Spritzgiessautomaten

Innovative into the Future – BOY-Injectioneering

Elastomer processing

What is an Elastomer?

The term “elastomer” describes the material’s property of being highly mouldable already under low pressure and of springing back into its original shape when the pressure is released. Although plastic materials are also highly mouldable under low pressure, they remain moulded after pressure release.

Therefore, the term “elastomer” describes the material’s most vital property without expanding on material-specific characteristics. High elasticity can be achieved by very different materials.

In plastics technology, three essential groups are distinguished:

- chemically crosslinked elastomers
- thermoplastic elastomers
- silicones

The basic structure of all three groups consists of long molecular chains whose basic structure and side chains determine particular properties. The molecular chains are movably connected at room temperature and can slide along each other in the elastomer’s basic shape.

Chemically crosslinked Elastomers

By adding further materials and catalysts, the side chains become reactive and form (usually under the influence of heat and pressure) chemical links to the side chains of adjacent molecular chains. This process is often called vulcanisation. The chain molecules movable against each other, develop a net-shaped macromolecule that is easily mouldable but that always returns to its basic shape after load removal. Since the side chains’ chemical links cannot be resolved by heating, a vulcanised elastomer cannot be melted again. Very high temperatures result in the decomposition of the netted elastomer.

Thermoplastic Elastomers

These are thermoplastic materials which can receive elastic properties in various ways. The chain molecules moving against each other often have side chains in certain sections, which in turn build up physical bonds to the side chains of other chain molecules. These bonds hold the chain molecules in place so that they cannot slide towards each other. Another kind of thermoplastic elastomers is based on plastic blends. When heated the adhesive mechanisms (physical bonds) are dissolved and the plastic melts like a thermoplastic. The moulding of these elastomers follows the same procedure as with a thermoplastic material.

Silicones

Silicones possess the unique characteristic of having alternately silicone and oxygen in their main molecular chain instead of carbon. Due to this unique characteristic, silicone has a high temperature resistance and a low glass transition temperature. Thus it is ultraflexible over a wide temperature range. Additionally, the material is transparent in its basic form. Through a catalyst, silicones become chemically crosslinked and thus, like vulcanising elastomers, do not melt.

Hereafter, this brochure exclusively refers to chemically crosslinked, carbon-based elastomers, since the three groups of elastomers are very different in their respective processing.

Conditioning of the Material

In their basic form, the classic as well as the synthetic elastomers are plastic moulding materials which consist of organic long-chain molecules. These molecules can move towards each other, which takes place under the effect of heat and becomes easier with increasing temperature.

In order to achieve a material of high technical quality, a number of additives is added to the basic elastomer which, on the one hand, causes the chemical crosslinking of the chain molecules and on the other hand optimally adapts the elastomer's properties to its planned use. About 15 to 30 different additives are common in elastomer blends.

Typical components of a finished elastomer compound:

- vulcanisation accelerators
- aging inhibitors
- fillers
- plasticiser
- processing additives
- softening agents
- blowing agents
- further materials for achieving certain properties

The moulding compounds provided with additives are described as Elastomer-Compounds. Depending on the type of kneader (very often a roller mixer, less frequently an extruder), the elastomer-compounds are available as „bulk“, „sheet“ or as an endless belt.

For further processing, the bulks are rolled out and, as well as the sheets, are cut into strips. In this shape or as endless belt the elastomer-compounds are processed in injection moulding machines.

The different types of Elastomers

Next to natural rubber and the first synthetic rubbers mentioned above, there is a large number of different rubber materials available today. All of them have certain outstanding properties which make them uniquely suited for specific applications.

By means of the nomenclature abbreviations the structure of the material's main molecular chain is described as the central feature (see table below).

Last letter	Chem. structure of main chain	Example
R	Unsaturated carbon chain	NR, BR, CR,NBR
M	Saturated carbon chain	ACM, EPDM, FPM
O	Carbon / Oxygen chain	ECO, GPO
Q	Carbon / Silicone chain	MQ, FMQ
U	Carbon / Oxygen / Nitrogen chain	AU, EU
T	Carbon / Sulphur chain	EOT
Z	Carbon / Nitrogen / Phosphor chain	FZ, PZ

Processing

Next to the classic compression moulding and transfer pressing methods, injection moulding is used more and more frequently, particularly for complexly shaped elastomer components. Through the conditioning of the material in a plasticising cylinder the elastomer is brought to a high energy level already before moulding so that often significantly less vulcanisation time is necessary in the machine than in conventional pressing processes.

Since closed moulds are usually used in the injection process and the pressure within the cavities is regulated via the holding pressure of the injection moulding machine, injection moulded components have a significantly better dimensional consistency than components produced by compression moulding.

The mechanical properties of injection moulded elastomer components are also superior to those of compression moulded parts. This is due to the effective homogenisation of the compound in the plasticising unit and during injection in the gate system.

Although injection moulds are usually more complex and expensive than pressing moulds, one essential advantage is the simple possibility of automating the injection moulding process. The material supply as well as the demoulding is fully automated in most cases. Especially for big series of complexly shaped parts this is a decisive economic factor.

BOY injection moulding machines for elastomer processing

Due to their concept, BOY injection moulding machines are very well suited for the processing of elastomers. The injection units, which are largely dimensioned in relation to the clamp force, and the cantilevered clamping unit with dimensionally stable clamping platens provide the best conditions for elastomer-specific requirements.

BOY injection moulding machines are ideally suitable for elastomer processing

The BOY-control system is the same as the control used in thermoplastic processing. All functions necessary for the elastomer injection moulding are implemented. Additionally, a comprehensive process documentation is included in the standard scope of supply. Extensive additional functions for the automated demoulding of elastomer components are also available.

Plasticising units for elastomer processing are available for all BOY injection moulding machines.

In addition to machines with horizontal clamping units, insert moulding machines with vertical clamping units and fixed lower clamping platen are offered as well. These machines are particularly suitable for composite components such as for elastomer-metal hybrids. The following options assist the manufacturing of elastomer products:

- Evacuation by vacuum
- Brushing and spraying
- Stuffing of the elastomer mass
- Coining and ventilation functions
- Precision coining gap control

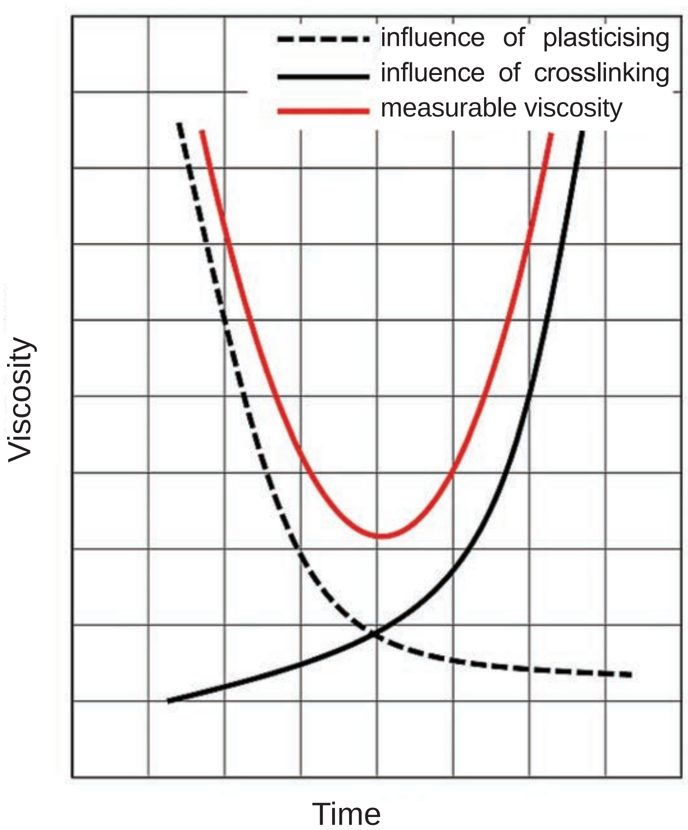
Elastomer – Injection Moulding

Unlike the processing of thermoplastics, elastomer processing is not an exclusively physical melting, moulding and cooling process. The compound is a not-yet-crosslinked basic material which only attains its elasticity and thus its dimensional stability through crosslinking.

During the injection moulding process, this chemical cross-linking reaction (vulcanisation) takes place under high temperature and pressure, transforming the plastic material into an elastic, dimensionally stable product. In the course of this reaction the viscosity of the material is substantially changed.

Due to the heating and kneading in the plasticising cylinder and the injection process as well the elastomer is fed very effectively and evenly with energy. This energy supply results in a significant decrease in viscosity. Simultaneously the energy input starts the cross-linking reaction.

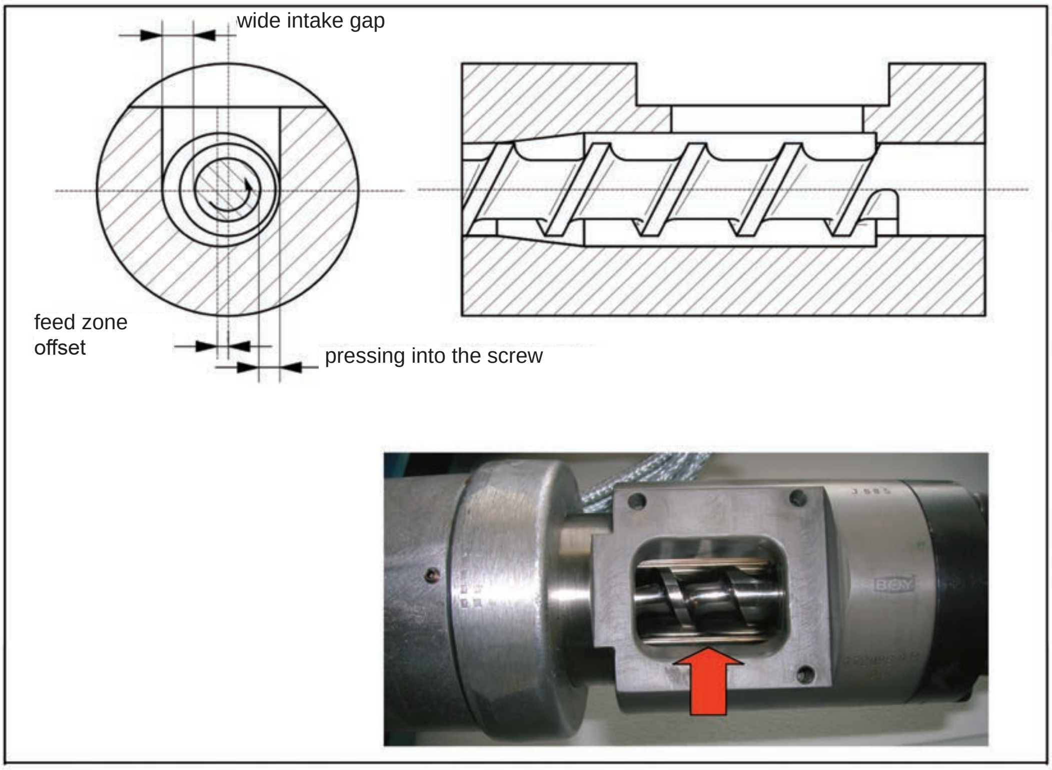
Under the high shearing-energy introduced during the injection process, the high mould temperature and the pressure, which is initially built up via the screw, but then to a greater extent via the expansion of the elastomer when heated, the chemical cross-linking reaction takes place. The viscosity increases again. The effective viscosity of the elastomer compound is the sum of the two viscosity processes.



Viscosity of the elatomer during the injection moulding process

As soon as the moulded part has reached a sufficient level of stability, it can be demoulded. It is not necessary for the vulcanisation to be entirely completed at this point. Due to the high temperature, the crosslinking reaction will also continue outside the mould.

Individual Process Steps



Feed section of the elastomer unit

Thermoregulated nozzle

Plasticising Process

The plasticising starts when the elastomer material is drawn into the plasticising unit. In order to securely draw the strip of compound into the plasticising unit, the feed zone must be of a particular geometry allowing the screw to seize the material which is usually considerably thicker than the screw channel depth. Constructionally, this is done through an eccentric widening of the feed zone on the screw's feed side.

The following list indicates the pitch depth of the feed zone for the respective screw diameter: Screw diameter / channel depth of the feed zone

- Ø 16 mm / 3.2 mm
- Ø 22 mm / 4.4 mm
- Ø 28 mm / 5.6 mm
- Ø 32 mm / 6.0 mm
- Ø 38 mm / 5.9 mm
- Ø 42 mm / 5.9 mm

With the rotation of the screw, the material is pressed into the screw channel and transported along the plasticising cylinder.

Depending on the type of elastomer, the plasticising cylinder is adjusted to a temperature between 60°C and ca. 95°C. If an extended diving nozzle is used, it is also integrated into the temperature control.

In addition to this temperature increase, the screw forms and kneads the elastomer strand, which results in additional heating of the material by friction.
In addition, the channel depth (compression zone) of the screw decreases towards the screw tip. Thereby, the flow cross-section is reduced, pressure is built-up in the transported material and the kneading process is intensified.

The screw's geometry results in a default cross-section for the material drawn in. The material strand's cross-section should thus be smaller than that of the screw channel in the feed zone of the plasticising unit, but larger than the screw channel's cross-section at the end of the screw. The following table indicates the maximum cross-section area, as well as the width and thickness of the strip material.

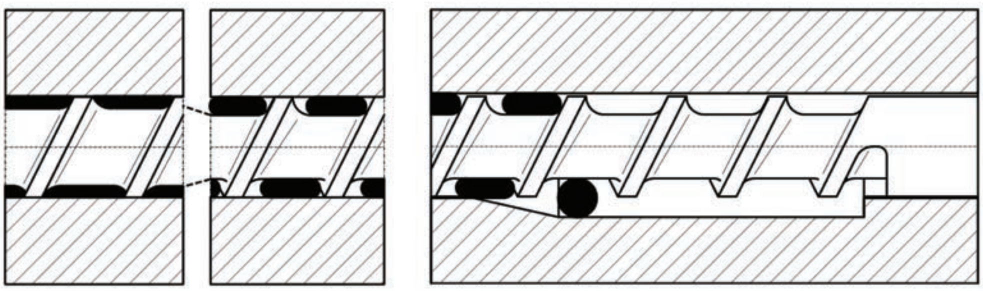
Screw-diameter	Cross-section area in mm²	Width x thick-ness in mm
16 mm	max. 51	16 x 3
22 mm	max. 96	24 x 4
28 mm	max. 156	26 x 6
32 mm	max. 192	32 x 6
38 mm	max. 226	37 x 6
42 mm	max. 237	39 x 6

The material's cross-section should be constant for the screw feeding to achieve high reproduction accuracy. Therefore, especially for small plasticising units, extruded strands are recommended. They are available as continuous belts and do not show the same cross-section fluctuations as strands cut from sheets.

The consistent strand diameter also facilitates the ventilation of the material in the plasticising unit. Due to the continuous increase of the core diameter of the screw, the air is largely pressed back towards the feed opening.

At the front of the screw the homogeneously heated and mixed elastomer compound streams through the non-return valve and flows into the antechamber of the screw. During the dosing process, the plasticising unit rests against the mould and the elastomer injected into the mould with the previous cycle seals the nozzle during the dosing process. The continuous feeding of the screw results in a high pressure in the antechamber of the screw.

Thus, the screw is continuously pressed back during the dosing process. The dosing volume for the elastomer part to be produced is measured by the return of the screw. When the set dosing volume is achieved, the screw rotation and thus the dosing process turn off. In order to reduce
the high pressure in the antechamber of the screw, the screw is pulled back by a short stroke. (Decompression)



Compression and pressure build-up in the compression zone.
Intensive mixing and energy supply

Feed zone:
the strip is pressed into the screw channel

Compression zone: decreasing channel depth of the screw

Feeding and Compression of the Elastomer Strip

After decompression, the plasticising unit can be detached from the hot injection moulding machine. This is necessary in order to prevent too much heat from flowing from the ca. 180°C hot mould into the water-thermostated plasticising unit and thus uncontrollably supplying the elastomer with energy, which could cause the cross-linking reaction to occur too early in the nozzle.

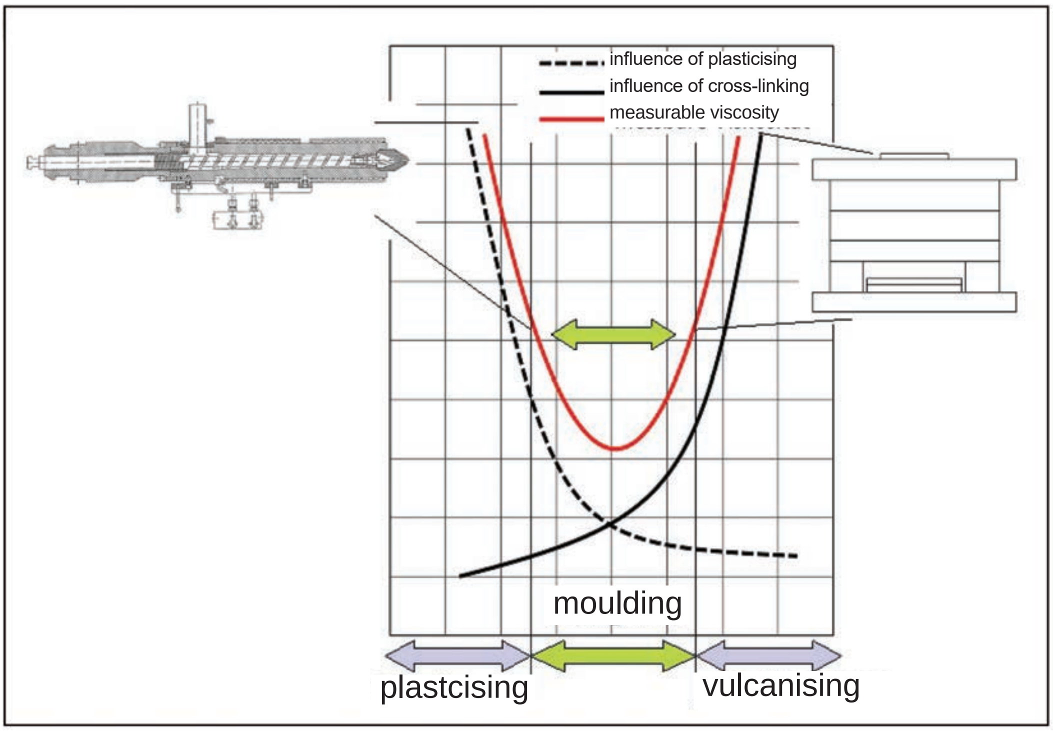
The material dosed in the plasticising cylinder is now ready for the following cycle.

Injection Process

As soon as the mould is closed and the clamping force is built up, the plasticising unit moves towards the mould's sprue bushing and the injection process is started. As an option, in order to prevent air traps, before the injection process, the cavity is evacuated using a controllable vacuum pump.

The screw is now moved forward axially. On the first millimetres of the stroke, the nonreturn valve at the screw tip closes so that the screw now works as a piston. The elastomer compound provided in the screw's antechamber is pressed into the circa 180°C hot mould through the nozzle. Inside the mould, the material flows through the gating system at high flow speed so that the elastomer compound is supplied with high frictional energy and high thermic energy during flow. Narrow flow cross-sections ensure a very continuous and effective energy supply. In this phase, the viscosity of the elastomer compound decreases very quickly and ideally reaches its minimum with the injection into the moulding cavity.

The processor can regulate the energy supply via the injection speed and the mould temperature.



Process Sequence in the Viscosity Diagram

For a good surface quality, a higher injection speed should be chosen which could, however, cause stronger edges (mostly near the gate) through the resulting higher injection pressure. The necessary injection pressure results from the chosen injection speed and is a measurement for the supplied mechanical energy.

Since air in the cavity needs to escape from the mould during injection, too high injection speeds can lead to air pockets resulting in burns on the moulded part (diesel effect). Constructional solutions within the mould should prevent the building of air pockets to a large extent.

Holding Pressure Phase

As soon as the moulding cavities are fully filled, the injection phase ends and the holding pressure phase begins. Since the elastomer is no longer flowing, the high pressure is no longer needed to overcome the flow resistance.

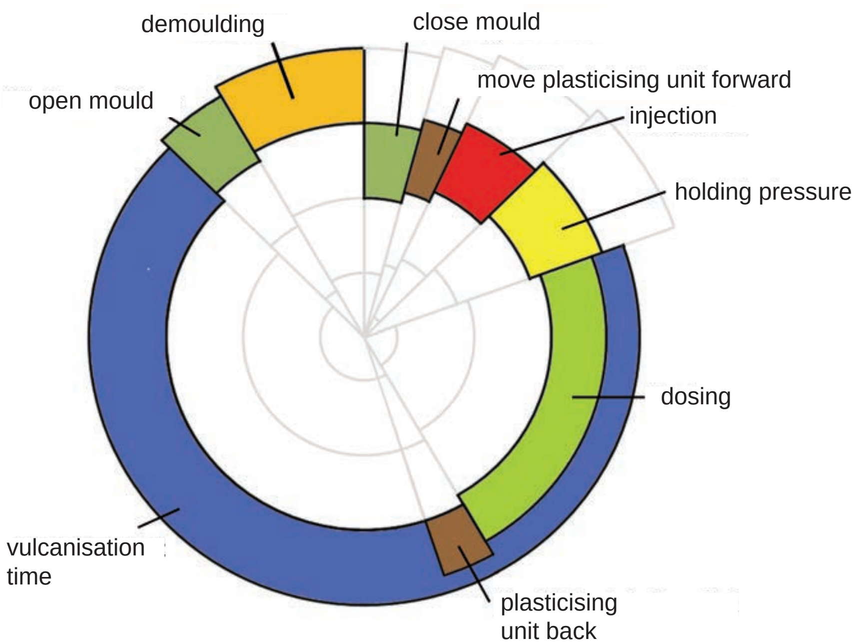
A static pressure is maintained inside the cavity so that no material can flow back into the gate system. Since the elastomer expands inside the hot mould, the machine must maintain counter-pressure. This pressure is significantly lower than the injection pressure.
The necessary holding pressure is, among other things, dependent on the wall thickness of the moulded parts and the sprue cross section.

Vulcanisation Phase

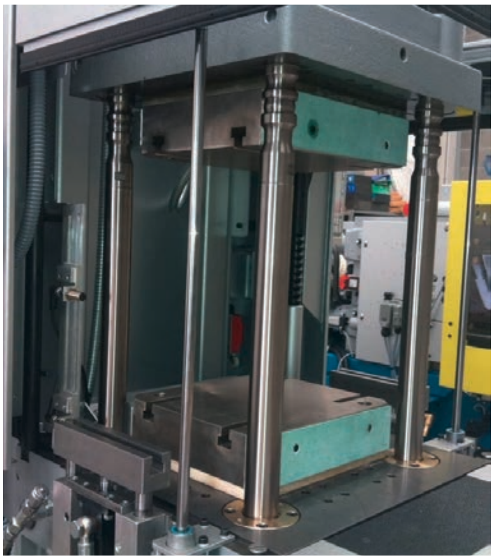
In fact, vulcanisation already starts during the plasticising, since the elastomer is already brought to a higher energy level. In terms of procedure, however, only the time after the holding pressure phase until the demoulding of the moulded part is referred to as vulcanisation time. At this point, the vulcanisation must have been progressed so far that the moulded parts can withstand the high mechanical load during demoulding. Outside the mould, the parts can fully vulcanize due to the residual heat.

Demoulding

In the injection moulding process, the demoulding should be automated in order for the process consistency to be at its highest level and for the product quality to achieve its highest consistency as well. During the demoulding, the high elasticity of the elastomer must already be taken into account during the construction of the mould. Since great undercuts are very common on elastomer moulded parts, simple ejector pins, as typically used in thermoplastic processing, are often not sufficient. Undercuts can often be demoulded without pusher due to the good elastic properties. Hydraulic ejectors, blow-out devices, brush devices or removal systems integrated in the machine control system are available for demoulding.



Schematic cycle procedure



BOY 35 E VV with heating platens (mould fixing by T-slots) and core lifting device.

Core lifter

Core lifters are used to open different mould levels during the mould opening to enable the demoulding of parts. Thus e.g. the sprue can be released in one mould level while the moulded parts are directly separated from the sprue in another mould level. With the aid of the core lifter, parts with larger undercuts can also be easily demoulded

Core lifters consist of two mechanically-synchronized hydraulic cylinders attached to the side of the moving platen. Bars with T-slots are fixed to the moving rods for assembly of mould platens. The demoulding sequence, as well as the travel paths, pressure and speed of the core lifter, are programmed in the machine control.

Brush devices

Brush devices are suitable to demould flat, soft parts. Thereby, a rotating brush roller is moved past the cavity plates at a specified pre-tension. The moulded parts hanging in the cavities are pulled out of the cavity by the rotating brush. In particular, in combination with the coining process (refer to Coining) the brush devices are often used, because not only the moulded parts but also the overflow is safely demoulded.

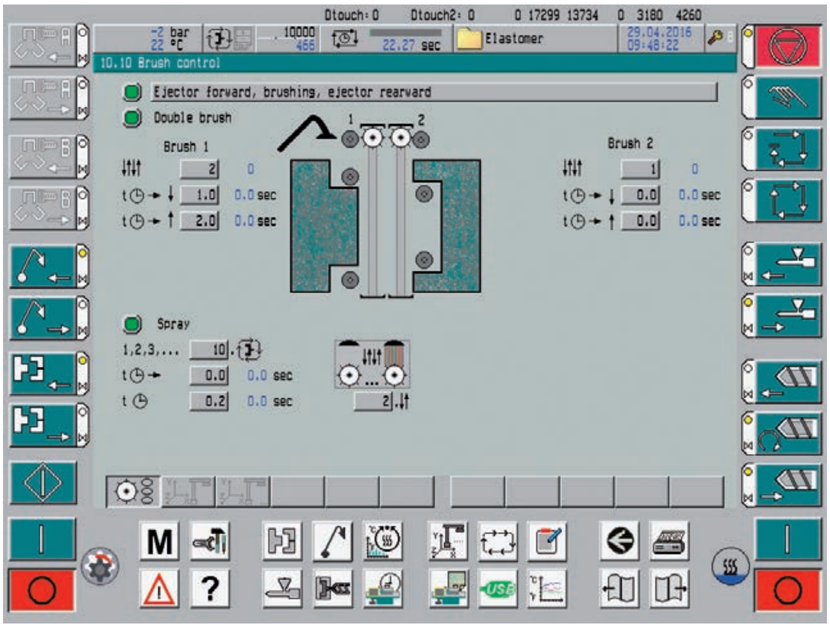
In addition to the demoulding function, the mould plates are also cleaned using the brushes. In the event of heavily bonded rubber compounds, a separating agent can also be sprayed onto the mould plates by the brush devices.

Different designs of brush devices are available. Simple designs (one rotating brush roller on a linear movable axis) can be used, for example, for moulds where the moulded parts remain reproducibly on one mould-half. Especially in case of applications where this is not guaranteed, systems with two counter-rotating brush rollers are suitable, i.e. moulded parts are safely removed from both, the fixed and the moving mould half.

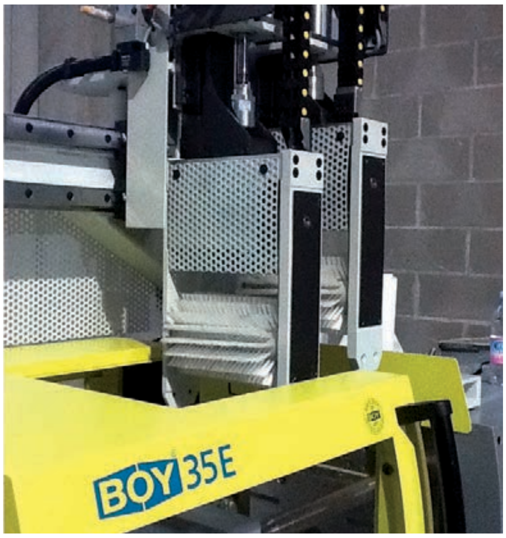
In case moulded parts or sprue respectively sprue and moulded parts are removed by brushes in two separated mould levels, this can be carried out by a dual brush system. Hereby, for each mould level, a brush device is provided which is equipped with rotary brushers.

Depending on the demoulding concept of the mould, it can be necessary to use different brushing sequences. Basic standard sequences and spraying processes can be realised using a brush control integrated in the machine control. Different, fixed pre-programmed sequences can be selected.

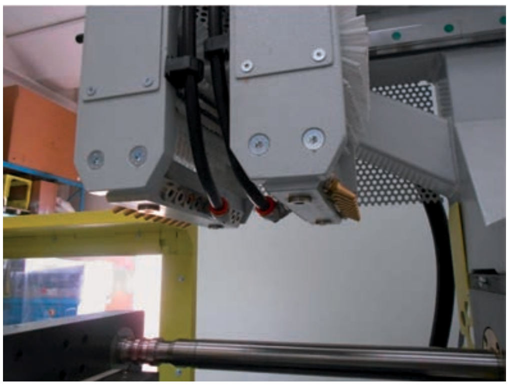
For individual brushing processes a handling control, internally in the machine, can be used. It permits the programming of brush processes using any desired sequence. The settings of the brush control, or the handling control, are always saved in the respective setting data protocol for the moulded part so that, in the event of using the corresponding mould again, the data is immediately available. Only path positions that are mechanically adjusted must be adapted.
Extremely complex sequences and brush devices, which have servo-driven motion, require its own control which communicates with the injection moulding machine via a handling interface EM 67.



Screen page Brush control in the machine control Procan ALPHA



Dual brush system



Spraying device beneath the brush rollers

Special Procedures

Compression-Injection Moulding

Compression-Injection Moulding is particularly suitable for flat, thin-walled parts. Air pockets and weld lines can be prevented with this procedure. It is frequently used in the production of o-rings and membranes.

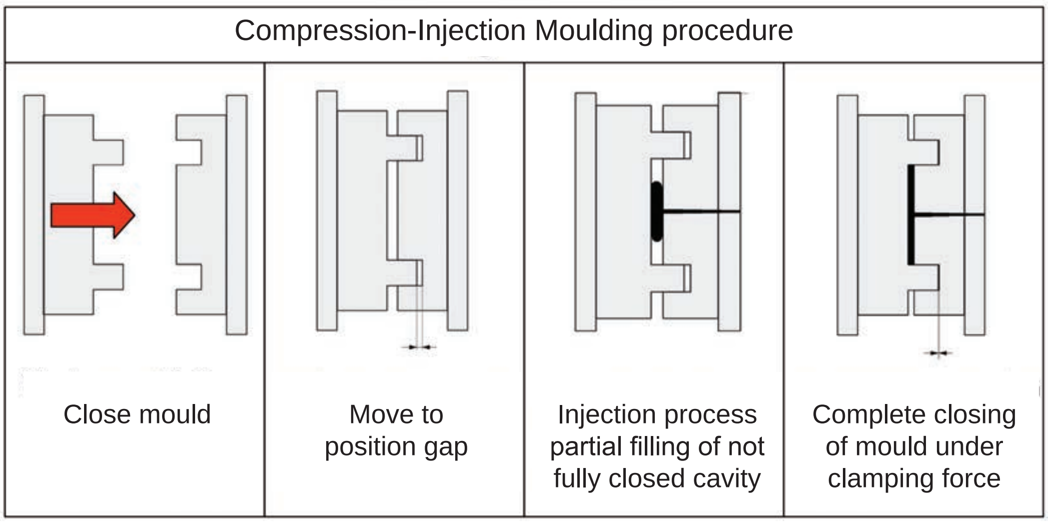
During compression-Injection Moulding the mould is not fully closed. In the parting plane, a gap of a few tenths of a millimetre to approx. three millimetres, depending on the moulded part, remains. The elastomer compound is injected so that a round “cake” forms in the centre of the mould which covers about a third to half of the cavity area.

At the end of the injection process, the mould is closed with the clamping force and the screw is kept under pressure in order to prevent the material from flowing back into the plasticising unit. In the mould’s parting plane, the “cake” is pressed outwards. Through the hot mould and the pressure induced by friction the viscosity of the compound decreases.

A thin coat forms between the cavities during compression-Injection Moulding connecting the moulded parts. It is important for the parts’ dimensional stability that the coat has an accurately reproducible thickness. For a constant thickness over the entire injection-moulded part a very solid construction of the compression-Injection Mould is crucial.

Around the moulded parts cutting edges and squish edges are arranged which make it possible to remove the parts from the coat in a deburring machine.

Compression-injection moulded o-rings



Schematic representation of the coining sequence

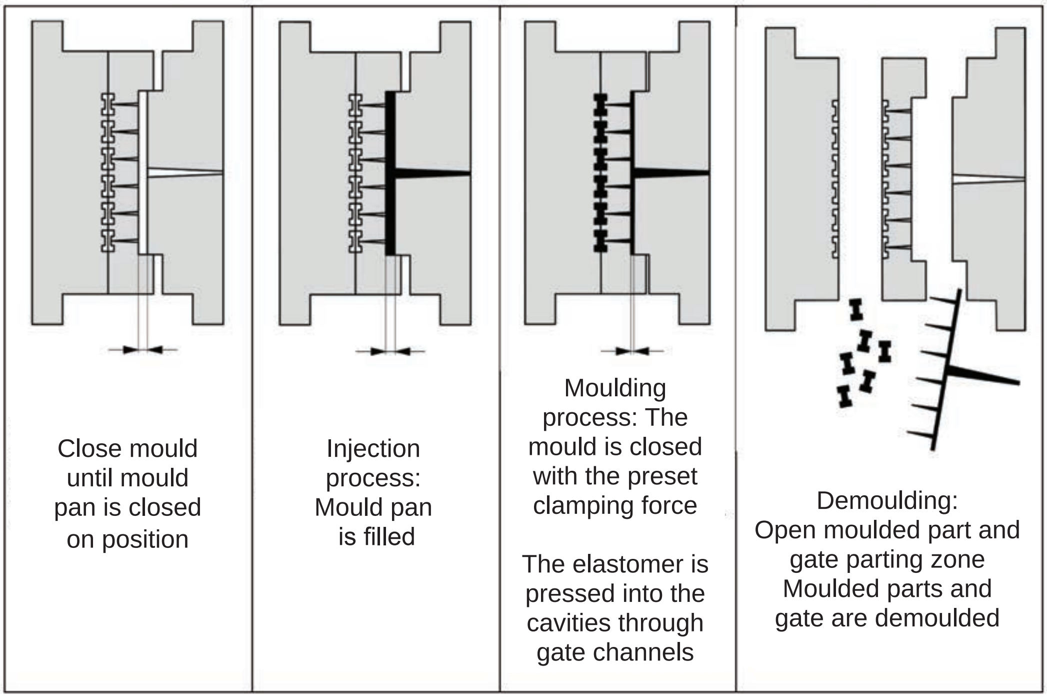
Transfer Moulding

Similar to the Compression-Injection Moulding the mould is not entirely closed as well. The transfer moulding process (ITM: Injection-Transfermoulding) works with moulds which have two parting planes. In the first parting plane near the gate there is a round transfer pan which is filled with the elastomer during injection. During the moulding process (close mould under clamping force), the elastomer in the pan is pressed into the cavities in the second parting plane via gate channels.

In this way and with a good mould design, a large number of closely placed moulded parts can be produced without burrs, since the lifting forces are always stronger in the gate parting plane than in the moulded parting plane due to the larger projected area.

Since a big gate lobe always accrues in standard-ITM process in addition to the moulded parts, the ITM process is commonly combined with a temperature-controlled transfer pan which is shielded from the hot moulding platens with an insulating board. This prevents the rubber from crosslinking in the transfer pan. Sprue waste can be completely prevented at higher mould expenditure. But since the elastomer's energy level must be kept lower in the transfer area, the crosslinking reaction in the cavities takes a little bit longer than in the standard ITM process.

Transfer coined plugs



Schematic representation of the transfer coining process

Evacuation

The evacuation is used to remove air from the mould. A constructional solution for the ventilation of moulding posts is not always possible, in particular for complexly shaped 3D-geometries.

As soon as the mould is closed, the air is evacuated for an adjustable amount of time by using a switching valve before and during injection. For this purpose, about 0.5 mm deep channels are milled around the moulding inserts at a distance of about 3 to 5 mm from the cavity. The bridges are precision-ground so that a gas-permeable but also an almost liquid-impermeable gap is created in the parting line.

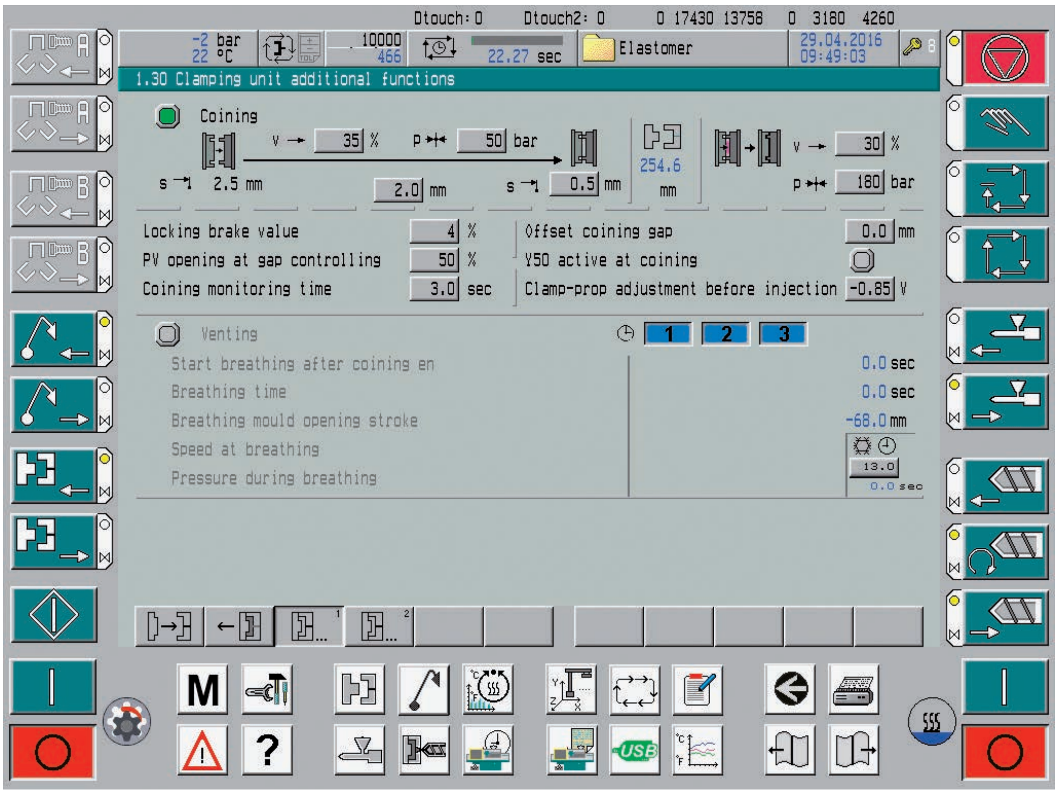
In order to evacuate effectively, the cavity area must be sealed. In the parting zone this is usually done using a high temperature resistant ring seal. Also ejector pin openings must be sealed. By putting the machine nozzle against the mould the cavity area is sealed on the side of the nozzle. After the expiry of an adjustable delay time or the receipt of a signal the injection process is started.

Evacuation can also remain active during the injection process.

Precision coining gap control

It can also be useful to evacuate the cavity area during the coining process. In particular with flat parts with different wall thickness configurations (e.g. diaphragms), air pockets might be developed, which can be reliably prevented by the aid of the evacuation. In order to seal the cavity area the mould is just closed only till it gets in contact with the seal of the other half of the mould. It is now important to keep the not completely closed mould reproducable previously in this defined position during the injection process.

During injection, the growing coining cake generates an increasing lifting force to the moving side of the mould, whereby, the coining gap slightly opens at the standard coining control. In order to ensure that the coining gap remains constant, despite the increasing lifting force, the option „Coining gap control“ is provided by using this control, the position of the moving half of the mould is measured during injection and actively kept in the predefined gap position.



Coining with coining gap control / evacuation with switch-off via a vacuum switch

Ventilation

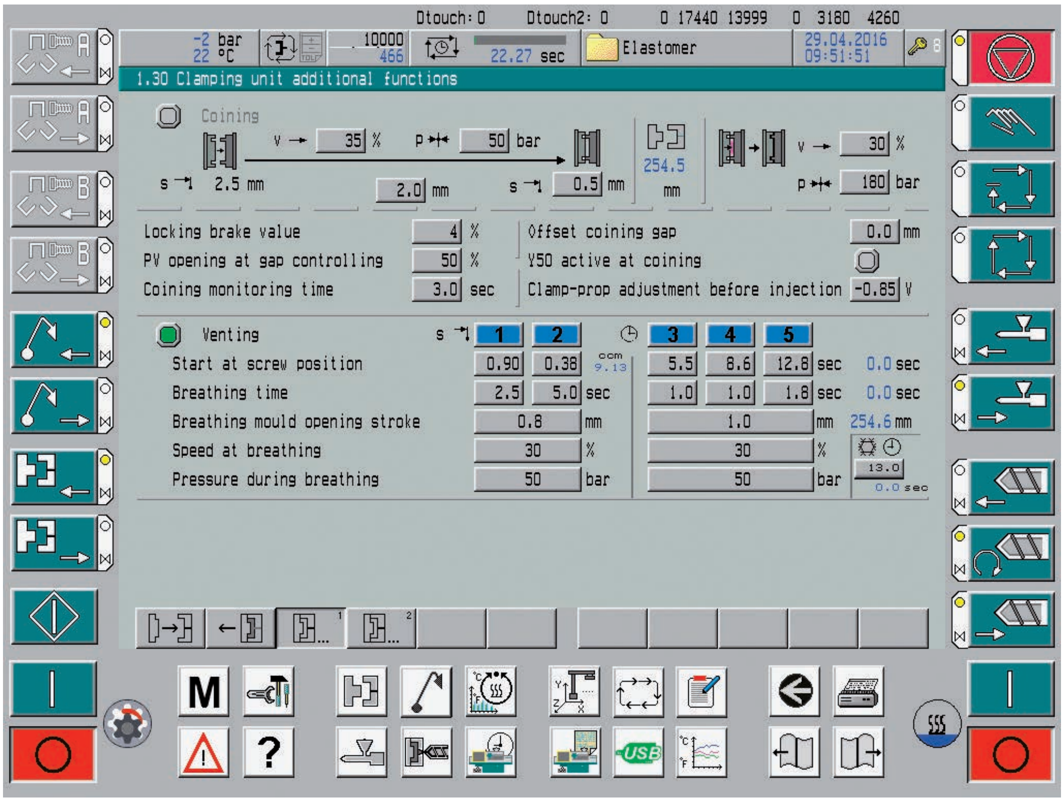
Ventilation is used to let gaseous spin-offs from the rubber mix and air (mainly when moulding moulded parts) out of the mould. For this purpose the mould is temporarily relieved during injection or (and) in the pressure holding phase so that it opens by a fraction due to the internal pressure. Sometimes the mould is also opened to a certain stroke. The ventilation process is repeated several times if necessary.

Ventilation is not possible during the coining sequence. As soon as coining is activated, a ventilation process can still be carried out, after the coining has ended. With the coining function switched on, the setting possibilities for the ventilation change.

Multiple ventilation

In order to ensure gaseous spin-offs across the complete injection and vulcanisation process. the option „Multiple ventilation path and time-dependent“ can be used.

Using this function, active ventilation can be activated at one or two stroke positions during injection. After completion of the injection process, up to three time-controlled ventilation sequences can be realised during the vulcanising time.Ventilation processes are particulary useful if low molecular (gaseous) split up products are generated during vulcanisation.



Screen page ventilation / Multiple ventilation

Equipment for elastomer processing

Stuffing units

Very soft rubber compounds as well as solid silicone moulding compounds are often very pasty already as a primary product. Material strips made of these materials for use in the injection moulding machine are thus not sufficiently tearing-proof to be continuously drawn in by the rotary screw. The results are constantly tearing material strands and uncontrollable plasticising processes. Stuffing units are offered in order to enable a secure and continuous production of these materials. A cylinder is attached to the feeding zone of the plasticising cylinder into which the elastomer can be filled in the form of cylindrical blocks. During the dosing, the material is pressed by a hydraulic cylinder into the plasticising cylinder. Depending on the size of the machine, stuffing units can be provided with a volume of 2 l to 15 l.

Hydraulic driven stuffing unit on top of a plasticising unit

Heating platens assembled to the machine

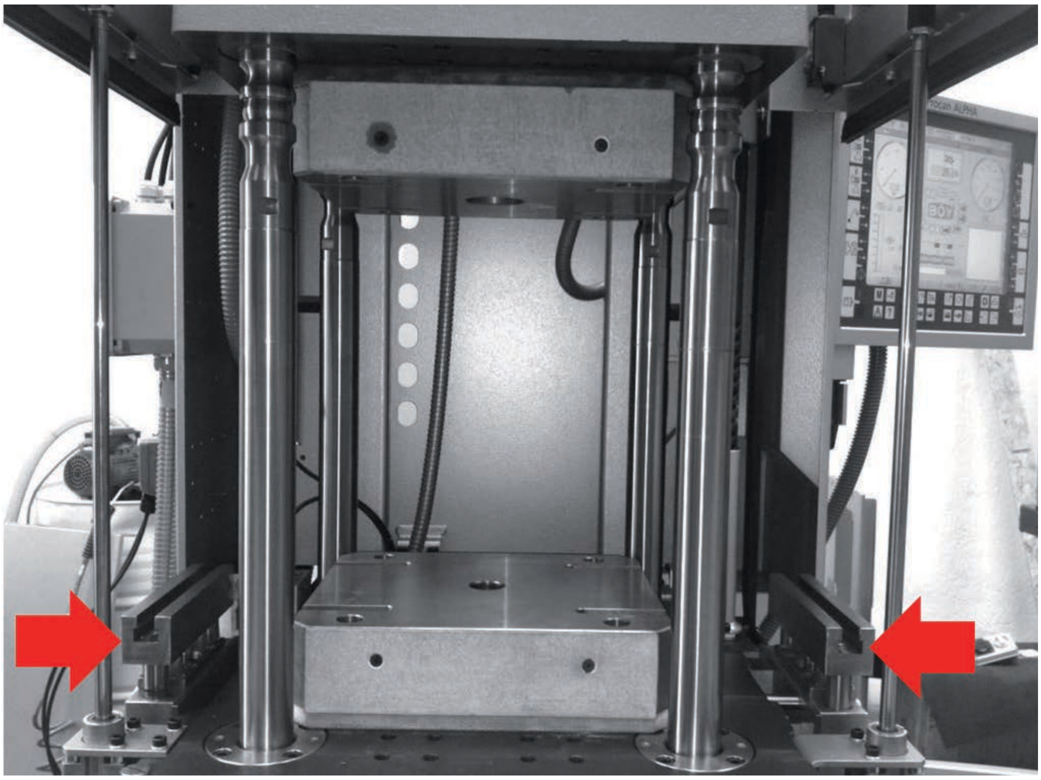
If the machine is exclusively used for the manufacturing of flat parts, e.g. O-rings or diaphragms, it provides the option to permanently install heating platens onto the mould fixing platens of the machine and only change the mould platens.
For this purpose, heating platens are provided which are insulated on the machine side and have options for attaching for the mould platens. Alternatively, magnetic heating platens can also be provided.
The heating platens each have two temperature regulating circuits that are directly controlled by the injection moulding machine. When using the heating platens, it has to be considered that the machine is equipped with a thermoregulated extended nozzle. The length of the nozzle has to be in accordance to the immersion depth due to the thickness of the heating platens. Furtheron the nozzle has to be thermoregulated to avoid heat transfer from the heating platens. For moulds with a cold runner system, the heating platen on the nozzle side cannot be used.

Tempering the plasticising cylinder

The plasticising unit is temperature controlled by one or two temperature control devices. Energy is added to the elastomer by kneading and compressing in the plasticising unit. By the two water temperature controlled jackets (BOY XS: only one jacket) energy is added from the outside.

The general processing temperature of cross linking elastomers is usually between 60°C and 90°C. The special advantage of fluid based temperature control is the possibility of discharging excessive ernergy which might be generated by friction.

For the optional thermoregulated nozzle (application with heating platens), another temperature controlled circuit is provided (also provided for a cold runner system). Temperature control units with data interfaces can be operated from the machine control. The actual values of the water temperature are indicated for each cycle and saved in the process documentation.

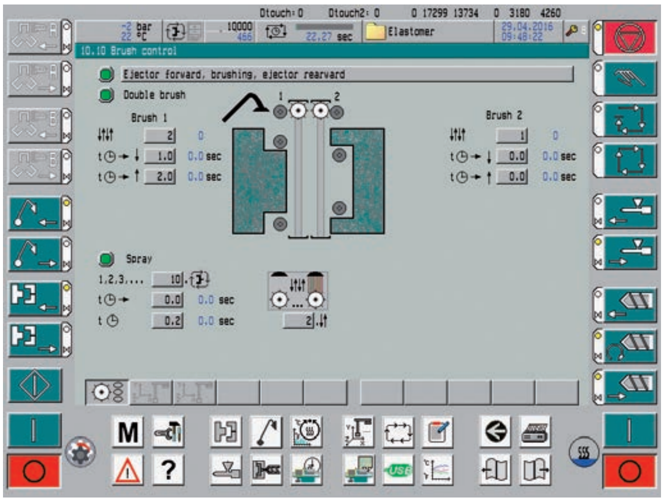


Core lifter on a BOY 35 E VV. Synchronously moving lifting device with T-slot bars for fixing of mould plates.

Mould Design

Demoulding

Typical elastomer parts are often considerably more complex than parts produced with classic moulding methods. Since they should usually work fully automated, the automatic demoulding should be taken into account in the arrangement of the parting planes. An ejector system suitable for elastic mouldings needs to be provided.



Integrated Brush Control

The individual ejectors should be monitored so that through their way of demoulding they do not cause the elastomer part to be bent at a different place in the mould. Stripper plates are often a more suitable solution.

Core lifter

Due to the material's high elasticity, large undercuts can be demoulded. During the stretching it must always be ensured that there is enough space for the material to deform in order to prevent the stretched material form shearing off. One way to support stretching is to inject compressed air which helps to support the stretching and make the sliding off the core easier, since a strong adhesion between the elastomer and the core can cause the moulded part to turn inside out. Large undercuts, which occur for example on bellows, are usually demoulded with compressed air combined with a support cylinder which is placed around the moulded part with a handling device. It is the support cylinder's task to support the stretching when the bellow is inflated so that the moulded part is not damaged through overstretching and can be reliably demoulded despite the undercuts.

Usually, flat parts such as o-rings and membranes may not show flow lines and ejector marks. Therefore, compression-injection moulding is often used for these parts. The parts and the compression-injection film can be detached from the mould with a brushing device. Instead of rotating brushes, flexible rubber blades or simple strippers can be used. The central gate rod is often held in the moving platen by a strong undercut. In order to safely demould the sprue as well, it is often moved forward by an additional ejector during brushing. A brushing device can be operated by the machine control.

Gating system

The gating system consists of the central gate rod and the distribution system in the parting plane. The distribution channels must be arranged to ensure that all cavities can be reached under the same flow conditions (flow length, number of deflections).

During filling, air entrapment due to inflow of the elastomer needs to be avoided. At the same time, ventilation through the parting plane and drillings of ejector pins need to be ensured. If this is not possible, a vacuum can be produced in a sealed mould by the evacuation right before the injection.

Cold runner systems are increasingly replacing the gating system vulcanising with the moulded part. In a cold runner system the prepared elastomer is transported to the hot cavity in a water thermostated piping system so that the moulded parts can be moulded directly without any sprue. Despite the usually higher moulding costs, cold runner systems are often superior to vulcanising gating systems both ecologically and (especially with increasing quantities) economically. A further advantage can be identified in automated processes. The problem of sprue demoulding disappears completely, whereby the handling system becomes significantly easier and the process reliability increases.

Coldrunner distributor with 16 nozzles
Source: Ökologische Kautschuk Technologie s.r.o.

Design of the Sprue Bushing

The contact surface between the nozzle of the plasticising cylinder and the sprue bushing of the mould must remain tightly sealed under the high pressure needed in the injection process.

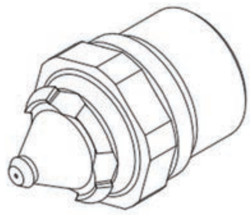
In order to achieve this without further sealing elements, the mould's sprue bushing usually has a spherical cap with a 40 mm radius. The nozzle radius is slightly smaller (35 mm). In this way both sealing surfaces touch each other on the smallest possible circumference with an extremely high surface pressure which can be regulated by the nozzle contact force.

The sprue bushing's opening always has to have a slightly larger diameter than the nozzle bore of the plasticising unit in order to make sure that the sprue can be demoulded from the sprue bushing without an undercut between the machine nozzle and the mould.

Sprueless nozzle for elastomers

The sprueless nozzle for elastomers is designed for use on the BOY XS / XSV with a 16 mm elastomer unit. With this nozzle elastomer parts can be manufactured on one-cavity moulds without sprue and without cost-intensive use of a cold runner.

The nozzle is optimised in the area of the contact surface so that the heat transfer from mould to nozzle is minimised. Due to the very short construction length, additional cooling of the nozzle is not required. Operation is similar to an open standard nozzle. In the event of problems with the material compound, for cleaning purposes, the nozzle can be quickly removed by a central connection thread.



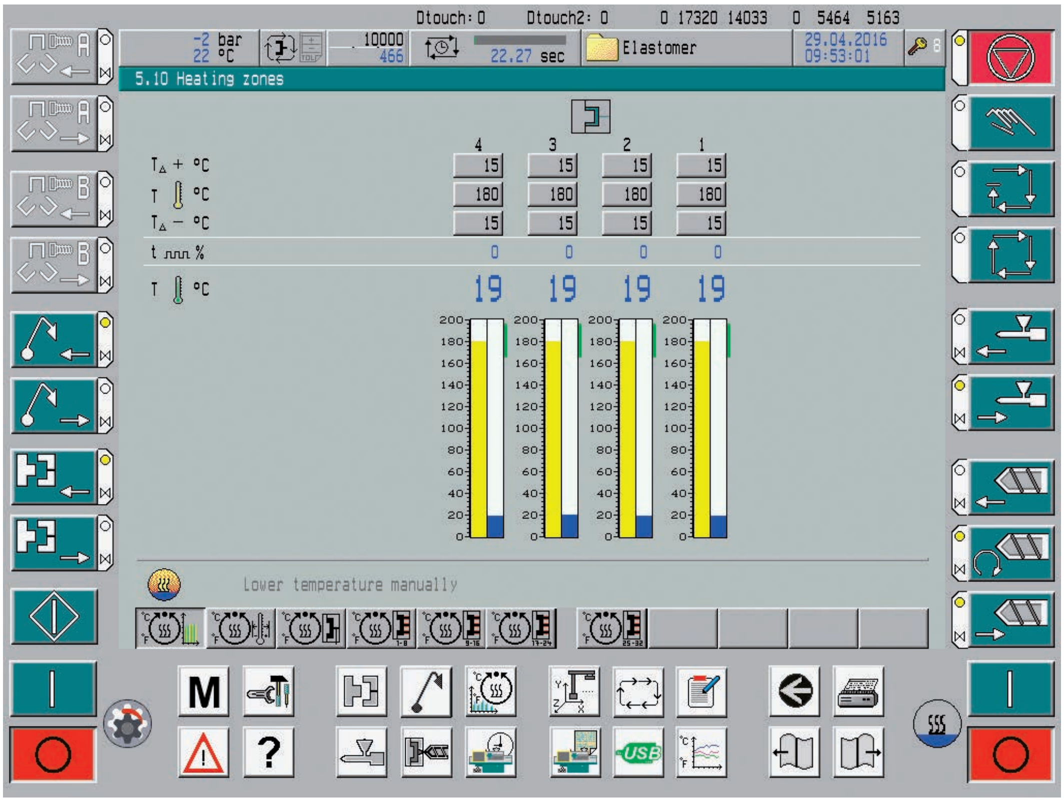
Sprueless elastomer nozzle

Heating the mould

Elastomer injection moulds are usually heated electrically. In this way an even temperature in the cavity areas can be achieved with little effort. Heating cartridges in the moulding plates are the most direct and most economic heating possibility. With low heat output the mould can be quickly heated and with the correct arrangement of the cartridges and the temperature sensor, the temperature can be precisely regulated by the injection moulding machine's temperature control.

An effective insulation of the mould is also important, since too great heat loss might have a negative effect on the even temperature distribution within the mould. The insulating boards should not be thinner than 6 mm.

Very simple moulds are often tempered with heating boards. Since the heating elements are arranged far away from the cavities, significantly higher installed thermal capacity is necessary for the heating boards than in directly heated moulds (moulding plates). Since the size of these heating boards is determined by the size of the largest moulds used, high heat emissions around the mould are the result if smaller moulds are used.



Mould tempering with the injection moulding machine's controls

Available elastomer units

Machine	EUROMAP	Diameter (mm)					
		16	22	28	32	38	42
BOY 2C S	100-81		X				
BOY 2C S	100-96			X			
BOY 2C M	100-205				X	X	
BOY XXS	100-14	X					
BOY XS / XS V	100-14	X					
BOY 22	220-52		X	X			
BOY 25 E	250-69		X				
BOY 25 E	250-82			X			
BOY 25 V	250-69		X				
BOY 25 V	250-82			X			
BOY 35 E	350-81		X				
BOY 35 E	350-96			X	X		
BOY 35 V	350-96			X	X		
BOY 50 E	500-69		X				
BOY 50 E	500-82			X			
BOY 50 E	500-170				X	X	X
BOY 55 A	550-205				X	X	X
BOY 60 E	600-69		X				
BOY 60 E	600-82			X			
BOY 60 E	600-110				X		
BOY 60 E	600-215				X	X	X
BOY 60 V	600-215				X	X	X
BOY 80 E	800-215				X	X	X
BOY 90 E	900-370						X
BOY 100 E	1000-215				X	X	X
BOY 100 E	1000-400						X
BOY 125 E	1250-215				X	X	X
BOY 125 E	1250-420						X
Rubber strips reference values							
Diameter (mm) Ø		5 bis 8	12	16	16	17	18
Cross-sectional area (mm^2)		51.2	96.8	156.8	192.0	226.1	237.4
Width (mm)		16	22	28	32	38	39.9
Height (mm)		3.2	4.4	5.6	6.0	5.95	5.95

Optional Equipment

- elastomer plasticising units with various diameters
- adjustable nozzle contact force over entire cycle
- sprueless nozzle for XS/ XSV
- thermoregulated extended nozzle
- stuffing unit with protective covering
- mould installation height decreased by 50 mm
- core pull system 1-, 2- or n-fold
- core lifter (strand over a core pull)
- injection-compression moulding and mould ventilation
- precision coining with gap control
- blow-out device 1- or 2-fold
- interface package: serial/ heating devices – USB/ printer – Ethernet/OPC
- 4 or 8 freely programmable inputs/outputs
- additional plugs in different combinations
- standardised handling device interface (EUROMAP 67)
- integrated handling device (instead of EUROMAP 67)
- sliding table for vertical systems
- temperature controller
- interface for vacuum pump
- interface for brush control
- interface for ejector plate fuse
- energy monitor
- 4 control zones with increased heat output for mould heating
- heating plates
- various brush systems
- For vertical machines we recommend the use of special protective bonnets

Technical Data

		BOY 2C S		BOY 2C M	BOY XXS	BOY XS/XS V	BOY 22 A		BOY 55 A		
Injection unit		81	96	215	14	14	52		205		
Screw diameter	mm	22	28	28 / 32 / 38	16	16	22	28	32	38	42
Max. stroke volume (theor.)	cm^3	30.4	58.5	76.9 / 100.5 / 141.8	8	8	30.4	49.3	96.5	136.1	166.3
Max. spec. injection pressure	bar	2656	1639	2800 / 2143 / 1520	1760	1760	1732	1069	2127	1508	1235
Max. screw stroke	mm	80	95	125	40	40	80		120		
Nozzle force/contact press.	kN	24		31	20	20	48		66		
Nozzle retraction stroke	mm	205		215	85	100	180		210		
Screw torque	Nm	180		280 / 350	100	100	180 / 290		280 / 350		

		BOY 2C S	BOY 2C M	BOY XXS	BOY XS/XS V	BOY 22 A	BOY 55 A
Clamping unit							
Clamping force	kN	-	-	63	100	220	550
Tie bar clearance	mm	-	-	160 (diag. 205)	160 (diag. 205)	254	360x335
Max. platen distance	mm	-	-	180 (opt. 205)	250 (opt. 200)	400	650
Min. mould height	mm	-	-	70 (opt. 95)	100 (opt. 50)	200	250
Centering diameter	mm	-	-	60	60	110	125
Mould opening force	kN	-	-	12	15	40	38
Mould closing force	kN	-	-	8	10	17.6	24.4
Max. ejector stroke	mm	-	-	45	50	80	80
Ejector force pushing/ pulling	kN	-	-	5 / 2.5	8.4	18.1 / 12	20.4 / 13.5 (20.4 / 13.5) (42.7 / 30)

		BOY 25 E		BOY 25 V		BOY 35 E		BOY 35 V		BOY 50 E				
Injection unit		69	82	69	82	81	96	96		69	82	170		
Screw diameter	mm	22	28	22	28	22	28	28	32	22	28	32	38	42
Max. stroke volume (theor.)	cm^3	30.4	58.5	30.4	58.5	30.4	58.5	58.5	76.5	30.4	58.5	100.5	141.8	173.2
Max. spec. injection pressure	bar	2277	1405	2277	1405	2655	1639	1639	1255	2739	1639	1692	1203	982
Max. screw stroke	mm	80	95	80	95	80	95	95		80	95	125		
Nozzle force/contact press.	kN	48		24		48 / HV 24		48 / 24		48		48		
Nozzle retraction stroke	mm	205		205		205		205		205		215		
Screw torque	Nm	130	180 / 300	180	180 / 209	130	180 / 300	180 / 209		180 / 300		280 / 350		

		BOY 25 E	BOY 25 V	BOY 35 E	BOY 35 V	BOY 50 E
Clamping unit						
Clamping force	kN	250	250	350	350	500
Tie bar clearance	mm	254	254	280x254	280x254	360x335
Max. platen distance	mm	400	400	500	500	650
Min. mould height	mm	200	200	200	200	250
Centering diameter	mm	110	110	110	110	125
Mould opening force	kN	17.6	17.6	29.5	29.5	38
Mould closing force	kN	17.6	17.6	21.4	21.4	24.4
Max. ejector stroke	mm	80	80	80	80	80 (130) (150)
Ejector force pushing/ pulling	kN	18.1 / 12	18.1 / 12	18.1 / 12	23.8 / 15.8	20.4 / 13.5 (20.4 / 13.5) (42.7 / 30)

Technical Data

		BOY 60 V			BOY 60 E						BOY 80 E		
Injection unit		215			69	82	110	215			215		
Screw diameter	mm	32	38	42	22	28	32	32	38	42	32	38	42
Max. stroke volume (theor.)	cm^3	100.5	141.8	173.2	30.4	58.5	100.5	96.5	136.1	166.3	100.5	141.8	173.2
Max. spec. injection pressure	bar	2142	1519	1244	2277	1405	1100	2127	1508	1235	2142	1519	1244
Max. screw stroke	mm	125			80	95	125	120			125		
Nozzle force/contact press.	kN	66			48	48	48	66			65		
Nozzle retraction stroke	mm	215			205	205	215	210			215		
Screw torque	Nm	390 / 490			180 / 300		280 / 350	390 / 490			280 / 350		

		BOY 60 V	BOY 60 E	BOY 80 E
Clamping unit				
Clamping force	kN	600	600	800
Tie bar clearance	mm	360x335	360x335	430x360
Max. platen distance	mm	550	650	725 (900)
Min. mould height	mm	300	250	250
Centering diameter	mm	125	125	125
Mould opening force	kN	38	38	70
Mould closing force	kN	24.4	24.4	51.1
Max. ejector stroke	mm	80	80 (130) (150)	130 (150)
Ejector force pushing/ pulling	kN	20.4 / 13.5	20.4 / 13.5 (20.4 / 13.5) (42.7 / 30)	20.4 / 13.5 (42.7 / 30)

		BOY 90 E	BOY 100 E				BOY 125 E			
Injection unit		370	215			400	215			420
Screw diameter	mm	42	32	38	42	42	32	38	42	42
Max. stroke volume (theor.)	cm^3	214.7	100.5	141.8	173.2	221.6	100.5	141.8	173.2	221.6
Max. spec. injection pressure	bar	1724	2142	1519	1244	1800	2142	1519	1244	1899
Max. screw stroke	mm	155	125			160	125			160
Nozzle force/contact press.	kN	65	65			65	65			65
Nozzle retraction stroke	mm	250	215			243	215			243
Screw torque	Nm	500 / 530	280 / 350			500 / 530	280 / 350			500 / 530

		BOY 90 E	BOY 100 E	BOY 125 E
Clamping unit				
Clamping force	kN	900	1000	1250
Tie bar clearance	mm	430x360	430x360	470x430
Max. platen distance	mm	725 (900)	725 (900)	825
Min. mould height	mm	250	250	300
Centering diameter	mm	125	125	125
Mould opening force	kN	65	70	48.5
Mould closing force	kN	47.2	51.1	49.2
Max. ejector stroke	mm	130 (150)	130 (150)	130 (150)
Ejector force pushing/ pulling	kN	20.4 / 13.5 (42.7 / 30)	20.4 / 13.5 (42.7 / 30)	20.4 / 13.5 (42.7 / 30)

Modification in design and
equipment reserved
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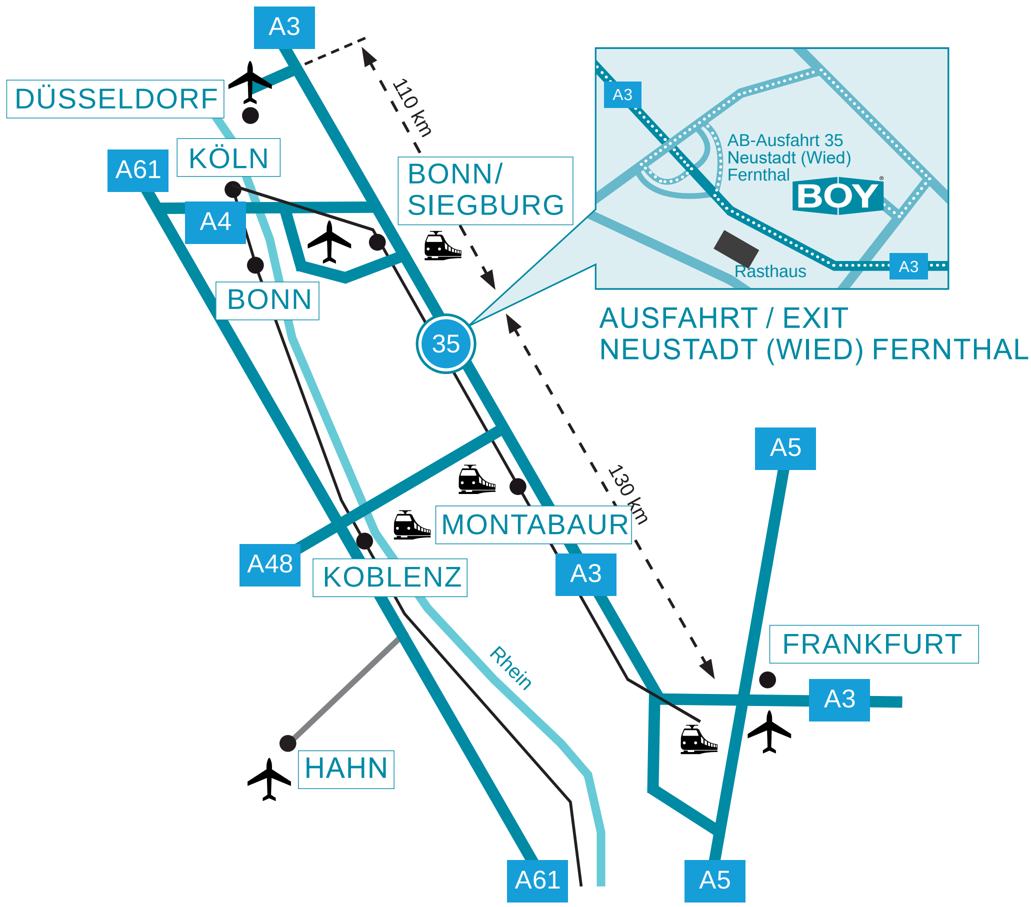

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