl.com/y63fropc>

# COLD EXTRUSION

□ Cold extrusion is the process done at room temperature or slightly elevated temperatures. This process can be used for materials that can withstand the stresses created by extrusion.

□ Materials that are commonly cold extruded include: lead, tin, aluminum, copper, zirconium, titanium, molybdenum, beryllium, vanadium, niobium, and steel. Examples of products produced by this process are: collapsible tubes, fire extinguisher cases, shock absorber cylinders and gear blanks.

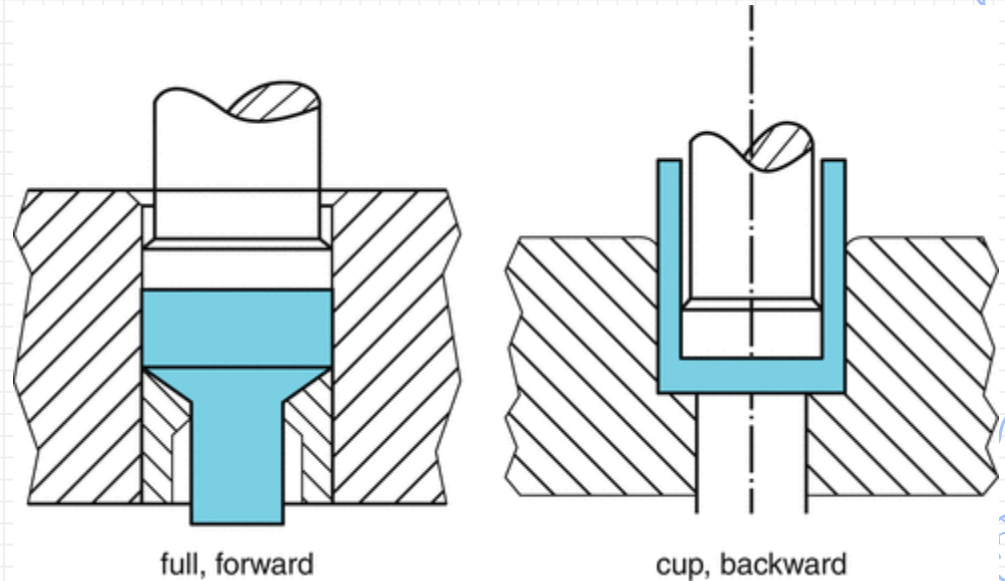


<https://tinyurl.com/yxfs3tbq>

# COLD EXTRUSION

## Advantages:

- No oxidation takes place.
- Good mechanical properties due to severe cold working as long as the temperatures created are below the re-crystallization temperature.
- Good surface finish with the use of proper lubricants.



<https://tinyurl.com/y6ccslr6>

# HOT EXTRUSION

□ Hot extrusion is a hot working process, which means it is done above the material's re-crystallization temperature to keep the material from work hardening and to make it easier to push the material through the die. The biggest disadvantage of this process is its cost for machinery.

□ Hot extrusion is done at fairly high temperatures, approximately 50 to 75% of the melting point of the metal. The pressure can range from 35-700 MPa .

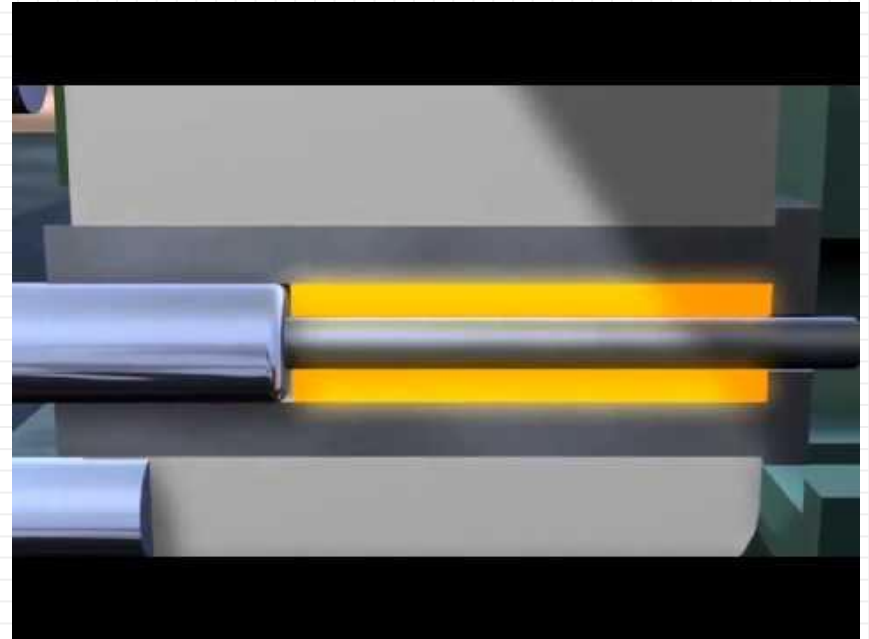


<https://www.youtube.com/watch?v=x0oSLKrBe9Y>

# HOT EXTRUSION

Due to the high temperature and pressure and its detrimental effect on the die life as well as other components, good lubrication is necessary.

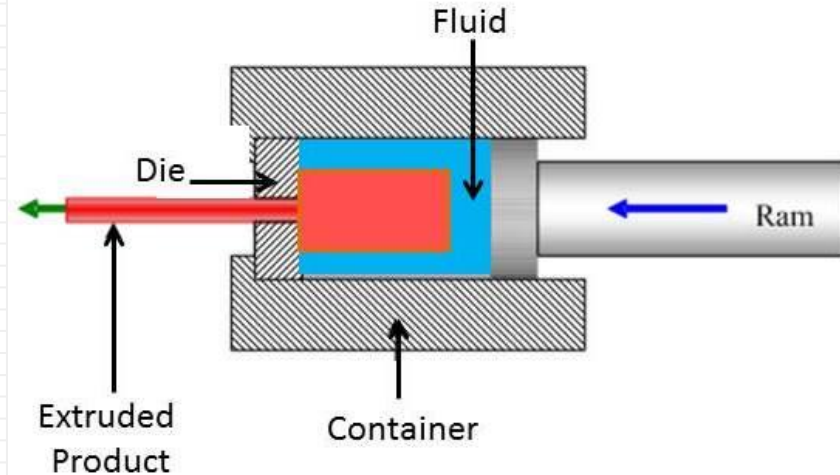
Oil and graphite work at lower temperatures, whereas at higher temperatures glass powder is used



<https://www.youtube.com/watch?v=ETz2WiX6tMI>

# HYDROSTATIC EXTRUSION

- In the hydrostatic extrusion process the billet is completely surrounded by a pressurized liquid, except where the billet contacts the die.
- The rate, with which the billet moves when pressing in the direction of the die, is thus not equal to the ram speed, but is proportional to the displaced hydrostatics medium volume.
- The process must be carried out in a sealed cylinder to contain the hydrostatic medium.
- Pressure = 1400 MPa (approx.)



## Hydrostatic Extrusion

<https://tinyurl.com/y63fropc>

# DIE MATERIALS

## Die Materials:

- Dies are made from highly alloy tools steels or ceramics
- Commonly used materials are Tool Steels and Carbides
- For improved wear resistance, steel dies may be chromium plated, and carbide dies may be coated with titanium nitride
- For Hot drawing, cast-steel dies are used
- Heat treatments such as nitriding are required (several times) to increase hardness (1000-1100 Hv or 65-70 HRC). This improves die life.

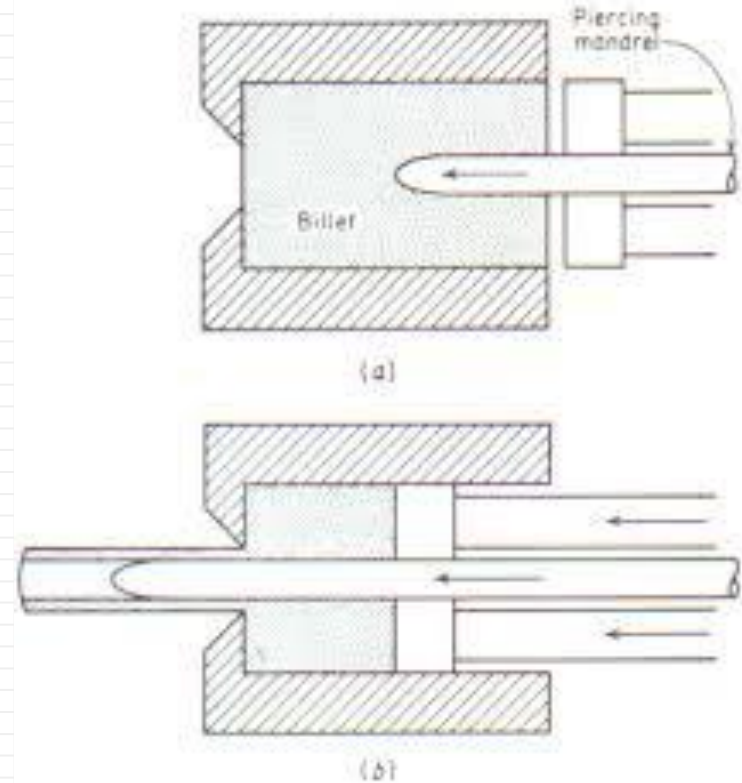
# DEFORMATION, LUBRICATION, AND DEFECTS IN EXTRUSION

- Low container friction and a well lubricated billet – nearly homogeneous deformation.
- Increasing container wall friction – producing a dead zone of stagnant metal at corners which undergoes little deformation. Essentially pure elongation in the center and extensive shear along the sides of the billet. The latter leads to redundant work



# DEFORMATION, LUBRICATION, AND DEFECTS IN EXTRUSION

For high friction at the container – billet interface, metal flow is concentrated toward the center and an internal shear plane develops – due to cold container. In the sticky friction, the metal will separate internally along the shear zone. A thin skin will be left in a container and new metal surface is obtained.



<https://tinyurl.com/yjr7j4vn>

# DEFECTS IN EXTRUSION

## 1) Inhomogeneous deformation –

- In direct extrusion, a dead zone along the outer surface of the billet due to the movement of metal in the center being higher than the periphery.

## 2) Surface cracking

- It is the ranging from a badly roughened surface to repetitive transverse cracking called fir-tree cracking.
- It is due to longitudinal tensile stresses generated as the extrusion passes through the die.

## 3) Centre burst or chevron cracking

- It can occur at low extrusion ratio due to low frictional conditions on the zone of deformation at the extrusion die.
- High friction(at a the tool-billet interface).

# DEFECTS IN EXTRUSION

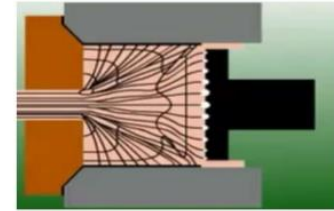
## 4) Variations in structure and properties

- Structure & properties are varied within the extrusions due to non uniform deformation for example at the front and the back of the extrusion in both longitudinal and transverse directions.
- Regions of exaggerated grain growth, due to high hot working temperature

## 5) Hot shortness (in aluminum extrusion)

- High temperatures generated cause incipient melting, which causes cracking.

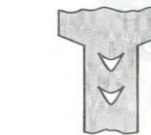
- Metal in contact with walls cools down rapidly as compared to center part resulting in non uniform flow of metal



<https://tinyurl.com/y5fss5zd>



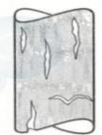
Extrusion defects



centerburst



Fishtailing



surface cracking

<https://tinyurl.com/y5vjp3ja>

# ASSESSMENT

1. Which of the following is true about the extrusion process?
  - a) Structure is homogeneous
  - b) No time is lost in changing the shape
  - c) Service life of extrusion tool is too high
  - d) Its leading end is in good shape as compared to rolling
2. In which extrusion process the direction of flow of metal is in same direction as that of ram?
  - a) Direct
  - b) Indirect
  - c) Impact
  - d) Hydrostatic

# ASSESSMENT

3. In direct extrusion process at higher temperature which of the following is used to avoid friction?

- a) Oil      b) Lubricants      c) Molten glasses      d) Wax

4. In which of the following process frictional loss is eliminated at the billet container interface?

- a) Direct      b) Indirect      c) Impact      d) Hydrostatic

5. Which defect arises due to high friction or high speed?

- a) Tearing  
b) Surface cracking  
c) Tearing & Surface cracking  
d) Flaking

The slide features a light blue grid background. The corners are decorated with various hand-drawn science icons in blue and yellow. Top-left icons include a gear with a lightning bolt, a beaker with 'H2O', a microscope, and a rocket. Top-right icons include a smartphone, a globe, a microscope, and a test tube. Bottom-left icons include a lightbulb, a brain, and a graph. Bottom-right icons include a globe, a microscope, a planet, and a test tube.

THANK YOU