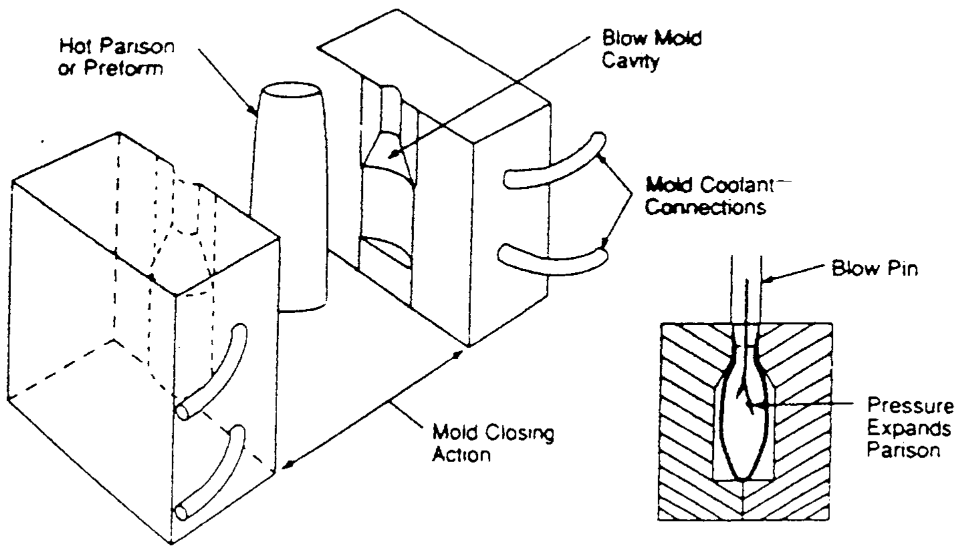
Blow Moulding

BLOW MOULDING

Blow moulding is a process used to produce hollow objects from thermoplastic.

The basic blow moulding process has two fundamental phases. First, a parison (or a preform) of hot plastic resin in a somewhat tubular shape is created. Second, compressed air is used to expand the hot preform and press it against mould cavities. The pressure is held until the plastic cools.

Basic Blow Moulding Process



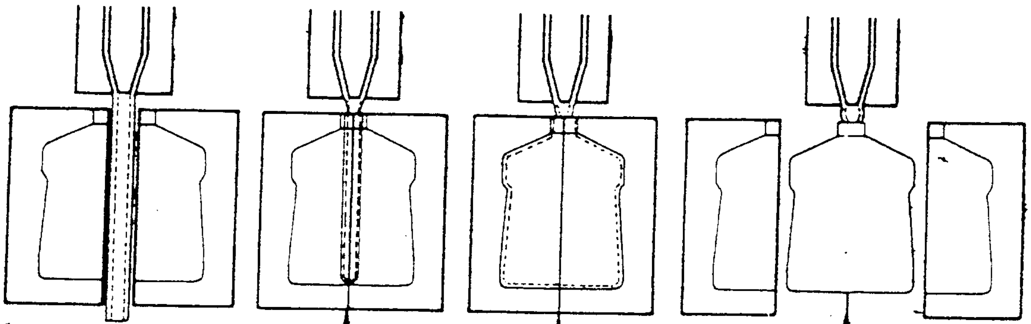
Extrusion Blow Moulding

1. Continuous Parison Type

   This is the simplest and most common type of blow moulding. A hollow tube called parison is continuously extruded from an annular die. When the desired length of the parison is reached, the mould closes around the parison. The parison is cut above the mould and the mould is transferred to a separate station where the parison is blown by compressed air, cooled and finally the article is ejected out of the mould.

2. Intermittent Type

   The parison is extruded between the two halves of the open mould. When the desired length of the parison is reached, the mould closes around the parison. Compressed air is blown through a bore in the mandrel. At the same time, the article is externally cooled by water circulating in the mould. The article is then ejected by compressed air or metal stripper.



1 Hollow parison is formed from extrusion through die to desired length for mould.

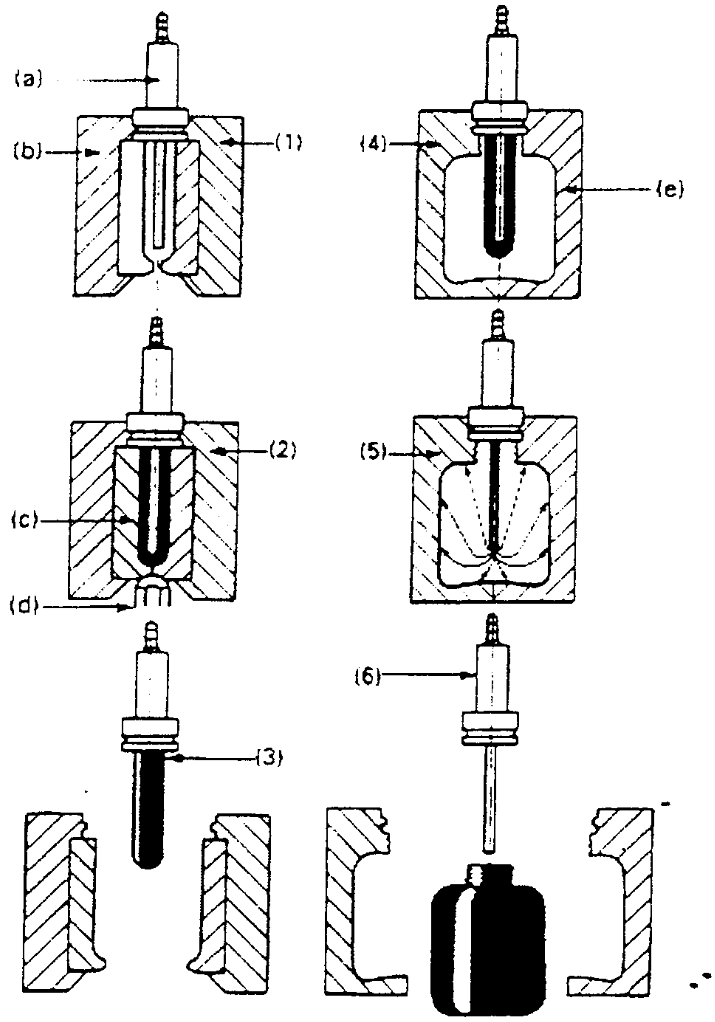
2 Mould closes on parison pinching bottom closed.

3 Parison is inflated by air pressure to force it against the mould surface to form bottle shape.

4 Mould opens after a cooling stage and finished part is ejected.

Injection Blow Moulding

In this process a parison is injection moulded directly on to a blow stick. The blow stick is then transferred with the molten parison, to the blowing cavity. The parison is blown to the shape of the cavity by compressed air which is passed through the blowing stick.

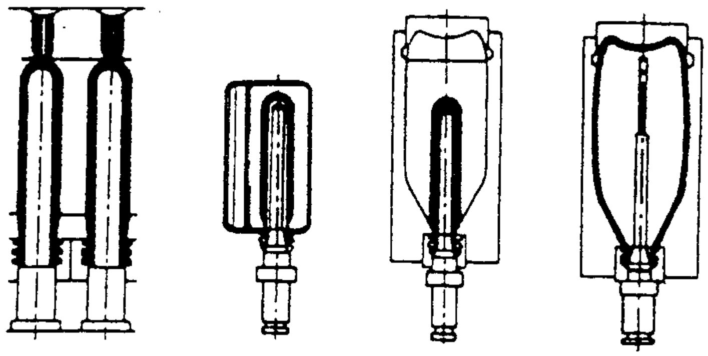


Injection blow moulding. 1, injection mould (b) containing transferable blowstick (a); 2, material injection via hot nozzle or runner (d) to form molten parison (c); 3, mould opens - blowstick removed with hot parison; 4, blowstick placed in blowing cavit (e); 5, air blown through holes in blowstick inflates parison; 6, blowing cavity opens - moulding removed.

Stretch Blow Moulding

Injection Stretch Blow Moulding

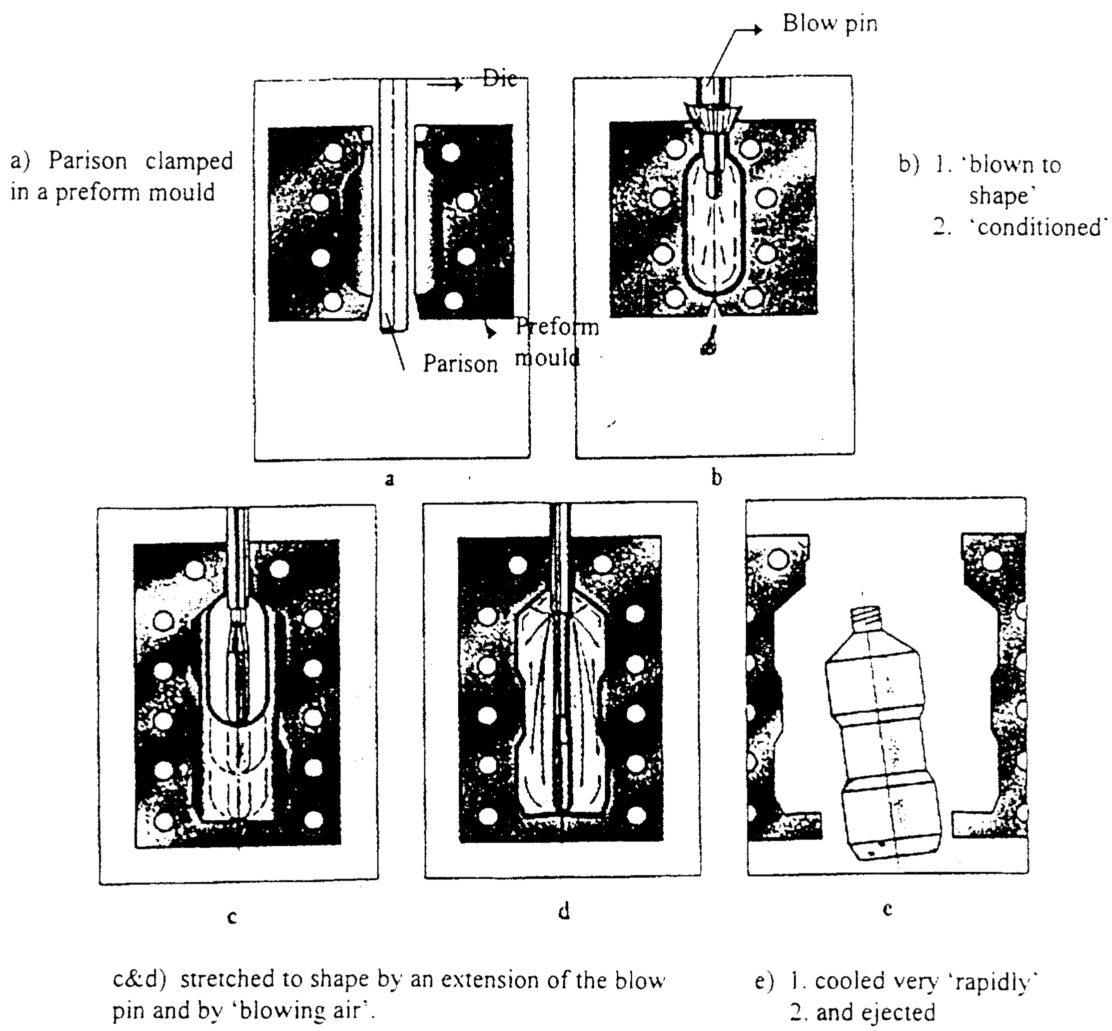
In this process, the first stage is to produce an Injection Moulded Preform. The preforms are then fed to a reheating device where it is heated to the thermoplastic temperature range. The reheated preforms are transferred into the blowing cavity where biaxial orientation of preform to the shape of mould takes place.



Injection stretch-blow moulding process sequence.
a) Multiple injection moulding of preform
b) Reheating stage c) Axial extension with telescopic mandrel (d) Blow moulding

Extrusion Stretch Blow Moulding

In extrusion stretch blow moulding, the free extruded hot parison is blown to a predetermined shape in a first station blow mould. This shape is then transferred to a second station blow mould where the final biaxially oriented container is produced.



Polymers used for Blow Moulding Process

Polyethylene
- Low Density Polyethylene
- Linear Low Density Polyethylene
- High Density Polyethylene
- High Molecular Weight, High Density Polyethylene

Polypropylene
- Homopolymer
- Random Copolymer
- Impact Copolymer

Polyvinyl Chloride

Polyethylene Terephthalate

Polycarbonate

Requirements for Blow Moulding Materials

From a processing technology standpoint, all materials with melts that have the following properties are suitable for blow moulding applications :

- Sufficient thermal stability for the processing temperature range and, if necessary, for repeated processing
- Sufficient flowability of the homogenous, plasticated melt.
- Sufficient stretchability of the tube (parison) even at high stretching speeds.
- Excellent repeatability of parison weight and length
- A smooth parison surface.
- Compatibility with additives such as masterbatches, pigments etc.
- A sufficiently wide processing range for the required finished part properties.
- Excellent lot to lot consistency.

Process Based Requirements for Material Suitability

Extrusion blow moulding

The various melt streams formed in the flow channels must be capable of reuniting into a consistent parison. The vertically hanging extruded parison must have sufficient melt strength to allow time for the mould to close. Good welding in the pinchoff area of the blow mould is important.

Injection blow moulding / Stretch blow moulding

Because the parison is supported on a core in this process. It is possible to use materials with a melt strength that would be too low for extrusion blow moulding. Multiple cavity moulds, often with hot runners, dictate that a material with easy flow and low adhesion to the core be utilized.

Coextrusion blow moulding

Low melt strength materials may be used if they are supported on a strong structural layer. The performance of the structural layer is typically put on a cost basis.

End Use Criteria for Material Selection

In addition to the general technological requirements, the requirements of specialized end uses must be taken into account. There are as many of these as there are applications, but some of the more common include :-

- Chemical resistance
- Permeation characteristics
- Environmental stress crack resistance (ESCR)
- Mechanical properties (eg. cold impact resistance)
- Physiological properties (eg. for food applications)
- Optical properties
- Weather resistance
- Long-term properties

Selection of Material for Packaging Application

Following requirements should be complied while selecting a raw material for both moulding products used for packaging applications

- Stiffness under load
- Dimensional stability at high filling temperatures
- Good surface quality
- Good printability
- Good drop impact resistance even at low temperature

End Use Applications of Polypropylene Blow Moulded Products

- Cosmetic bottles
- Shampoo bottles

- Mineral water bottles
- Oil bottles
- Feeding bottles
- Containers for pain balms and linaments
- Pharmaceutical bottles
- Tablet containers
- Mouth wash bottles
- Antiseptic liquid bottles
- Chemical containers
- Containers for harsh liquid cleansers
- Barrier bottles (one layer)

PROPERTIES OF REPOL BLOW MOULDING GRADES

Property	**ASTM test method**	**H020EG**	**R019MZ**	**C015EG**
Type		Homopolymer	Random copolymer	High impact copolymer
MFI (g/10min)	D 1238	2.0	1.9	1.5
Tensile yield strength (MPa)	D 638	34.0	27.0	26.5
Elongation at yield (%)	D 638	10.0	10.0	7.0
Flexural modulus (1% secant) at 1.3mm/min MPa	D 790	1350	1025	1280
Notched izod impact strength at 23°C (J/m)	D 256	40	80	265
Notched izod impact strength at -18°C	D 256	-	26	85
Heat deflection temp. at 455 kPa (°C)	D 648	104	84	88

Properties determined on ASTM D638 Type I specimen injection moulded and tested in accordance with ASTM D4101

WHY POLYPROPYLENE FOR BLOW MOULDING ?

Polypropylene offers following distinct advantages over other polymers due to which it is becoming popular with processors and end-users

- Very low density
- High stiffness
- High surface hardness
- Very good chemical resistance
- Contact clarity and gloss
- Good resistance to high temperatures
- Very low water absorption and transmission
- Very good processing
- Very good toughness at low temperatures when alloyed with elastomers

As compared to homopolymers, random copolymers have more clarity and impact resistance, both strong advantages for blow moulding product.

PROCESSING POLYPROPYLENE

Polypropylene presents no extreme difficulties for processors. Certain guidelines need to be followed for ease in processing

(I) Screw and Barrel Design

Generally screws used for polyethylenes are widely used for processing polypropylenes. But ideally a screw with depth compression ratio of about 3.5:1 is recommended. The L/D ratio should be minimum of 20. Higher the ratio, better the homogeneity.

(II) Processing Temperatures

Polypropylene can be processed at temperature settings of about 170-190°C at feed throat and gradually increased in steps to about 200-205°C at the die. The melt temperature should be between 180 and 240°C

(III) Tooling for Polypropylene

Polypropylene exhibits 70% of the die swell of HDPE hence it is recommended to tailor the die ring / mandrel design to suit the product for processing of polypropylene. Highly polished tooling will give better parison surface.

(IV) Moulds

(i) Finish : Highly moulds may be used with polypropylene to accentuate its glossy appearance

(ii) Venting : For effective mould venting it is recommended that radial polishing of the mould cavity using 360 grit paste be done and to allow air to escape upto parting line

(iii) Pinch off design : Generally pinch-off for polypropylene are sharper than that used for HDPE or PVC. A pinch-off land of about 1.2 mm is recommended for PP as compared to 2.4 mm for PE & PVC. It is recommended to use steel or beryllium-copper alloy inserts for pinch-off inserts when making moulds for PP as likely chances of wear-out are posed due to sharper pinch-off.

(iv) Mould cooling : Mould cooling should be very effective and uniform for polypropylene to get faster cycles and better clarity since PP has lower thermal conductivity.

(V) Deflashing

Polypropylene bottles should be deflashed immediately after moulding otherwise it will give problems in deflashing due to stiffness and good flexural properties. When using automatic deflashing as done with I.V.Fluid bottles punching off the pinch flashes is recommended than deflashing by pulling cylinders to obtain sharp cut

(VI) Parison Transfer

When using extrusion blow moulding for polypropylene, hot wire cutter is required for PP processing before parison transfer to blowing station to obtain a sharp cut.

RESIN PROPERTIES

For blow moulding applications, polypropylene with MFI between 1 to 3 g/10min are used resin upto 6.5% ethylene copolymer exhibit more clarity and impact stiffness than homopolymer

Additives

- Polypropylenes need a moderate level of antioxidant for better thermal stability and colour stability
- Lubricants may be added for better mould release
- Nucleating agents may be added to a low level to enhance stiffness and reduce cycle times
- Clarifying agents may be added to improve clarity

Shrinkage

Polypropylenes exhibit a moulding shrinkage of 1.2-2.2% which is similar to shrinkage value of HDPE 1.2-3% due to rigidity and stiffness of containers, it is difficult to eject the products from the undercuts which may be stripped off in case of HDPE

BASIC FEATURES OF A TYPICAL MOULD