# INTRODUCTION

- It is Referred by many names such as “squeeze casting” , “pressure infiltration”, “liquid metal forging”, “extrusion casting”, “liquid pressing", “pressure crystallization”.
- squeeze forming is the combination of the casting and forging processes that can be done with help of high pressure when it is applied during melt solidification.
- Non ferrous alloys like Al, Mg and Cu alloy components are readily manufactured using this process. but now steel and cast iron is also manufactured by this process.

## PROCESS

Squeeze forming consist of entering liquid metal into a preheated, lubricated die and presses the metal while it solidifies.

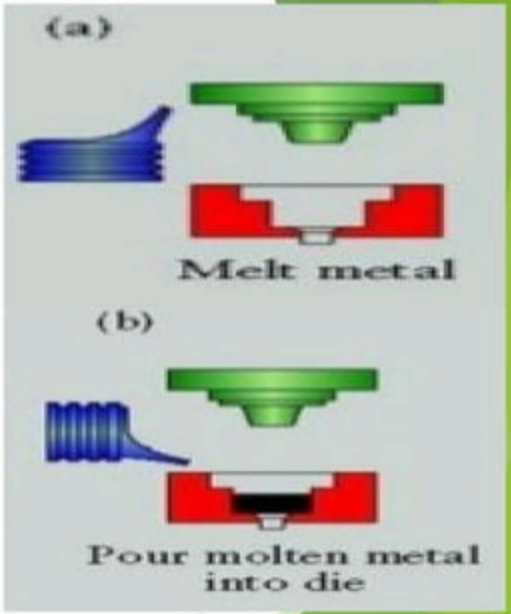



Fig 1 Process

- The load is applied shortly after the metal begins to freeze and is maintained until the entire casting has solidified.(Fig c)

- Casting is ejected with the help of ejector pins(Fig d).

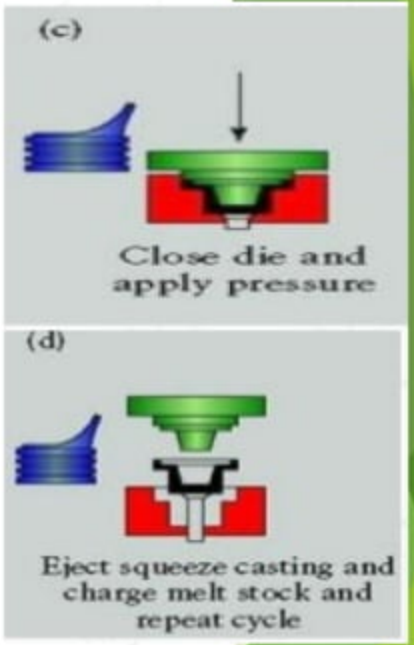



Fig 2 Process

# CLASSIFICATION

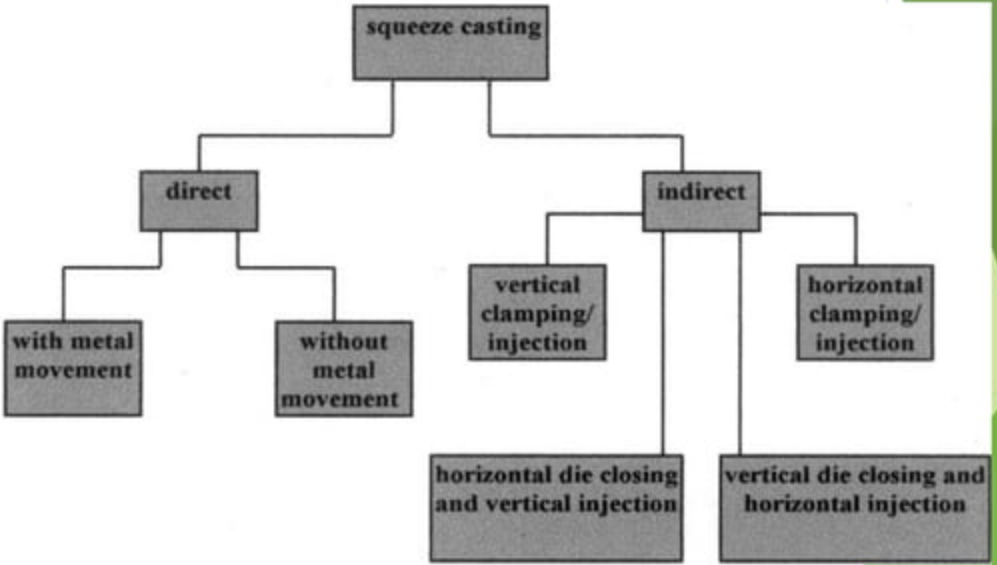



Fig 3 Classification

# DIRECT SQUEEZE CASTING

- The pressure for the infiltration of the pre fabricated preforms is applied directly to the melt.
- The die is thereby part of the mold, which simplifies the structure of the tools substantially.

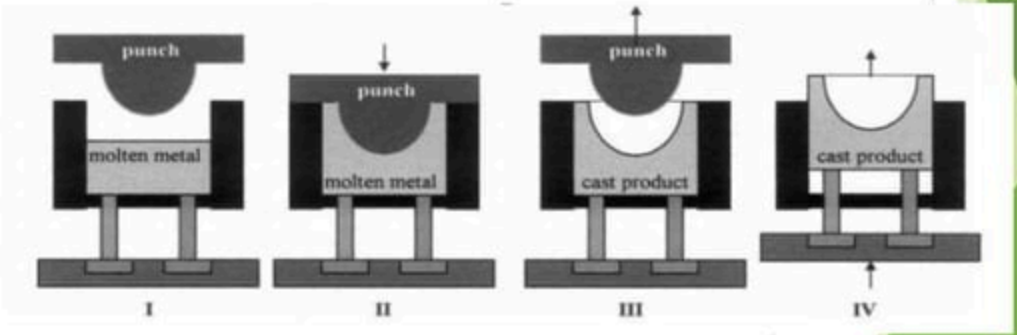



Fig 4 Direct squeeze casting(with liquid metal movement))

# INDIRECT SQUEEZE CASTING

- The metal is injected into the die cavity by a small diameter piston.
- Pressure is transmitted from the hydraulic source to the metal in a cavity through a runner system.
- It is designed to combine the net shape advantage of high pressure die casting with the internal structural advantages of squeeze casting.

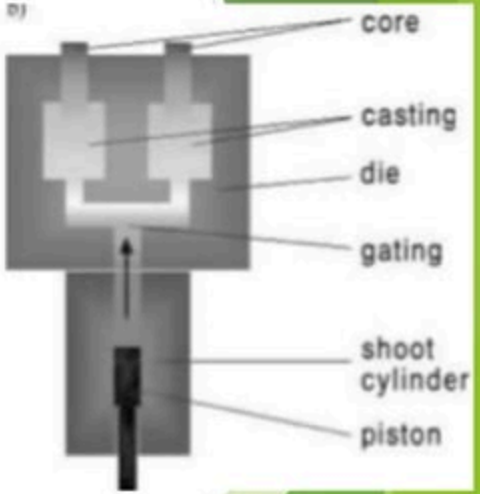



Fig 5 Indirect squeeze casting

# PROCESS PARAMETER

## CASTING TEMPERATURE –

- The casting temperature is extremely critical from the standpoints of both casting quality and die life.
- For Aluminium , casting temperature is normally 10 to 100°C above the liquidus temperature.
- For Copper & Steel , casting temperature is around 30 to 150°C above the liquidus temperature.

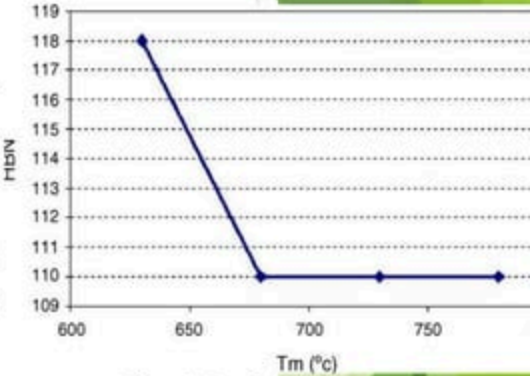



Fig 6 Hardness vs casting temperature of Mg-Alloy

# TOOLING TEMPERATURE

- Low temperatures (below 150°C can lead to thermal fatigue failures in the dies and also cold laps on the surfaces of the casting).
- Very high tooling temperatures (above 400°C can cause hot spots and shrinkage pores in the casting). An additional problem with overheated dies, primarily for ferrous squeeze casting, is a greater tendency for welding between the casting and the die.
- The temperatures of the die cavity and the punch are maintained between 200 and 300°C.

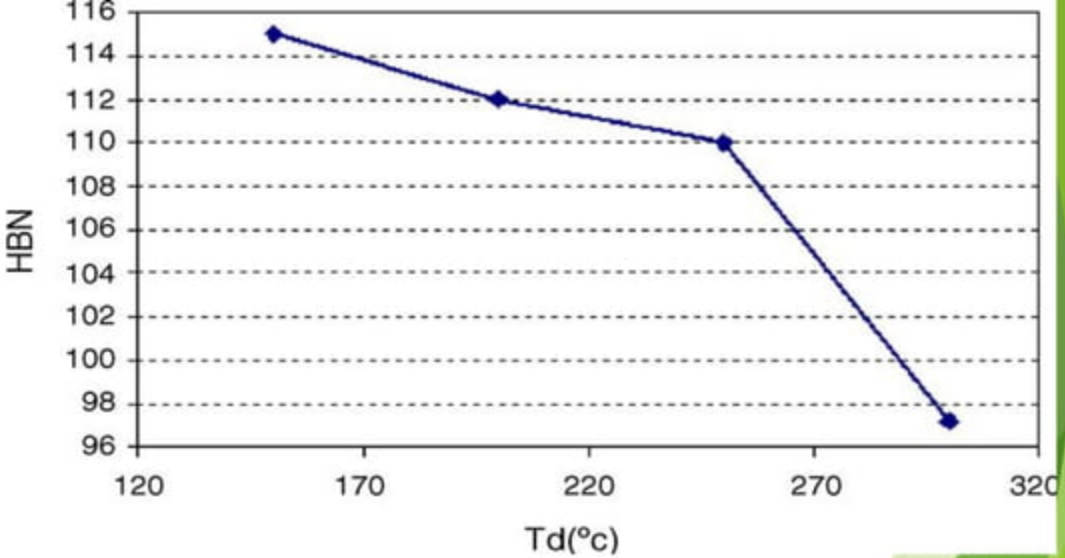



Fig 7 Effect of die temperature on the hardness of squeeze cast LM13 Mg alloy

# PRESSURE LEVEL

- A minimum pressure level of 70 to 105 MPa is required in order to eliminate shrinkage and gas porosity for most ferrous and nonferrous materials.
- Raising the pressure level above the minimum level consistent with sound castings has been found to provide little additional benefit, although extremely high pressures in excess of the yield stress of the casting have been reported to provide grain refinement and higher properties.
- This pressure is usually in the range of 70 to 105 MPa for simple shapes and 140 to 210 MPa for thin sections and complex shapes.

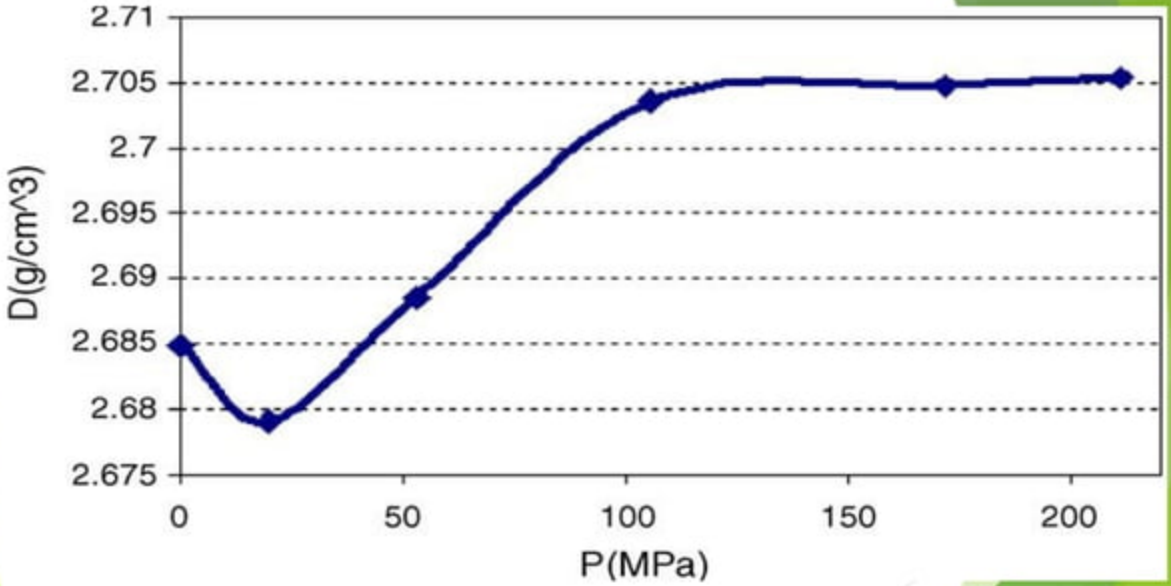



Fig 8 Effect of external pressure on the hardness of squeeze cast LM13 Mg alloy

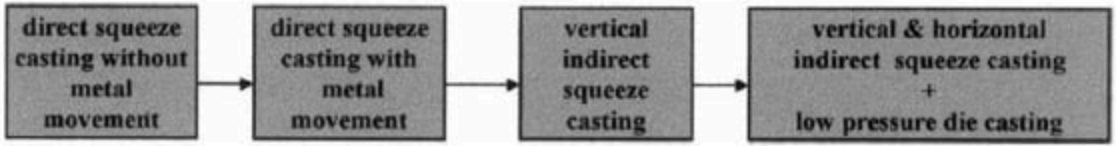
# LUBRICANTS

- A thin layer of colloidal graphite, sprayed on the hot die between pours, works satisfactorily for most nonferrous and cast iron applications. Commercial graphite forging lubricants are generally adequate.
- For steel castings, ceramic parting agent is used on the die surfaces which make contact with the molten steel must be sprayed, when hot. This is a commercially available mixture of alumina powder and a binder in an aqueous medium.

# TIME DELAY

- Optimum results are obtained when the pressure is applied near the zero fluidity temperature* (* The zero fluidity temperature is defined as the temperature below which the metal loses its fluid flow properties).
- In the case of steel castings, however, the metal reaches the optimum pressing temperature extremely rapidly, owing to the high temperature differential between the dies and the molten metal. A deliberate time delay is rarely necessary, except in the case of unusually heavy-section castings which are over 60 mm in thickness.

# Recent Development in Squeeze Casting



| Different Process → / Casting Quality ↓ | Low Pressure Die Casting | High Pressure Die Casting | Vaccum Die Casting | Semi Solid Forging | Squeeze Casting |
|---|---|---|---|---|---|
| Cycle Time | Fair | Good | Fair | Poor | Fair |
| Surface Finish | Fair | Excellent | Fair | Excellent | Excellent |
| Gas Entrapment | Fair | Excellent | Good | Good | Excellent |
| Shrinkage Pores | Poor | Poor | Poor | Excellent | Excellent |
| Casting Density | Fair | Good | Fair | Excellent | Excellent |

Table 1 Comparison of casting quality with respect to casting processes

## ADVANTAGE:

- High yielding.
- Fine micro-structures with higher strength components.
- Good surface texture.
- Little or no machining required in post casting process.
- Due to high pressure applied during solidification porosity can be prevented or eliminated.
- Soluble or machinable cores allow more complex forms to be cast.
- In addition to casting alloy the longer freezing range wrought or forging alloys can be very effectively employed.
- Better mechanical properties.

## LIMITATION:

- Cost are very high due to complex tooling.
- No flexibility as tooling is dedicated to specific component.
- High costs means high production volume are necessary to justify equipment investment.
- Process needs to be accurately controlled which slow the cycle time down and increase process cost.
- Can be affected by premature chemical reaction, air entrapment and failure to fill the cavity resulting in reject component.
- Close control on parameter is essential, otherwise it may damage the part or machine etc.
- Limitation on size.

## APPLICATION:

- This process mostly used in automotive industry in producing aluminum front steering knuckles, chassis frame, brackets or nodes,piston etc.
- Making of high capacity propellers for boat-engine.
- Nickel hard-crusher wheel inserts also manufactured by squeeze casting.
- Aircraft industries.
- Automotive industries.
- Marine industries.

# Conclusion and future scope

- The squeeze casting process has many advantages over other casting processes including high mechanical properties, near-net shape capability, minimal gas and shrink porosity, and the ability to heat treat.This process is capable of producing lightweight, high integrity, automotive components that can be used for structural , automotive , aviation industries etc.
- Even with the many advantages of the squeeze casting process, desired quality level cannot be guaranteed without proper design and proper control on. Carefully planned casting geometries and tooling designs can offset issues with manufacturability and casting performance.

Future Scope

- Earlier Squeeze casting was only used for non ferrous metal. But with the technology advancement Now Ferrous material is also used for squeeze casting. Researchers also trying to use composite material in Squeeze Casting.

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THANK
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