Polymer Processing 3

Thermoforming and Summary

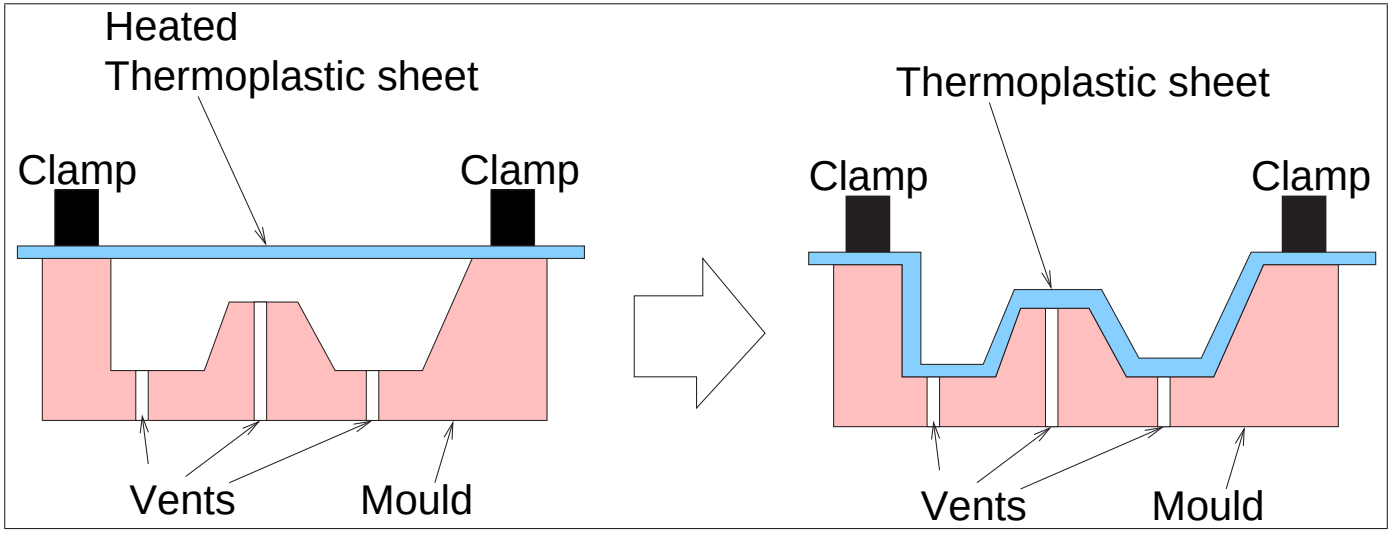
Vacuum Forming

Dates back to 1950s.

Relatively simple technique:

1. Thermoplastic sheet is clamped over a negative mould
2. Sheet is softened by heating
3. Vacuum is drawn within mould through vents
4. Sheet is drawn into contact with mould and allowed to cool

Once the sheet is cooled it can be removed from the mould.



Vacuum Forming

Disadvantages:

- Wall thickness varies
- Need to do a lot of finishing work $\Rightarrow$ waste (time and material)
- Polymer is heated twice (once to make sheet, second time to mould sheet)
- Limited range of shapes available
- Detail not great due to low pressure differential

However, the process is not without its uses...
Advantages/Applications:

- Technique is simple and has low capital cost
- Suitable for large formings
- Widely used for thin walled packaging (e.g. for sandwiches, electronics, blister-packs).
- Useful for short-runs or prototypes

Vacuum Forming

This is potentially a **very** simple technique, and can be implemented at little cost, even by hobbyists:

`http://www.studiocreations.com/stormtrooper/main.shtml`

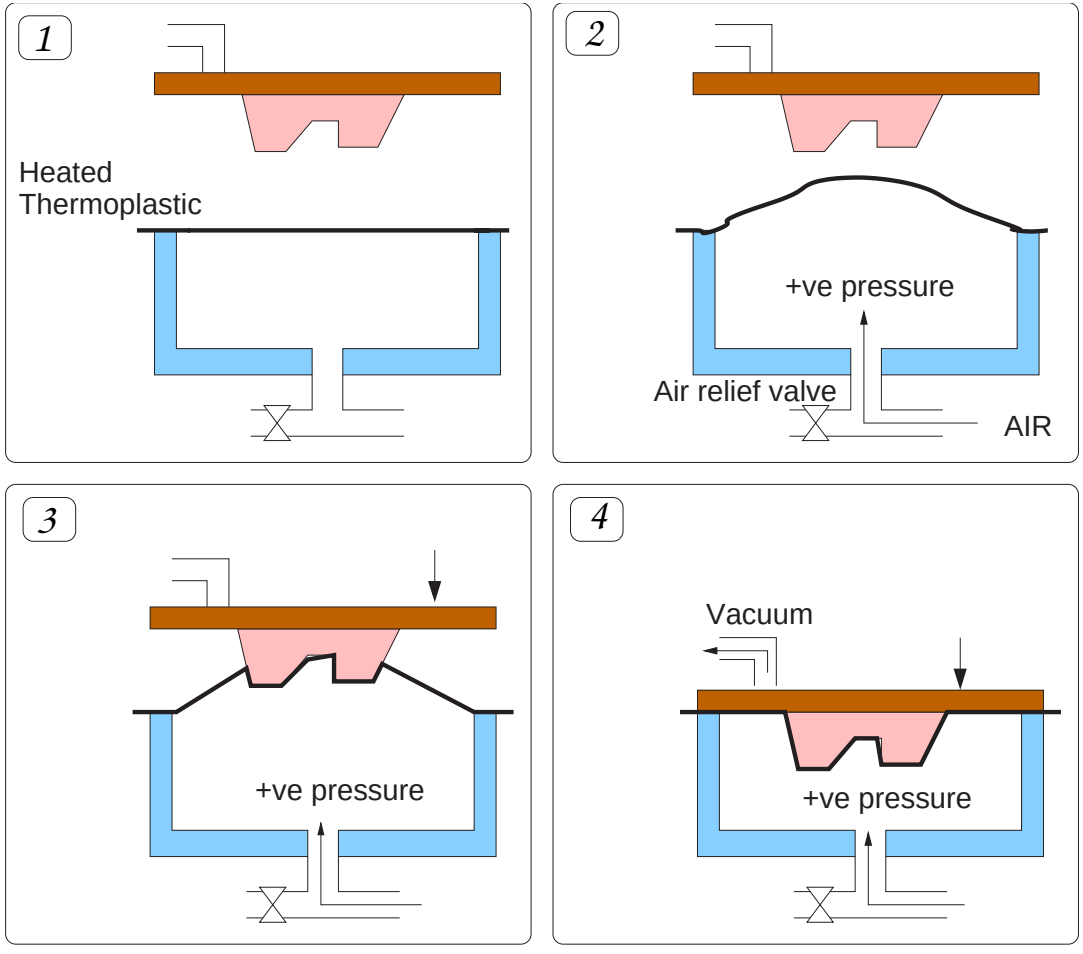
Vacuum Forming

Some notes

- Tool/mould can be negative or positive (see previous slides). Negative gives good external detail, positive give good internal detail.
- Tool can be made of wood, metal, plaster or epoxy.
- Vacuum gives pressure differential of about 1 atm. Can add positive pressure on other side for total differential of up to 10 atm. Better output but costs increase.
- Sheet material needs to have reasonable form stability when heated $\Rightarrow$ needs to have a fairly high relative molecular mass. E.g. Polystyrene, Acrylics, PVC, Polypropylene
- *Pre-stretch* can be employed to give better distribution of material in wall and to produce deeper formings. E.g. Vacuum bubble snap back technique.

Vacuum Forming

Vacuum Bubble Snap Back Technique



Blow Moulding

This technique is used to make simple parts like plastic bottles in very high volumes at very low cost.
Procedure begins with a **parison** which is a plastic cylinder.

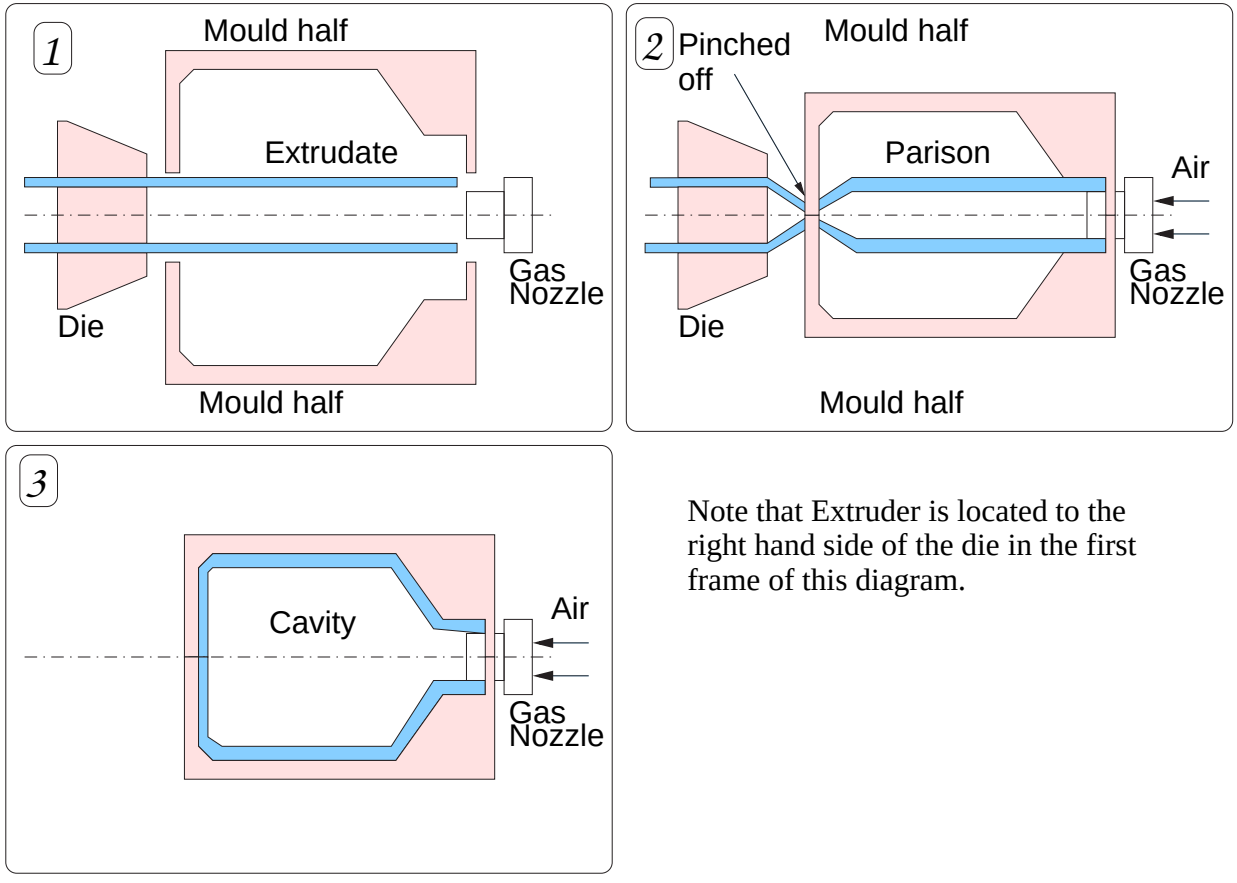
1. This is closed at one end,
2. it is softened with heat
3. then it is inflated while inside a mould
4. Having taken on the shape of the mould the part cools and is removed.

Two types of blow moulding will be mentioned here:

- Extrusion Blow moulding
- Injection Blow moulding

Blow Moulding

Extrusion Blow Moulding

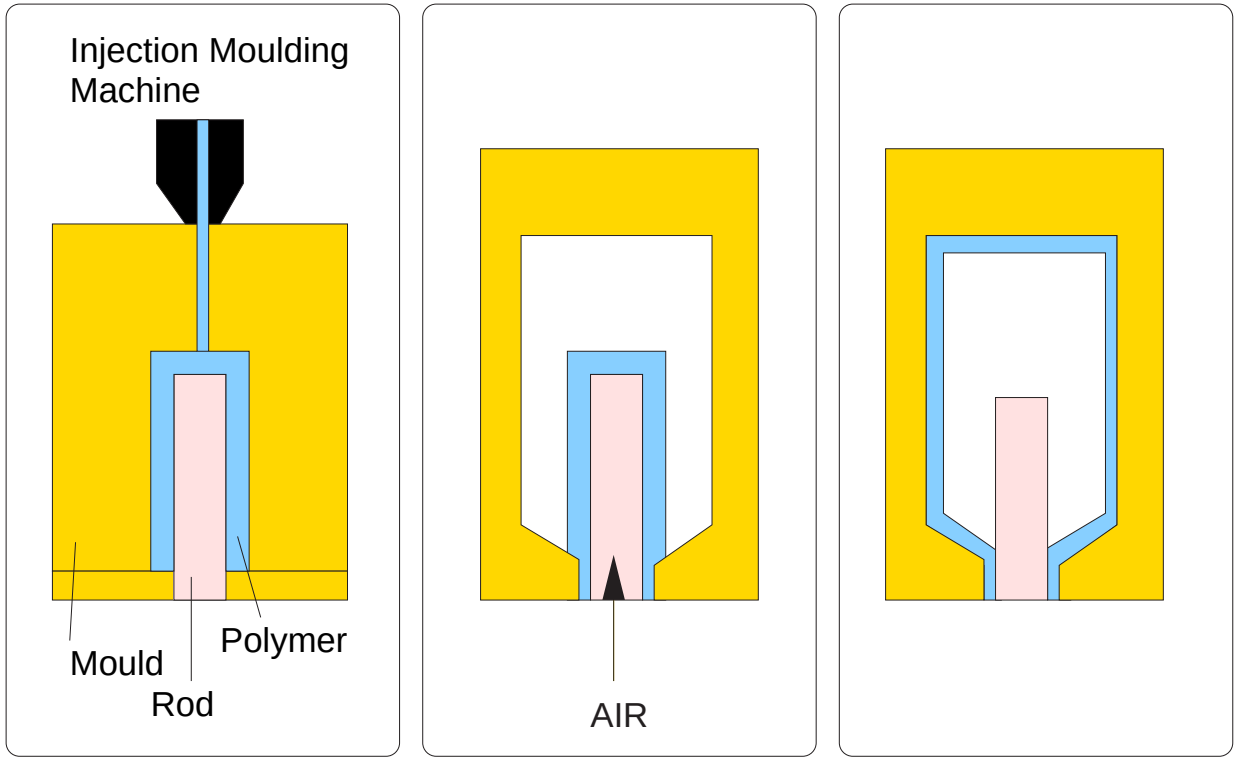


Note that Extruder is located to the right hand side of the die in the first frame of this diagram.

Blow Moulding

Injection Blow Moulding

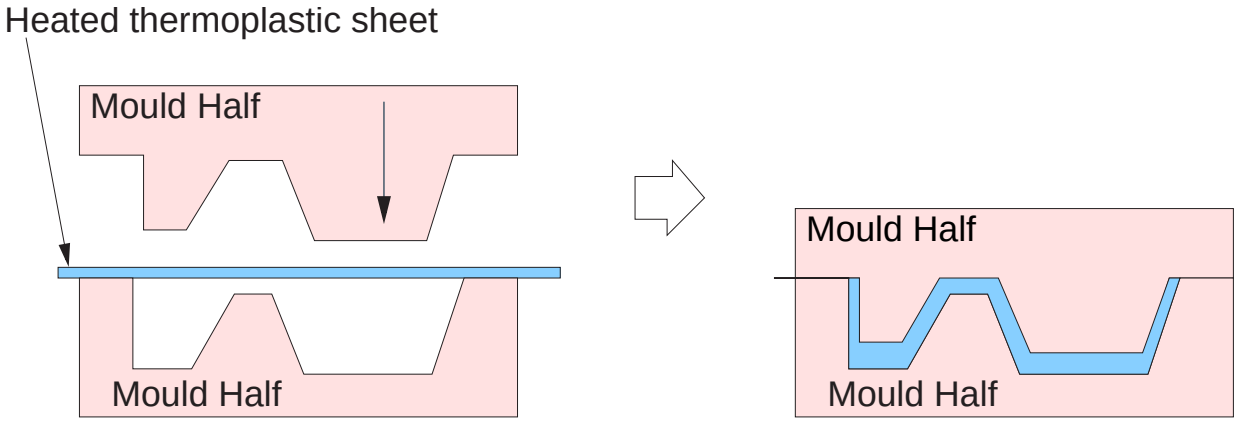
Parison is injection moulded onto a steel rod. Rod and Parison are then inserted in to a mould. The parison is inflated and takes up shape of the mould. Finally completed part can be ejected.



Other Thermoforming

Thermoforming with Matching Moulds

This is similar to Vac-Forming but produces more detailed and controllable product



Other Thermoforming

Compression Moulding

Used for thermosetting polymers. A metred amount of polymer is placed in the mould cavity. Two halves are closed (like in matching mould setup). Mould is then heated allowing the thermoset to cure. Advantages:

- Polymer flows short distances, reducing frozen in stresses
- No gates $\Rightarrow$ less likely to have weakspots
- Moulds are cheaper to make and maintain
- No need to design sprue and runner layout