Processing
Injection Moulding

Machine Design

Screw injection moulding machines with single-flighted, 3-zone screws are suitable for the processing of Elastollan. Because of the high shear stress, short compression-zone screws are not suitable.

The following screw design has proven successful (see Fig. 4):

The compression ratio should be around 1:2 and should not exceed 1:3. The recommended flight depths are shown in Fig. 5.

A check ring (shut-off ring) should be incorporated. Both free flow and automatic shut off nozzles are suitable, although care should be taken to ensure smooth flow through the nozzle channels. Dead spots where the melt could accumulate and become charred should be avoided.

Screw configuration (diagrammatic view)

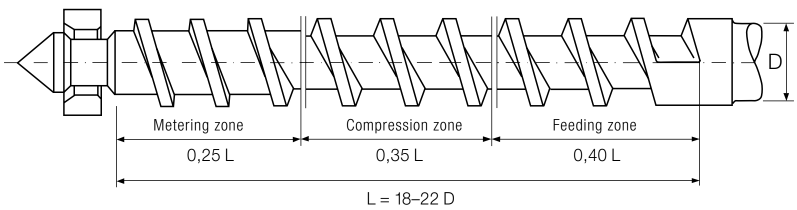


Fig. 4

Relation: screw diameter – flight depth (feeding zone)

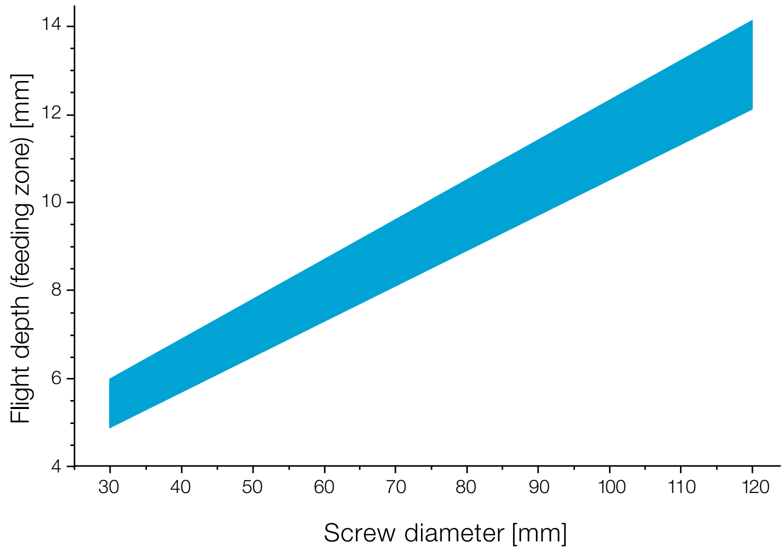


Fig. 5

Processing
Injection Moulding

Processing Parameters

To ensure trouble-free processing and consistently high quality moulded parts, precise and constant temperature control in the injection moulding cylinder is necessary.

The temperature should increase by roughly 10 to 20°C from the feeding zone to the metering zone. Nozzle temperature should be adjusted to suit the melt temperature.

Table 3 shows the recommended barrel temperatures for various ranges of hardness:

It is recommended to measure melt temperature and to adjust machine temperature controllers accordingly (see table 4).

As Elastollan melts are shear-sensitive, excessive screw speed can cause reduced product properties.

Fig. 6 shows recommended screw speeds in relation to screw diameter.

Where cycles are interrupted for longer periods, the material remaining in the cylinder will become overheated. It is therefore necessary to purge out the cylinder before resuming production.

Recommended barrel temperatures in °C

Shore hardness	Heating zone temperature	Nozzle temperature
60 A–80 A	170–210	200–210
85 A–95 A	190–220	210–225
98 A–74 D	210–230	220–240

Table 3

Recommended melt temperatures in °C

Elastollan hardness 60 Shore A to 80 Shore A	190 to 205
Elastollan hardness 85 Shore A to 95 Shore A	205 to 220
Elastollan hardness 98 Shore A to 74 Shore D	215 to 235

Table 4

Relation: max. screw speed – screw diameter

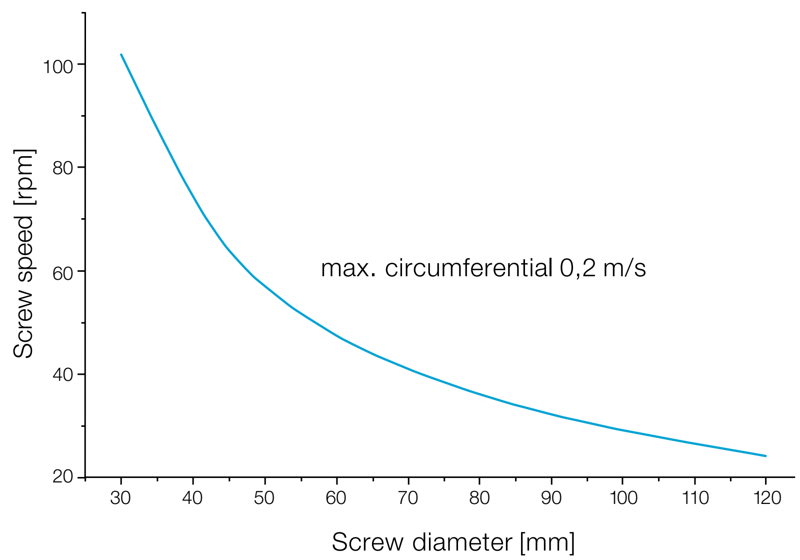


Fig. 6

Processing
Injection Moulding

Processing Parameters

Cavity pressure pattern during processing

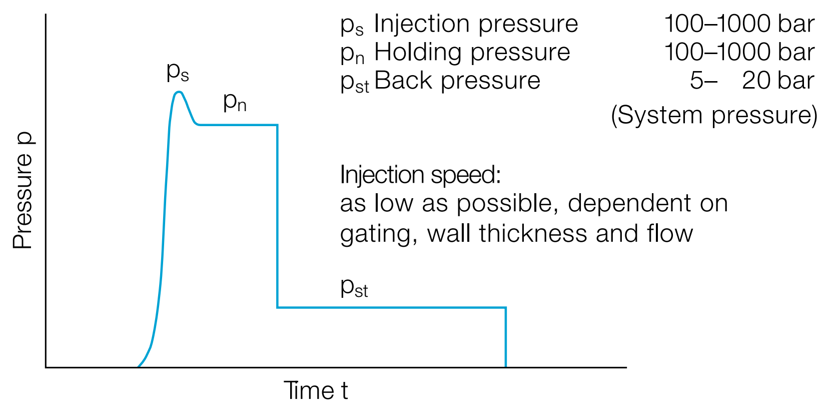


Fig. 7

The following machine parameters are especially important for the processing of Elastoflan (see Fig. 7):

Injection Pressure and Holding Pressure
These factors influence dimensional stability and ease of demoulding of the finished parts. If holding pressure is too low, sink marks may occur.
If injection pressure is too high, then demoulding is more difficult.

Back Pressure
This effects the homogenization of the melt. It should not be set too high, owing to the shear sensitivity of the material.

Injection Speed
The correct injection speed is dependent on gating, wall section and flow. It should be kept as low as possible.

A typical cycle sequence for Elastollan is illustrated in diagrammatic form in Fig. 7.

Cycle Time
The cycle time depends on crystallisation-behaviour and demoulding characteristics. Demoulding time is determined primarily by mould temperature, wall section and hardness of the material.

Fig. 8 shows cycle time in relation to wall thickness for grades of different Shore hardness.

Cycle time in relation to wall thickness

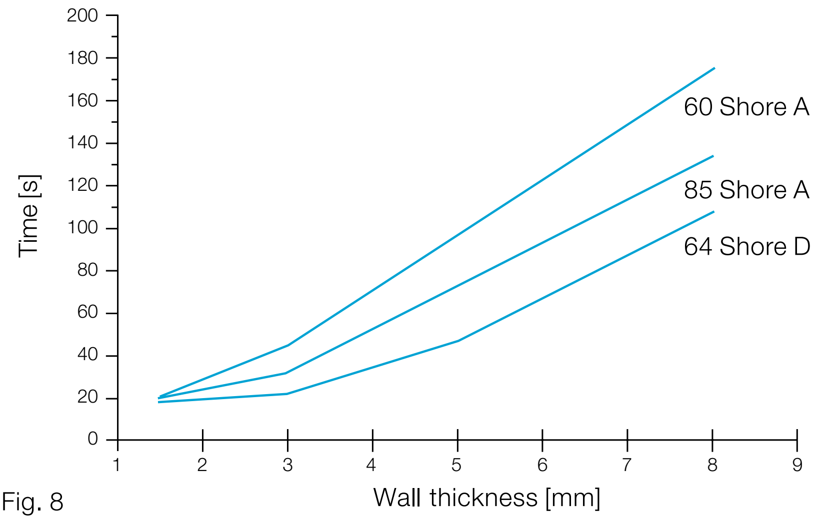


Fig. 8

Processing
Injection Moulding

Mould Design

Materials for Mould Construction
Materials commonly used for tools, like steel or steel alloys, are suitable for Elastollan mouldings. Moulds made from non-ferrous metals, mainly aluminium, are also working successfully; these cost-effective moulds are often used in footwear manufacture.

Sprues
The maximum sprue diameter should not exceed the maximum wall thickness of the moulding. The diameter of the sprue cone should be adjusted to the nozzle and exceed the nozzle diameter by 0.5 mm. The gate should be located in the area of maximum wall thickness.

Sprue cones should be as short as possible and with a minimum angle of 6°. A sprue puller is advisable for easier demoulding.

Runners
The melt properties of Elastollan require large diameter runners to avoid localized shearing and to enable the maximum pressure transfer to ensure mould filling.

For Elastollan, the best flow characteristics are achieved by using a **circular runner cross section.**

If **hot runners** are used preferably **external heated systems** should be selected. Internal heated systems are not suitable.

Multi-cavity tools need a balanced runner system.

Runner systems

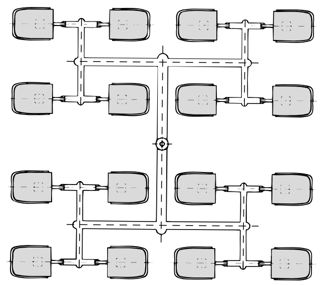


Fig. 9

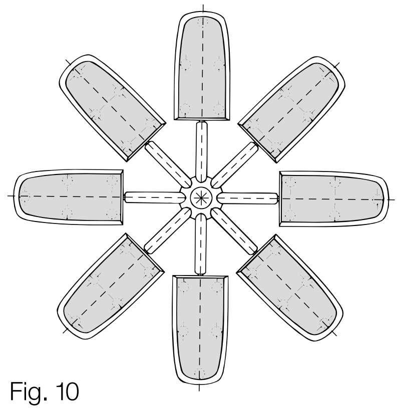


Fig. 10

Gating
Gates for the processing of Elastollan should be large, to ensure adequate holding pressure and to avoid sink marks. Critical shear rate is 25 000 s^{-1}.

Runner cross section

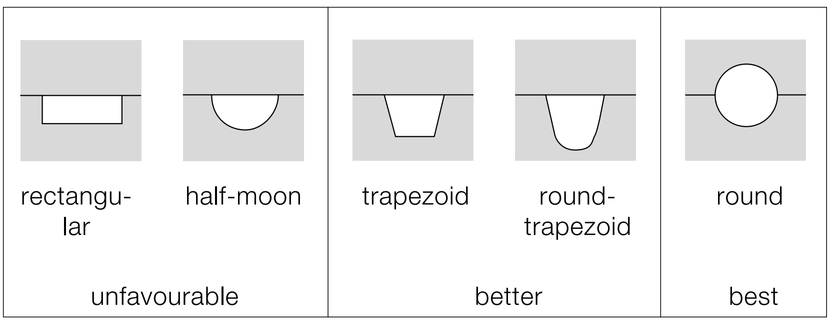


Fig. 11

Processing
Injection Moulding

Mould Design

Designs commonly used include sprue, diaphragm, ring and film gates. Small parts may also be injected through pin gates.

Submarine gates are not recommended because of the high elasticity and possible shear degradation of the material. The softer Elastollan grades are especially prone to problems with this type of gate.

Venting
Air must be able to escape easily from the mould cavities during injection of the melt, to prevent compressed air causing burn marks. Vent channels of 0.02 to 0.05 mm in depth are best located at the parting line, at inserts and at pins.

Mould Surface
To facilitate demoulding, particularly when processing the softer Elastollan grades, mould surfaces with a roughness height of approx. 25 to 35 µm are recommended.

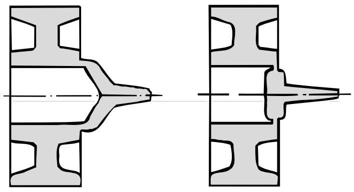
Polished and chrome-plated mould surfaces are less suitable, since, especially with the softer grades, they promote sticking of the parts to the mould surface.

Demoulding
The flexibility of Elastollan in the lower Shore hardness range allows quite large undercuts. Experience shows that short-term overstretching of less than 5% will not lead to permanent deformation.

For trouble-free demoulding, ejectors should be two to three times larger than for harder thermoplastics. They should be provided with venting channels, to prevent vacuum during demoulding.

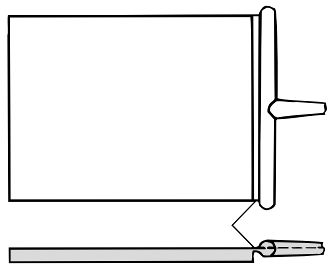
Mould Temperature Control
A good mould temperature control system is essential for production of high-quality mouldings. Mould temperature has an influence on surface quality, shrinkage and distortion.

Recommended types of gate for Elastollan



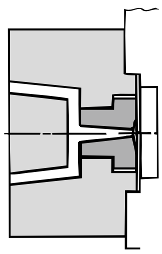
Ring gate

Fig. 12



Film gate

Fig. 13



Sprue gate

Fig. 14

Mould temperatures may vary from 15 to 70°C, depending on the Elastollan grade and type of moulding.

Possible distortion of the moulded parts can be avoided by varying the temperature in each half of the mould.

Processing
Injection Moulding

Shrinkage

The shrinkage of Elastollan mouldings is influenced by the following parameters:

- part design
- wall thickness
- gate design
- processing conditions, in particular melt temperature, injection pressure, holding pressure, mould temperature.

Total shrinkage is a result of moulding shrinkage and post-shrinkage which occurs not only during annealing, but also during longer-time storage of the parts.

For this reason it is difficult to predict shrinkage with any great accuracy.

Fig. 15 shows total shrinkage for unreinforced Elastollan grades in relation to wall thickness and Shore hardness.

Depending on glass fibre content glass fibre reinforced Elastollan grades show shrinkage of 0.05 to 0.20% in flow direction and of 0.1 to 0.5% transversal to flow direction.

Shrinkage in relation to wall thickness

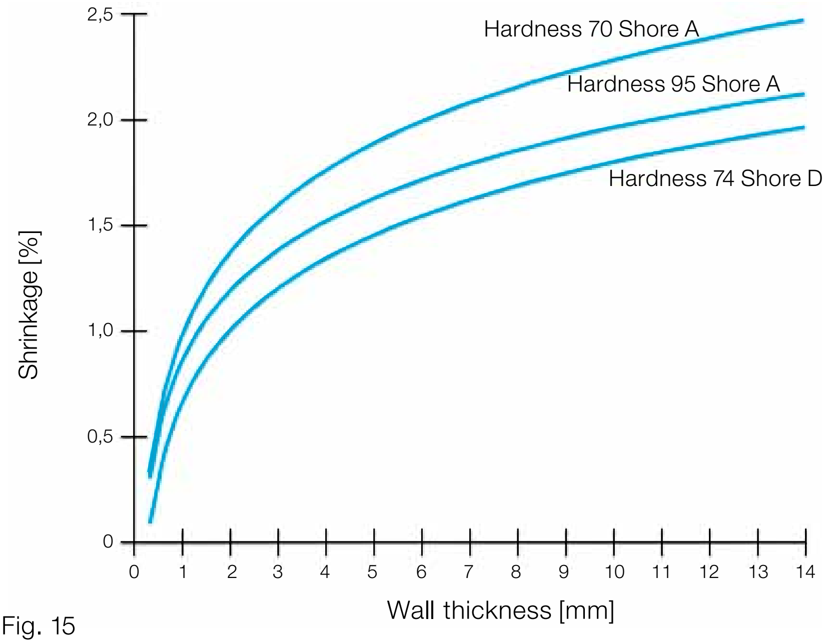


Fig. 15

Inserts

Inserts can be moulded-in without difficulty. However, for this purpose, Elastollan grades without lubricant are preferred.

Metal inserts must be free from grease, and should have features for mechanical anchorage, such as holes, undercuts, knurled grooves or notches.

Bonding may be further improved by the use of primers.

It is helpful to temper the inserts.

Processing
Injection Moulding

Special Processing Methods

Following methods are suitable to combine other thermoplastic materials with Elastollan:

Multicomponent Injection Moulding
Injection moulding of Elastollan and compatible plastic materials on multicomponent machines creates good bonding without using additives and mechanical anchorage. Polyolefin based materials are incompatible with Elastollan.

Sandwich Injection Moulding
This is a special method of multicomponent injection moulding where a core component is combined with a different plastic material as outer layer. Besides the combination of different thermoplastics it is possible to use regrind as core component and virgin grades as outer skin.

Gas Injection Moulding
It is in principle similar to sandwich moulding. Gas is injected as core component for weight reduction.

Trouble Shooting Guidelines

Trouble shooting guidelines

	Melt temperature	Mould temperature	Injection speed	Holding pressure/ time	Back pressure	Shot size/ Melt cushion	Clamping pressure	Cooling time	Venting	Moisture content	Material contamination	Gate size	Lubricant	Residence time
Contamination											▼			▼
Bubbles/Blisters	▼		▼	▲	▲				▲	▼		▲	▼	▼
Burned spots	●	●	▼						▲	▼		▲		
Distortion/Shrinkage	●	●	●	●				●				▲		
Flow lines	●	●	●						▲	▼		▲		
Gloss/Matt surface	●	●	●	●					▲	▼		▲	●	
Flashing	▼	▼	▼	●			▲			▼		▲		
Short shot	▲	▲	▲	▲		▲			▲			▲		
Sink marks	●	●	●	▲		▲			▲	▼		▲		
Splay marks	▼	●	●						▲	▼		▲	▼	▼
Demoulding	●	●		●				●		▼		▲	▲	
Material degradation	▼		▼		▼					▼		▲		▼

▲ Increase to solve problem
▼ Reduce to solve problem
● Increase or reduce to solve problems

Table 5