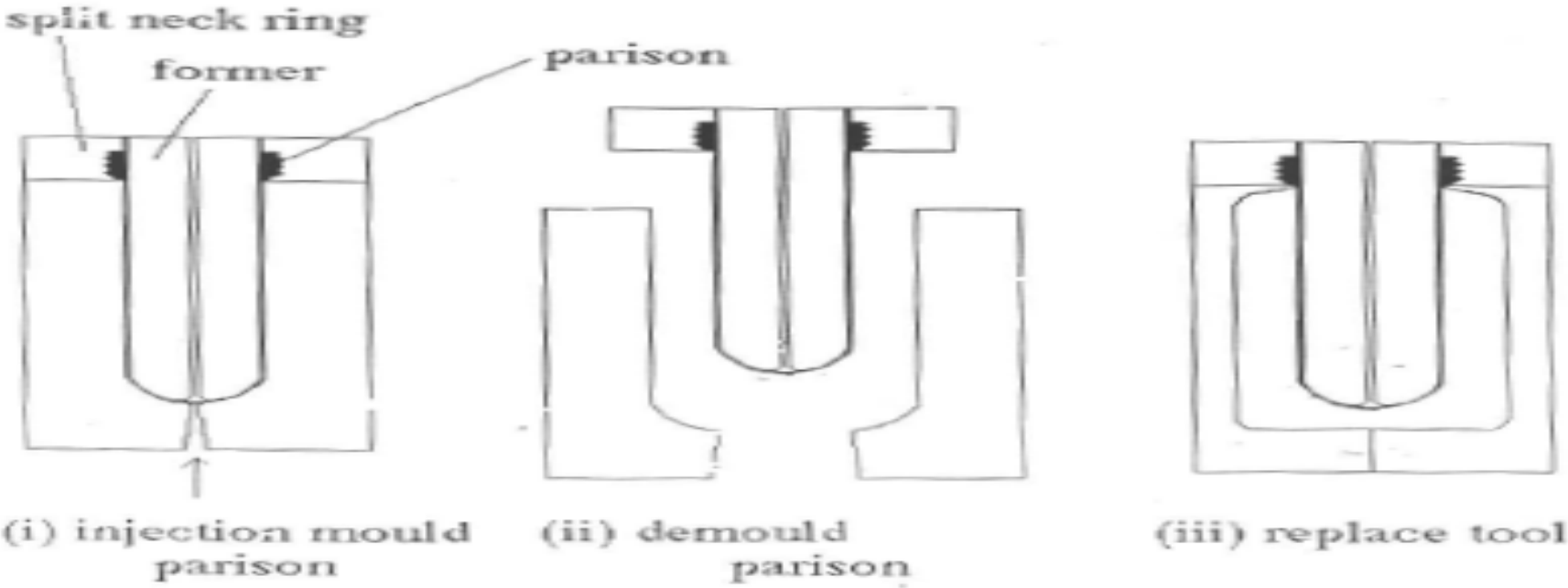
Injection Blow Moulding

- The principle of the injection blow moulding process is that:
- A melt is injected to give a parison.
- The parison is then cooled.
- The parison is then reheated and inserted into the mould where it is inflated in a radial direction with air to produce a bottle.
- The inflated parison is cooled and shaped as it makes contact with the mould wall being usually cold.

INJECTION BLOW MOULDING



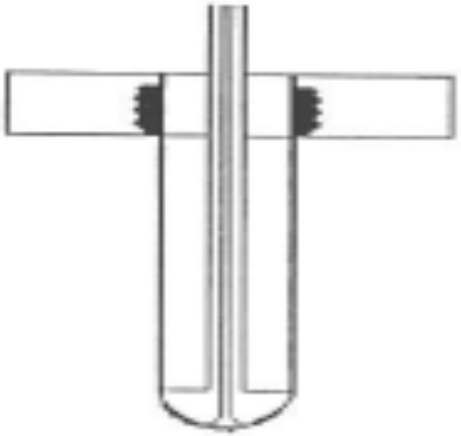
Injection Blow Moulding

Further modification

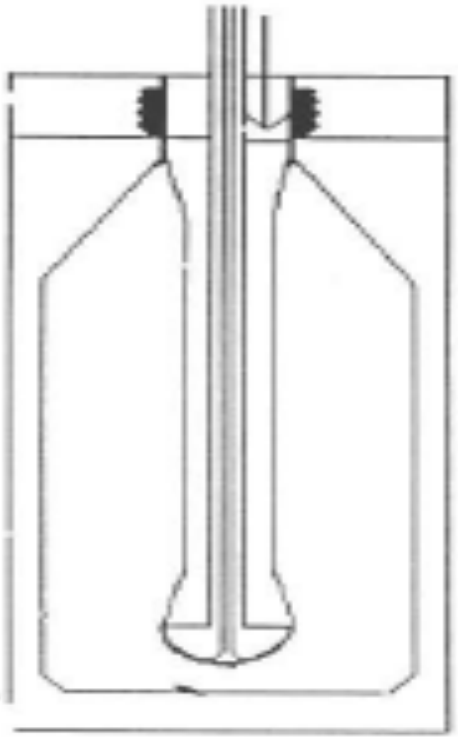
This is referred to as "Stretch injection blow moulding".

This process involves biaxial stretching of a preform at a low temperature and thus stress-induced crystallisation. This enhances the mechanical properties of the product. Examples of products include PET and PC bottles.

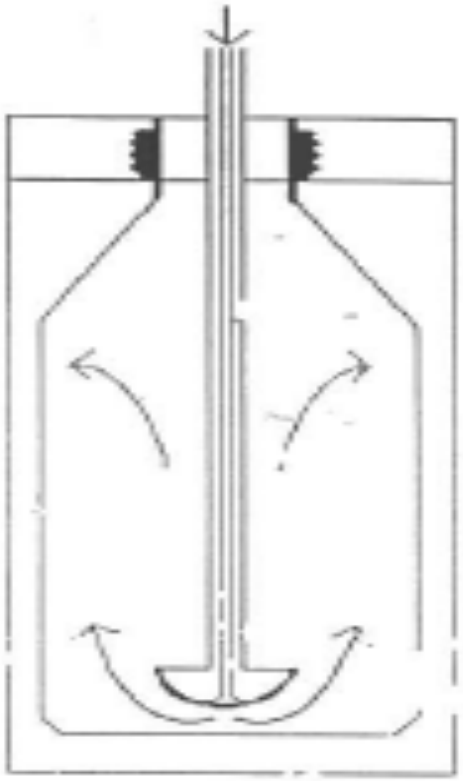
STRETCH BLOW MOULDING



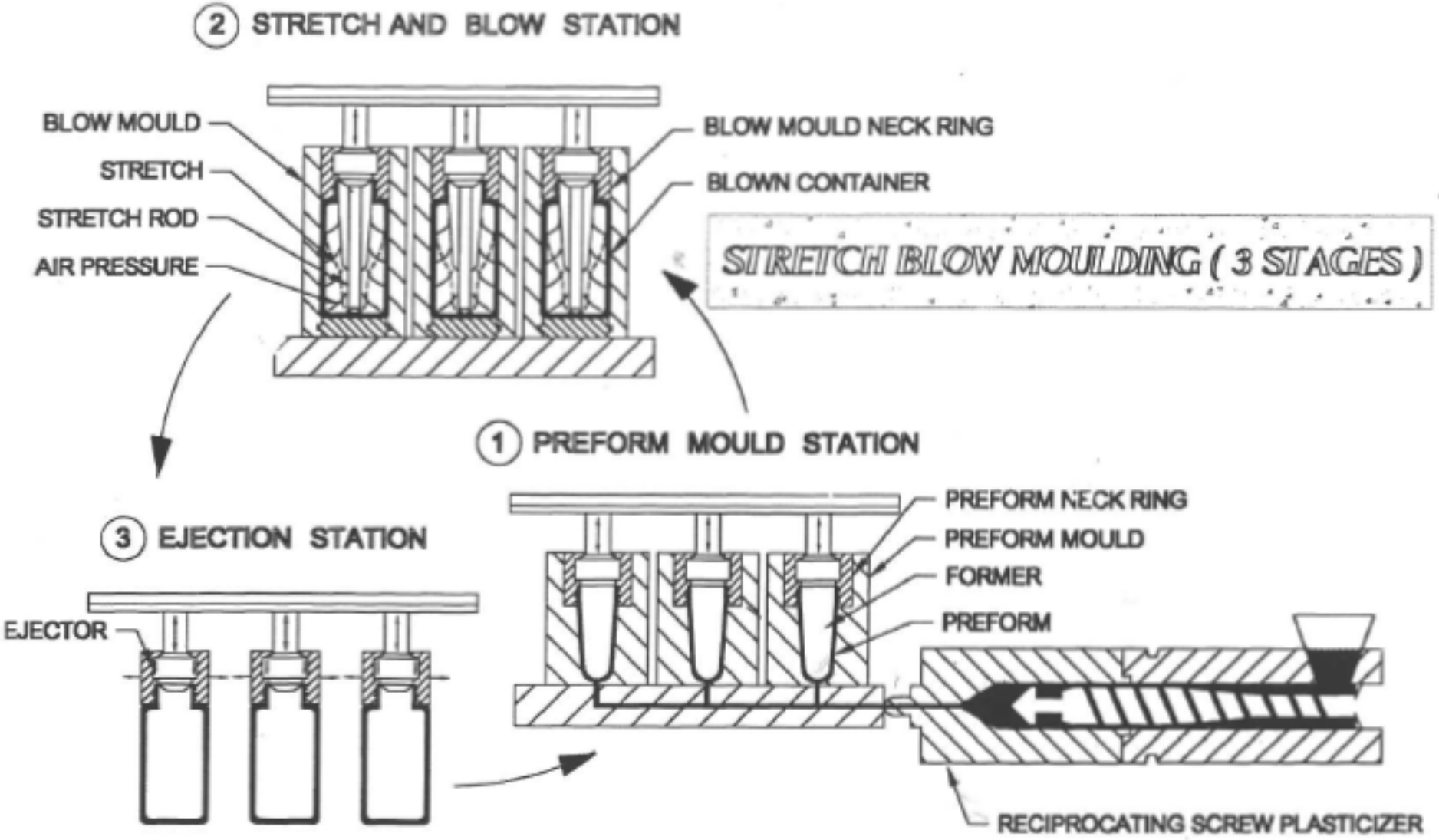
former replaced
by stretch rod

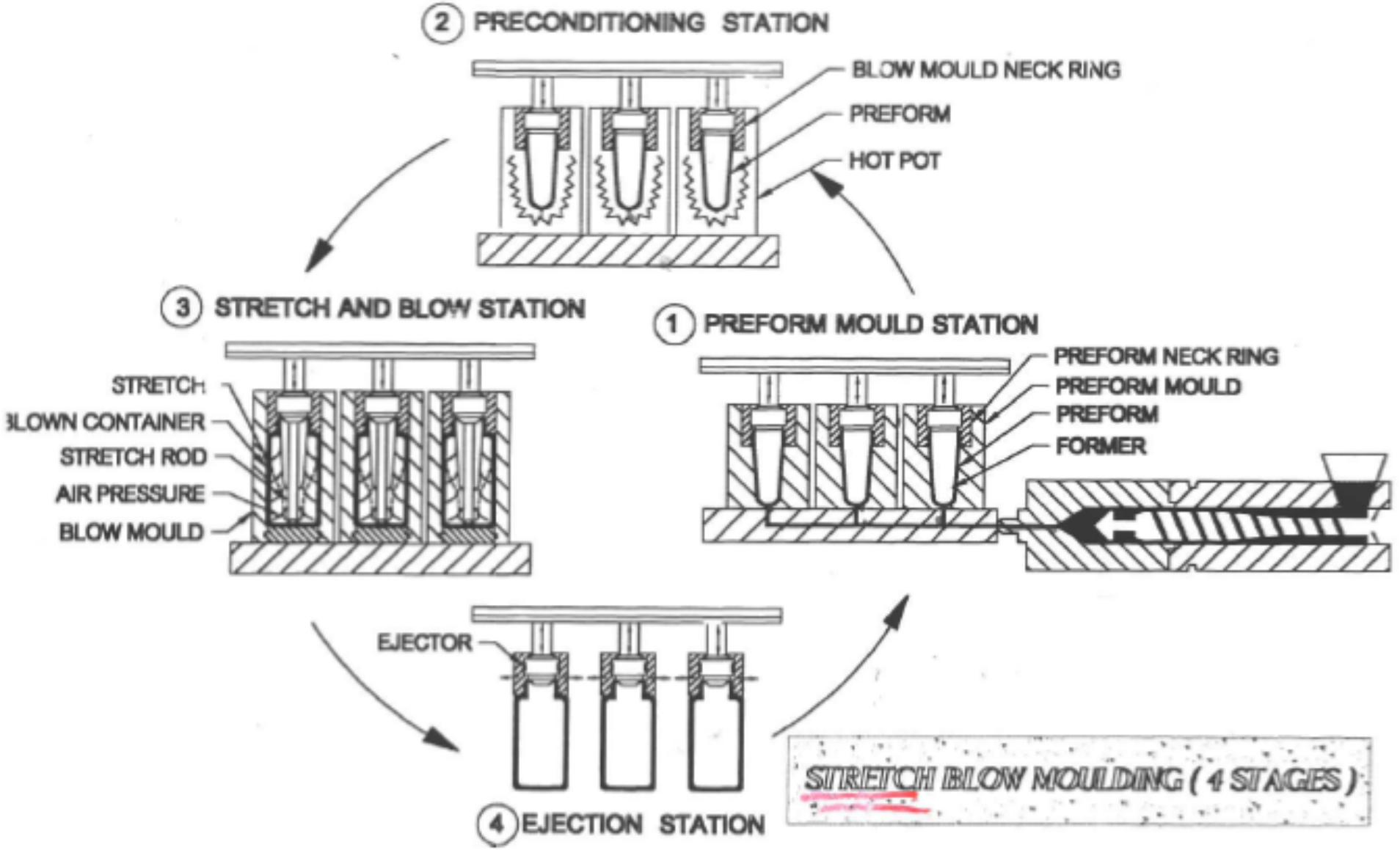


stretch rod gives
axial orientation



blowing gives
circumferential
orientation


2 STRETCH AND BLOW STATION
BLOW MOULD
STRETCH
STRETCH ROD
AIR PRESSURE
BLOW MOULD NECK RING
BLOWN CONTAINER
STRETCH BLOW MOULDING (3 STAGES)
1 PREFORM MOULD STATION
PREFORM NECK RING
PREFORM MOULD
FORMER
PREFORM
3 EJECTION STATION
EJECTOR
RECIPROCATING SCREW PLASTICIZER


2 PRECONDITIONING STATION
BLOW MOULD NECK RING
PREFORM
HOT POT
3 STRETCH AND BLOW STATION
STRETCH
BLOWN CONTAINER
STRETCH ROD
AIR PRESSURE
BLOW MOULD
1 PREFORM MOULD STATION
PREFORM NECK RING
PREFORM MOULD
PREFORM
FORMER
EJECTOR
4 EJECTION STATION
STRETCH BLOW MOULDING (4 STAGES)

Structural Foam Injection Moulding

This process involves injecting a molten polymer containing a chemical blowing agent into a cold mould. In the mould cavity, the blowing agent (usually nitrogen gas) releases gas when heated and expands to produce the foam product having a dense skin. Introduction of the gas is usually carried out by pre-blending with the polymer before injecting the polymer into the mould or by direct injection into the mould.

Structural Foam Injection Moulding

In general, this is for the case where the thickness of the product is required to increase. The structural foam injection moulding is used to increase the thickness of the product and thus the strength. The advantages of this technique:

Structural Foam Injection Moulding

- Give greater rigidity and strength (Stiffness = Es^3)
- Low pressure is required
- Give low internal stresses
- Lightweight of the product is obtained
- Give low orientation and thus shrinkage

Co-injection moulding (Sandwich moulding)

- The process involves the use of two separate injection units.
- The moulded product consists of two different layers including skin and core layers (the same materials). The core layer is usually an expandable material, the cheap material containing blowing agent whereas the skin is the expensive one

Co-injection moulding (Sandwich moulding)

The procedure is begun by:

- **Injecting a skin layer in the form of annular ring.**
- **Shortly afterwards the core layer is injected into the skin layer, the skin layer being still injected.**
- **As required shot size achieved, the core injection unit is stopped and the skin unit runs for a moment before being shut off. By this time, the expansion of the core skin will take place to fill the mould and finally the moulding is ejected.**

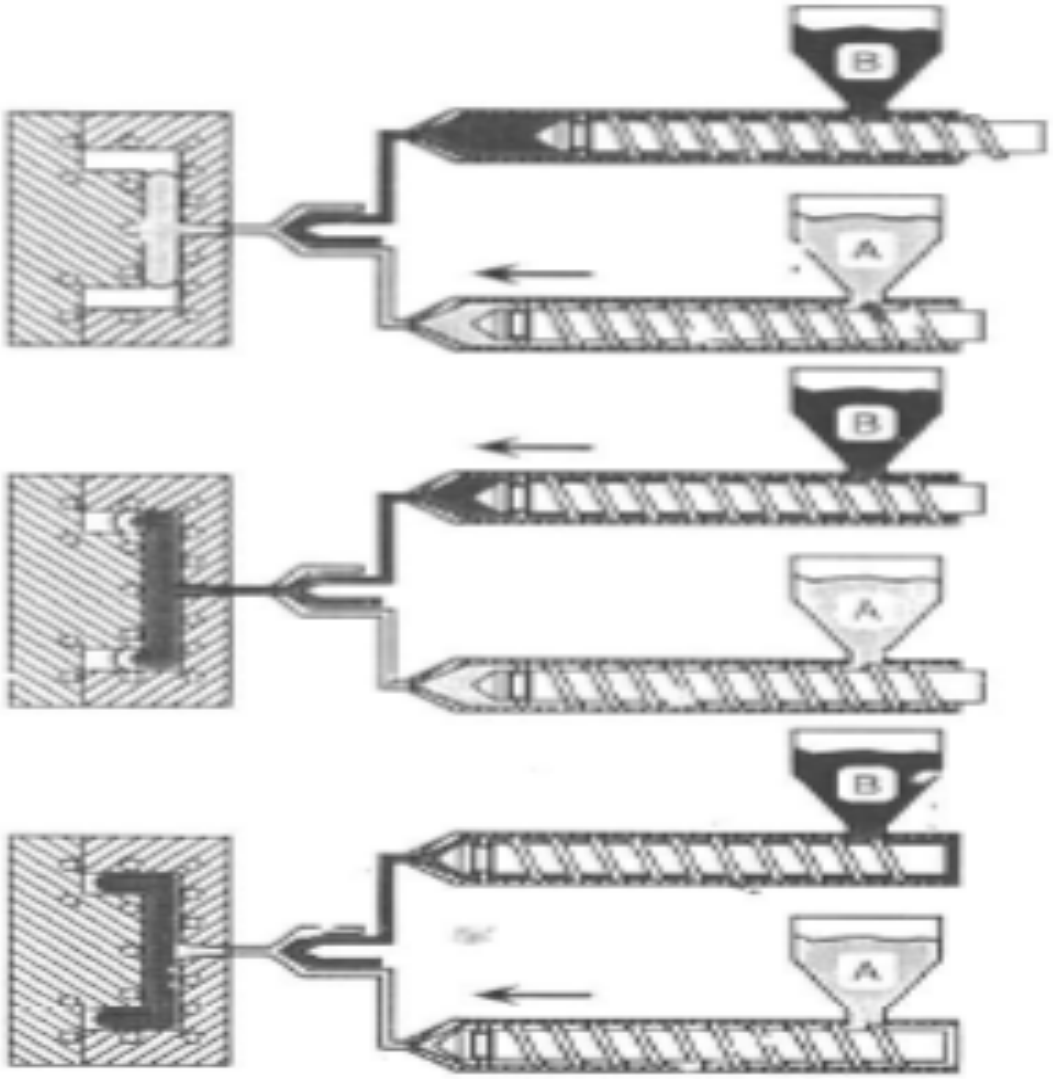


Figure 1.3: Principal of mould filling (A,B,A) with t..e Ba:tenfeld system

Co-injection moulding (Sandwich moulding)

- This technique reduces the material costs and weight. The principle of the co-injection process is very useful when making foamed polymer products.

Gas assisted injection moulding

General descriptions

- **This is relatively a new modification of the conventional injection moulding process.**
- **The gas injection moulding can produce a moulding with less internal stress and warpage because lower pressure is involved.**
- **The weight and cycle processing time are also reduced.**

Gas assisted injection moulding

Basic operation of the gas assisted injection moulding is as follows:

i) 1st melt filling: A short shot of molten polymer is injected into a mould, in which a channel of inert gas (usually nitrogen) is provided.

ii) 2nd melt filling: Shortly afterwards, the nitrogen compressed gas is injected to penetrate.

Gas assisted injection moulding

iii) Melt packing: After mould filling is completed, higher pressure of the gas is provided in order to pack, the gas pressure also being maintained for a compensation for shrinkage.

iv) Demoulding: The gas is then released from the moulding either by ventilation pin or sprue breakaway before the moulding is ejected.

Gas assisted injection moulding

Typical examples of products manufactured from the gas assisted injection moulding process include:

- **keyboard and television enclosures**
- **Electrical panels**
- **Tubes**
- **Handles**

Injection Moulding of Thermosets

Partially polymerised polymer granules, containing necessary additives, are injected into a hot mould where the polymer cures and the moulding is produced. The melt flows slowly in the barrel and cures quickly in the mould.

General aspects

- Screw has constant depth over its length
- No check valve is required.
- Barrel is warm, not hot and below curing temperature.

Injection Moulding of Thermosets

- Mould is hot for curing the polymer.
- High energy input is required due to high viscosity of the thermosetting material.
- Wastes are very difficult to be reused and recycled.

Exampling materials to be injected include: phenol-formaldehyde, unsaturated polyester, dough-moulding compound (DMC) and rubber rubber compounds.

General Strategies In Injection Moulding

1. Cleaning an injection moulding machine
   - Back pressure: short residence time, low η polymers preferred
   - Purging process: long residence time, high η polymers preferred
2. Changing polymers: Use of purging process
   - From lower η to higher η
   - From higher Tg & Tm to lower Tg & Tm
   - From lighter to darker colour
   - From less to greater thermal-sensitive polymers

General Strategies In Injection Moulding

3.Changing machinery parts

- **Nozzle**
- **Screw**
- **Heaters**
- **Mould**

4. **Setting processing conditions**

- **Injection speed and hydraulic pressure: complicated by various injection speeds for each zone of the barrel (very fast-slow-fast)**
- **Hold-on pressure: slightly less than the hydraulic pressure to prevent overpacking.**

General Strategies In Injection Moulding

- Injection shot size: just for sufficient filling
- Barrel and nozzle temperature profiles: Increasing by 10oC from hopper to nozzle
- Mould temperature
- Clamping pressure: approximately 20% higher than injection pressure

5. Start-up

General Strategies In Injection Moulding

6. Shutdown
   - Very much depending on the stabilities of the polymer used.
   - Methods: purging, cooling, lowering the temperature to below Tg or Tm and turning off
   - Short shutdown
   - Long shutdown
7. Safety

Avoidable Troubleshooting In Injection Moulding

- Undesirable appearances on moulding
- Blister
- Flashing
- Voids and sink marks
- Non-fill (short shot)
- Jetting
- Freeze-off nozzle
- Drooling at the nozzle
- Wear in screw and barrel