Micro injection moulding

Efficient solutions for complex tasks
Thanks to our modular ALLROUNDER machines, the manufacture of micro components with weights under one gram today represents the „state of the art“. Furthermore, this is possible in high unit volumes and at a consistently high quality level, without requiring expensive and complicated special machines. Both your production facility and our ALLROUNDERs remain free for a host of other applications. Our product range extends from screws with diameters of 15 and 12 mm, special micro injection units and modules featuring an 8-mm injection screw for extremely small shot weights, through to your customised system solution for micro components. Homogeneous material preparation according to the first-in, first-out principle, as well as a high degree of reproducibility are a matter of course!

Example, the watch industry: ARBURG has a comprehensive product portfolio ranging from modular standard machines to individual system solutions for micro-components.

Special equipment for micro-injection moulding

<table>
<thead>
<tr>
<th>Standard Options</th>
<th>Options</th>
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<tbody>
<tr>
<td>Choice of hydraulic or electric drive technology</td>
<td>Position-controlled injection with high repeat accuracy</td>
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<tr>
<td>Generously-dimensional clamping units</td>
<td>Adaptive temperature control</td>
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<td>First-in, first-out thanks to screw/piston principle</td>
<td>15-mm screw</td>
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<tr>
<td>Highly wear-resistant bimetallic cylinder</td>
<td>12-mm screw for micro-granulates</td>
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<tr>
<td>Accessories such as clean room modules or ionisation systems</td>
<td>Micro injection unit or Micro-injection module with 8-mm injection screw for extremely small shot weights</td>
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<tr>
<td>Integrated robotic systems</td>
<td>Effective quality assurance</td>
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<tr>
<td>System solutions from a single source</td>
<td>Freely-programmable sequences</td>
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Ensuring first-in, first-out
ARBURG targets its developments where they are most effective: the existing hydraulic and electric standard machine technology is combined with optimised injection units, which makes the technology very cost-effective. All the injection units operate according to the screw-piston principle and all the screw geometries are designed for optimal material preparation as well as minimal dwell times. Special micro injection units and modules combine an 8 mm screw for injection with a second screw for melting the material. With this pioneering technology, you can reliably process even the smallest shot weights under one gram. This allows application and technology to be perfectly coordinated – right up to the system solution for micro-components. This means that the customer always gets the best solution for their specific needs.

Reproducible work practices
Clean and reliable processing of extremely small moulded parts requires high process stability by means of precise adaptive control of temperatures, pressures, speeds and positions. SELOGICA, the perfect, freely programmable machine control system can ensure this for micro-injection moulding. A good example is position control for screws for precise and dynamic injection movements. If all the peripherals such as robotic systems are integrated in the control system and therefore in quality monitoring, the process can be selectively controlled via mould signals. The result is maximum process control and therefore absolutely reproducible work practices. In absolutely every respect.

Trust an experienced partner
When it comes to injection moulding of small plastic parts, ARBURG can draw upon know-how that has been growing continuously since the production of the first injection moulding machine in 1954. Today, all of our customers benefit from this in-depth expertise:

• Through application-specific consulting that designs all the equipment with utmost precision in accordance with specific requirements
• Through detailed consulting on the machine and process technology
• Through close cooperation when designing moulded parts and moulds
• Through individual design and evaluation of all the alternative solutions
The focus here is always on finding the most cost-effective solution.
Stringent requirements – perfect solutions

When it comes to micro-injection moulding today, the details and tolerances of the articles are measured in microns. Specifically when producing micro-components, the choice of machine technology for you as the user revolves primarily around the shot weight of the moulded part to be produced and the type of sprue and runner system. At ARBURG, extremely small part weights can be realised via adapted, but always cost-effective, standard machine technology. This permits cost-saving production of even your miniature parts.

Smaller equals more complicated
Micro-components place by far the most stringent demands on machine and mould technology and require close cooperation between the two areas. The components are often smaller than a single grain of granulate. This means that high-quality production is only possible if
- all drives are operating precisely and dynamically in order to guarantee maximum process reliability and repeat accuracy,
- the prepared melt is perfectly homogeneous,
- the dwell time of the melt in the injection unit as well as the shearing of the material is kept correspondingly low (first-in, first-out principle),
- the plasticising and injection processes demonstrate a high level of reproducibility for even extremely small shot weights,
- the flow paths of the melt are kept as short as possible to avoid unnecessary pressure losses,
- the finished parts are reliably removed using robotic systems integrated in the production and control systems.

The mould technology in particular is crucial for the production of micro-structure components. The most important equipment features here include reliable venting of the cavities and variotherm temperature control. With this type of temperature control the mould wall exhibits similar high temperatures to the melt during injection, which results in much slower cooling and hardening and therefore perfect demoulding of micro-structures. Ultimately, precision micro-components can be reliably produced on precisely-operating standard machines.

Further information:
Hydraulic ALLROUNDERs brochure
Electric ALLROUNDERs brochure
Basis: modular standard machines
At ARBURG, precisely controlled hydraulic and electric ALLROUNDER machines are suited for the production of micro-components. In the injection moulding process, precision bears a direct relation to the dynamics and reproducibility of the injection movement. The Position Regulated Screw (PRS), which is optionally available for the hydraulic ALLROUNDER, offers optimum process reliability here.

All machines feature large clamping units, three-platen technology and four tie-bar guidance for precise and gentle mould use. The possible equipment versions range from processing of multiple components through to system solutions for micro-components, for example using clean-room modules, ionisation or automation.

Important: optimised plasticising
To reliably guarantee highly accurate dosage and injection with even extremely small melt quantities, screw/piston injection units that process the granulate according to the first-in, first-out principle are used. Correspondingly small screw diameters prevent excessive dwell times for the plastic during plasticising.

Optimised injection units with screw diameters of 15 mm that can cover most applications are standard at ARBURG. Screws with a diameter of 12 mm are available for smaller shot weights, however micro-granulates are required for these. All screw geometries are adapted to short and precise travel of the non-return valve. The screw and the cylinder can be designed to be highly wear-resistant in order to be able to process the abrasive materials often used in micro-injection moulding.

<table>
<thead>
<tr>
<th>Screw</th>
<th>15</th>
<th>12</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shot weight</td>
<td>mm</td>
<td>g PS</td>
<td>g PS</td>
</tr>
<tr>
<td>min.</td>
<td>0,5</td>
<td>0,3</td>
<td>0,05</td>
</tr>
<tr>
<td>max.</td>
<td>9,5</td>
<td>6,0</td>
<td>2,3</td>
</tr>
<tr>
<td>Displacement distance of the screw at 0.5 cm³ shot volume</td>
<td>mm</td>
<td>2,8</td>
<td>4,4</td>
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The long dwell time of the material in the injection unit and an extremely short displacement distance of the screw: these are the problems that can occur when processing extremely small shot weights of less than one gram. Here too, ARBURG has a practical solution for your production: our micro injection unit and our micro injection module combine an 8 mm injection screw with a second screw for melting the material. Further clear-cut advantages: homogeneous preparation of the melt, short dwell times of the plastics, high process reliability and operation according to the first-in, first-out principle. This combination allows the entire range of plastics to be used without forfeiting anything in terms of precision or part quality. And most importantly: your production remains simple, problem-free and therefore effective.

**Wide variety of options**

The Euromap size 5 micro injection unit is characterised by extremely precise control over short travel strokes in conjunction with high filling dynamics. Greater flexibility is offered by the micro injection module, which operates according to the same principle. Due to its enclosed module design, it can quickly and conveniently be removed and installed. This means that the range of machine applications is not restricted to micro injection moulding.

**8-mm injection screw**

First, a servo-electrically driven pre-plasticising section, which is installed at 45 degrees to the horizontal injection screw, ensures optimum preparation of all standard granulates. In terms of screw channel depths, the short plasticising screws are similar in design to a conventional three-zone screw. The molten material reaches the injection screw from the pre-plasticising stage through pressurised flow.

Modular design: micro injection module enables flexible machine use.
With the micro injection module and the micro injection unit, ARBURG meets all the requirements for cost-effective production of miniature and micro components.

- Two-screw combination operates according to the screw/piston principle.
- 15 or 18 mm screw for pre-plasticising, 8-mm screw for injection.
- Minimal dwell times of the plastic combined with longer displacement distance of the screw.
- Special dosage control ensures constant injection conditions.
- Homogeneous melt preparation, high process reliability and reproducibility.
- Works on the first-in, first-out principle with all common plastics.
- Enclosed modular construction enables short set-up times and convenient expansion and conversion.
- Range of machine applications not limited to micro-injection moulding.
- For use on electric ALLROUNDER 270 and 370 A machines with a size 70 injection unit.
- Machine-side equipment package with guarding, connection for servo motor, pressure measuring channel and SELOGICA functional upgrade.

**Highlights**

The screw is used purely for material transport and has a diameter of only 8 mm. It is fitted with a non-return valve and operates according to the screw/piston principle. This permits the smallest shot weights to be achieved with great precision and with the longer required travel distances.

**Homogenous material preparation**

The perfect interaction of the two screws continuously feeds the melt from the material inlet to the tip of the injection screw in a pressure-controlled manner. This ensures compliance with the first-in, first-out principle. A homogeneous, newly dosed melt is always available for each shot. The minimal dwell time of the material, which prevents thermal damage, ensures high processing quality.
Maximum process control: SELOGICA control system

1 Optimum process control
The SELOGICA has innovative control systems that permit precise position, speed, temperature and pressure control. Special dosage control ensures a homogeneous melt feed for the micro-injection module, while the position control ensures precise screw movements. Finally, adaptive temperature control achieves high temperature stability.

2 Flexible sequence management
The SELOGICA enables all peripherals, for instance for temperature control, as well as robotic systems to be centrally monitored and completely freely programmed in relation to the machine, mould or peripheral signals. This comprehensive synchronisation of movements ensures shorter cycle times, but also permits user-related process optimisations such as pressure or stroke-related cycle starts.

Reliable optimisation: the entire process can be centrally monitored.

Maintaining control over sophisticated machine, mould and robotic technology is the domain of SELOGICA. With this freely programmable setting and monitoring system, you can quickly set up both simple and complex injection moulding processes, operate them intuitively and perform reliable optimisation. In other words: central management. All technical features of the SELOGICA control system, such as the graphical sequence editor, are also ideally suited for the production of micro-components and aimed at making operation quicker, more reliable and more convenient. Here too, ARBURG provides you with decisive application advantages: because we have already integrated all the necessary functions for high-quality and cost-effective part production in the SELOGICA.

Further information:
SELOGICA control system brochure
Effective quality assurance

The SELOGICA enables programmers and operators to monitor freely selectable signals in detail. This makes it possible to set up completely individual quality assurance. This means that the flow volumes of temperature control devices, for example, as well as the compressed air or water supply of the ALLROUNDER machines can be checked.

The subsequent functions can also be flexibly determined and configured. For example, an immediate stop, a stop after cooling ends or a stop at the end of the cycle can be executed in response to a specific event. The cycle can also be terminated without production of a moulded part. This makes it possible to achieve maximum process reliability at every stage of production.

Highlights

- Control centre for all injection moulding technology
- Real-time plausibility checks
- Freely programmable synchronisation of all movement axes
- Individual programming and monitoring of the peripherals
- Freely selectable monitoring of different signals and subsequent functions
Application examples

1 Broad basis: 15-mm screw
High reproducibility is an absolute must for smooth and high-quality production, especially with micro-injection moulding. For example, the base plate for a clock movement calls for correspondingly strict tolerances. This requirement is met by a hydraulic ALLROUNDER with 15-mm screw. Position control guarantees injection with high repeat accuracy and offers optimum process reliability comparable with electric machines. However, the freely programmable SELOGICA control system not only ensures precise, dynamic injection. High process stability is also achieved by means of precise control of temperatures (adaptive), pressures, speeds and positions.

2 Production with 12-mm screw
A solution for smaller shot weights is the miniaturisation of the proven three-zone screw. This enables the dwell time to be reduced and the screw stroke to be increased with a 12-mm screw thanks to the reduced diameter with the same dosage volume. The mechanical stability of the screw is guaranteed here through a reduced screw channel depth in the inlet zone. However microgranulate must then be used. Its grains have a diameter of 1 mm and weigh approx. 0.01 g. The shot weight therefore comprises several grains of granulate, which guarantees very constant product properties.
Micro gear wheel weighing 0.001 g

Eight minute cogwheels are produced in 6.9 seconds on a fully automated system solution comprising an electric ALLROUNDER A, micro-injection module and MULTILIFT robotic system. The material processed is POM and the screw pre-plasticising guarantees optimum preparation of the standard granulate. The 8-mm screw injects extremely small shot weights. The melt feed is continuously fed in a forward direction with feed control, which means that the first-in, first-out principle is fully observed. Due to the intricate structure and small size of the injected parts, removal is performed individually via vacuum grippers. Precise, gentle demoulding is also achieved by means of the servo-regulated ejector.

Ferrule with minimal tolerances

Ceramic ferrules are used for connecting optical fibre bundles for the transmission of data. The concentricity and the highly accurate drilling of the through-hole measuring just 0.125 mm is a decisive factor with respect to the quality of the components. In comparison to other production processes, the ferrule can be produced with a higher degree of precision when powder injection moulding with a hydraulic ALLROUNDER is used. This application allows ARBURG’s position-controlled screw to demonstrate its full potential. Tolerances of ±10 μm are possible for concentricity, whereby the finishing work is reduced to a minimum. Part removal via the MULTILIFT H robotic system delivers additional process reliability.

Coil shell with system

At ARBURG, fully automated system solutions for producing micro-components are designed together with the customer, based on their specific requirements. This also applies to the example of a coil shell made from a fibre glass-reinforced polyamide PA, produced in a 4-cavity mould. The material is introduced via a cold-runner sprue; the cycle time is 12.5 seconds. The parts are removed by a MULTILIFT H robotic system that also moves the articles individually past an optical inspection station. A camera checks whether the parts are dimensionally perfect. After the camera check, the MULTILIFT H transfers the items, sorted according to cavity, to four trays on a rotary table by means of a tube system.
Distances between tie bars from 170 x 170 mm | Clamping forces from 125 kN | Injection units with screw diameters from 8 mm