Silicone injection moulding

Optimum system solutions for LSR and HTV
At a glance

Whether rain sensors or connectors for the automotive sector, optical pulse measurement or teats for babies’ bottles in medical technology – the application range for moulded parts made from liquid silicone (LSR) or solid silicone (HTV) is extremely broad. As a pioneer involved in the development of silicone injection moulding, we possess comprehensive process expertise as well as individually adaptable injection moulding technology. With ARBURG, you can combine the standard ALLROUNDER machines with numerous process-specific equipment options more effectively than with any other manufacturer. We can therefore always devise the perfect system solution for your LSR or HTV application, including precise material dosage, temperature control adapted to the material, precise demoulding and reliable removal. And this applies throughout the entire high-volume production run.

Rain sensors: New product ideas can be implemented to perfection using liquid silicones – with the aid of ARBURG’s extensive applications technology expertise.

Special equipment for silicone injection moulding

<table>
<thead>
<tr>
<th>Necessary basic equipment</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder modules with adapted screws for LSR or HTV</td>
<td>Customised nozzle technology</td>
</tr>
<tr>
<td>Precise liquid temperature control of the cylinder module</td>
<td>INJESTER tamping device for bubble-free feed of HTV</td>
</tr>
<tr>
<td>Cylinder heating for processing thermoplastics</td>
<td>Pneumatic and servo-electric LSR dosage systems</td>
</tr>
<tr>
<td>Interfaces for special peripherals</td>
<td>Air bowl and vacuum technology close to the mould</td>
</tr>
<tr>
<td>Water-flow monitor</td>
<td>Adapted brushing units and demoulding devices</td>
</tr>
<tr>
<td>Control functions such as temperature-dependent post cooling</td>
<td>Integrated robotic systems</td>
</tr>
<tr>
<td>Adaptive mould heating circuits</td>
<td>Turnkey solutions from a single source</td>
</tr>
</tbody>
</table>
Exploiting all possibilities
ARBURG offers a comprehensive range of technologies for processing liquid silicone (LSR) and solid silicone (HTV). Individual adaptation of machine technology and the injection moulding task at hand can always be implemented down to the last detail. This is based on a number of factors:

- The modular product range offers hydraulic, hybrid, electric and vertical ALLROUNDERs.
- The ALLROUNDER range provides a wide variety of clamping forces and injection units, which can be flexibly combined.
- Numerous equipment versions are available, for example for the processing of several components.

The result is always an efficient system solution from the individual machine level through to completely automated turnkey systems.

Keeping processes reliably under control
With the freely programmable SELOGICA machine control system, the process-specific peripherals can be fully integrated in the overall sequence. The graphic symbols, as well as the immediate plausibility check during sequence programming ensure an excellent overview. The set-up of even complex production processes is also simplified. Moreover, numerous options are available for optimising, monitoring and documenting production processes.

Silicone processing is rendered stable and reproducible by means of important functions such as adaptive mould heating or the venting of cavities.

Building on the expertise of pioneers
As one of the pioneers, ARBURG has been involved in the processing of liquid silicone since 1980. Several thousand silicone applications have already been realised and, with the appropriate comprehensive service offerings, ARBURG has also set the standard within the sector in terms of information and training.

An interdepartmental team of silicone specialists ensures expert consulting at all times, from the requirements-based specification of the ALLROUNDERs, machine and applications technology, through to customer consulting and moulded part and mould design. Detailed trials at our excellently equipped Customer Center complete the offerings. Finding a systematically cost-effective solution always also includes the elaboration and evaluation of alternative solution concepts.
Sophisticated: the processing conditions

Special materials require special machine technology. Precise temperature control of the process is essential for reliable processing. Whereas high temperatures are required for the vulcanisation of LSR and HTV in the mould, the cylinder module must be kept cool. Otherwise, the reactive material mixture would undergo premature cross-linking. Consequently, thermal separation of the cooled machine nozzle from the heated mould must also be achieved – for example by retracting the cool nozzle from the hot mould.

LSR: “liquid” becomes highly elastic
Liquid silicones are addition cross-linking silicone rubbers made from two components (catalyst and cross-linking agent), which are provided ready for use in two separate containers. This allows cross-linking to be initiated at the required time. Moreover, the separate agents also result in significantly better delivery capability and storage characteristics.

A special LSR dosage system homogenously mixes the two “liquid” components as well as the added dyes and additives. The now reactive material mixture vulcanises extremely quickly at high temperatures, permitting appropriately short cycle times. No decomposition products are produced.

Material classification

Silicone rubber
- Hot-vulcanising
  - LSR
    - Liquid Silicone Rubber
  - HTV
    - High Temperature Vulcanisation
- Cold-vulcanising
  - RTV
    - Room Temperature Vulcanisation
HTV: “solid” becomes highly elastic
Solid silicones are self-crosslinking silicone rubbers made from a single component supplied in the form of bales, blocks or strips. For the processing of the “solid” feedstock, a special INJESTER tamping device is required in order to ensure a continuous, bubble-free material feed. Solid silicones also vulcanise quickly in the moulds, which can be heated to up to 220°C.

Material characteristics
The material properties of silicones are only created after crosslinking. The use of LSR and HTV is always advantageous wherever thermoplastic (TPE) and conventional elastomers reach their limits. The finished silicone moulded parts are extremely elastic and highly resilient, odourless and tasteless, chemical, UV, ageing and temperature resistant (up to 180 °C) as well as flexible when cold (down to -50 °C).

Benefits of LSR and HTV compared

<table>
<thead>
<tr>
<th>Requirements</th>
<th>LSR</th>
<th>HTV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex, delicate part geometry</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Small components</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Simple automation</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Short vulcanisation and cycle time</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>High number of cavities</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Low number of cavities</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Material configurable</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Material costs</td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>
The quality of your production can only be as good as the components you use. Particularly in the field of LSR, where two components have to be mixed homogeneously and fed “cold” into a “hot” mould, numerous main and auxiliary conditions must be met in order to achieve a stable, reproducible process. We can save you a great deal of work with our ALLROUNDER injection moulding technology, which is precisely tailored to the application, and our extensive process expertise. LSR processing really can be fun with the right system partner at your side!

**Important: adapted plasticising**
The LSR cylinder module is particularly significant due to the low viscosity of liquid silicones. Special technology is required to ensure correct feed of the LSR material, as well as precise dosage and injection. For constant thermal conditions, the cylinder module and nozzle feature multi-zone liquid temperature control. Premature cross-linking of the material is thereby effectively prevented. The zero-compression screw with reduced channel depth and L/D-ratio reduces the material volume to the required amount and additionally mixes all the components. The disc-type non-return valve, which shuts automatically via spring force, enables precise dosage as it ensures a minimal return flow during injection and holding pressure.

Repeat accuracy: automatically closing disc-type non-return valve.
In order to adapt the injection units perfectly to the required shot volume, a wide range of LSR cylinder module sizes are available. This makes possible a high degree of control accuracy of the screw movement and consequently maximum repeat accuracy.

**Effective LSR processing**
Additional sealing of the cylinder module ensures the necessary cleanliness during LSR processing. In addition to an open nozzle, a number of needle shut-off nozzles featuring a standardised hydraulic drive are available. A simple cold-runner nozzle also enables direct injection and consequently sprueless part production, without requiring a mould-specific cold runner system.

**Sizes**

Matched to the mould: large selection of different nozzles.

<table>
<thead>
<tr>
<th>Injection units according to EUROMAP</th>
<th>Screw diameter [mm]</th>
<th>Injection volume [cm³]</th>
<th>Injection pressure [bar]</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>12</td>
<td>6.8</td>
<td>2200</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>10.6</td>
<td>2200</td>
</tr>
<tr>
<td>70</td>
<td>18</td>
<td>23</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>44</td>
<td>1550</td>
</tr>
<tr>
<td>100</td>
<td>15</td>
<td>18</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>31</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>71</td>
<td>1390</td>
</tr>
<tr>
<td>170</td>
<td>25</td>
<td>59</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>85</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>115</td>
<td>1470</td>
</tr>
<tr>
<td>290</td>
<td>25</td>
<td>73</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>106</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>188</td>
<td>1530</td>
</tr>
<tr>
<td>400</td>
<td>35</td>
<td>154</td>
<td>2500</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>201</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>254</td>
<td>1580</td>
</tr>
<tr>
<td>800</td>
<td>45</td>
<td>318</td>
<td>2470</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>474</td>
<td>1650</td>
</tr>
</tbody>
</table>
Bubble-free HTV feed: INJESTER tamping devices

Important: Special material feed

INJESTER tamping devices have been developed for the automatic feeding of paste-like materials. All standard containers can be processed problem-free. They contribute towards optimum pre-compression, which results in minimal air and gas inclusions. This keeps products free from voids and their surfaces flawless. Here, ARBURG offers INJESTER tamping devices. These are fully integrated in the SELOGICA control system. The delivery pressure is programmable.

The precisely matched combination of ALLROUNDER machine and INJESTER tamping device results in a compact injection moulding solution for the smooth production of HTV items. The technology is thought-out to the last detail. The INJESTERS, for example, are easy and quick to clean. This is particularly advantageous in the case of single-component silicones. The HTC materials used are often not standard, but produced on an individual basis according to the product requirements. As well as representing a challenge in processing terms, this also results in frequent material changes. The significantly shorter setup and downtimes, in conjunction with the high process reliability, lead to a high level of cost-efficiency for you.
Perfect HTV processing

Also during HTV processing, precise temperature control is especially important. The nozzle and cylinder module therefore feature liquid temperature control, preventing premature cross-linking of the material. The adapted feed opening of the cylinder module is prepared for installing an INJESTER tamping device. The zero-compression screw with a special non-return valve is adapted to HTV processing requirements. Moreover, a large selection of different nozzles is available.

Sizes

Piston INJESTER
- For 70, 100 and 170 size injection units
- Design with hydraulic tamping cylinder
- Conveying pressure can be programmed via SELOGICA
- Easy cleaning during material changes
Versatile: modular machine technology

Individual options
Thanks to the modular design of the ARBURG injection moulding technology, silicone processing is possible on all ALLROUNDERs with the appropriate equipment packages and options. The machine technology can be individually tailored to the manufacturing tasks at hand. In addition to a variety of drive concepts - from fully hydraulic to fully electric - clamping forces and injection units can also be flexibly combined. Various positions of the injection units with respect to one another are possible for the processing of several components. Last but not least, vertical and rotary table machines are available for the overmoulding of inserts with LSR or HTV – nothing could be more universal.

Basis: precise movements
All machine concepts provide ample space under the protective hood in order to facilitate the feed of various media, for example. The proven three-platen technology with four tie-bar guidance applies the force centrally to the mould, ensuring low mould stress and highly precise moulding. The entire technology effectively counteracts flash and overfeeding. This is particularly important in silicone processing because finishing the flexible parts is very difficult and expensive.
System solutions for LSR and HTV
ARBURG also offers modular system solutions for silicone processing. This ensures the implementation of individually tailored concepts, which are efficient throughout. In some cases, an ALLROUNDER with process-specific equipment may be sufficient, in others, a complex automation cell with quality assurance and/or packaging stations may be the perfect solution. This is why ARBURG is a system supplier, as only in this way, can it provide companies with the best possible injection moulding technology.

Accessories

Dosing units
• Interfaces for actuation and monitoring
• Pneumatic, hydraulic or servo-electric dosing units – complete solution with injection moulding machine

Brush and demoulding device
• Interfaces for actuation and monitoring
• Programmable via SELOGICA control system
• Special servo-electric demoulding device for fast cycles – complete solution with injection moulding machine

Vacuum and air blow units
• Air blow unit with pressure relief valve
• Electrical connections for up to four air blow units
• Connections optionally routed to the fixed and moving mounting platen
• Large selection of different vacuum concepts: from SELOGICA interface to vacuum pumps via vacuum valves
• Programmable via SELOGICA control system

Robotic systems
• Numerous robotic systems – complete solution with injection moulding machine
• Programmable via SELOGICA control system
• Ideal for multi-component injection moulding of hard/soft combinations

Custom adapted: evacuation of the moulds with modular vacuum technology.
User-friendly arrangement: media supply close to the mould.
Maximum process control: SELOGICA control system

Reliable evacuation

An important technique for smooth silicone processing is evacuation of the mould prior to injection. This prevents burns to the surface of the silicone parts as well as air inclusions, and ensures complete mould filling with uniform filling characteristics. Venting can be programmed with great flexibility via dedicated symbols, whereby integration of all common vacuum concepts is possible. Moreover, SELOGICA also utilises signals from vacuum devices for process and quality control. This ultimately results in the transparent control and documentation of the entire venting process directly on the control screen.


Further information:
SELOGICA control system brochure
2 Adaptive mould heating
The adaptive mould heating automatically adapts the control parameters to the control response of the mould. Several heating zones can also be controlled in parallel via a sensor. This achieves high temperature stability in the mould for excellent reproducibility in production.

3 Fully integrated peripherals
The SELOGICA central control system integrates robotic systems as well as all necessary peripherals such as brush and demoulding devices. All processes can be programmed as a function of and synchronous with machine movements. They are therefore part of the overall sequence, appear in the sequence editor with their own symbols and can be centrally monitored.

Highlights
- Control centre for the entire injection moulding technology
- Convenient sequence programming with graphic symbols
- Direct plausibility checks
- Free programmability of production sequences
- Common data record for the entire production unit
- Water-cooling for continuous temperature control in the control cabinet
Application examples

Silicone moulded parts, whether purely made from that material, combined with other plastics, or as hybrid components with metal are gaining significance in many areas of industrial production. Owing to their many excellent characteristics such as temperature and chemical resistance, new solutions and product ideas frequently arise with regard to liquid silicones (LSR) or solid silicones (HTV). Those who have mastered the processing methods can work successfully in many fields of application. ARBURG’s system technology offers you the best basis here, with cost-effective, customised technology and well-founded expertise.

1. Clean teats for babies’ bottles
Particularly in the field of baby care, strict standards apply worldwide with regard to cleanliness and quality during production. Here, LSR scores points thanks to its resistance aspects and suitability for sterilisation. With automated ALLROUNDER production cells, teats for babies’ bottles can be produced in large volumes, flash-free and without the need for refinishing. Manufacture is fully autonomous and without human intervention, under extremely clean conditions. The SELOGICA machine control system permits seamless documentation of the production quality.

2. Clever demoulding of seals
Providing customised solutions for difficult-to-demould LSR parts means getting all those involved in a project to sit around a table. This leads to developments such as an emission-free servo-electric demoulding device like the one used on an ALLROUNDER with a 128-cavity mould for the production of single-wire caps. Simultaneous movements as well as continuously adjustable travel and rotational speeds enable fast, process-reliable demoulding of the parts. The demoulding device is fully integrated in the SELOGICA control system for this purpose. Consequently, only one data record and no re-thinking is required during programming.
3 Soft-touch keypad
On a project system for production of a washing machine keypad, thermoplastic and silicone are processed to form a hard-soft combination. Here, various material properties can be brought together in a single production step. A particular challenge is the joint processing of “hot” and “cold” materials in one cycle and one mould: LSR cross-links at high temperatures, whereas PA requires cooling. The relevant sections in the mould must consequently be separated from one another by means of thermal insulation. This is why transfer technology is particularly suitable here. The moulded parts are transferred in the mould via a MULTILIFT robotic system.

4 Integrated seals
The possibilities for automating manufacturing processes involving LSR processing are virtually unlimited. One good example is the system for Sinzheimer Kunststofftechnik GmbH (SKT) for the production of a metal cover featuring a moulded-on LSR seal. The production cell is fully autonomous. Strict quality standards must be met for this automotive component. In addition to the ALLROUNDER, a MULTILIFT robotic system, a feeding device with pre-warming station, a cooling station and a leak testing station are integrated in the system. The complex production sequence of the cell proceeds according to the “first-in-first-out-principle” while strictly adhering to the heating and cooling times.

5 Turnkey projects
ARBURG also supplies customised clean room solutions as complete turnkey systems. The practical example here: vaginal rings (medical implants) for HIV prevention produced waste-free in a 16-cavity mould via a cold-runner system. Part handling is performed by a compact, emission-free, servo-electric six-axis robotic system which is programmed via the same user interface as the ALLROUNDER. The system meets the highest hygiene requirements in accordance with ISO 13485, FDA and GMP thanks to application-specific adaptations such as enclosures with ISO Class 3 clean air modules, nickel-plated mounting platens or an encapsulated stainless steel clamping unit.
Distance between tie bars from 170 x 170 to 920 x 920 mm | Clamping force from 125 to 5,000 kN | Injection units from size 30 to 800 (according to EUROMAP)