AIRMOULD®/AQUAMOULD® – Fluid Assisted Injection Molding

- **AIRMOULD®**
  Internal gas pressure technique

- **AIRMOULD CONTOUR®**
  External gas pressure technique

- **AQUAMOULD®**
  Water assisted injection molding
Gas assisted injection molding

There are two BATTENFELD gas assisted processes:

- **AIRMOULD® Internal gas pressure**
- **AIRMOULD CONTOUR® External gas pressure**

Both processes, with their possibilities and advantages, are presented in detail below and the components required for execution of the process are described.

**AIRMOULD®** is the process developed and patented by BATTENFELD for gas assisted injection molding. Alongside this internal gas pressure process, BATTENFELD also offers the external gas pressure process **AIRMOULD CONTOUR®**.

**Water assisted injection molding**

**AIRMOULD®** is the process developed and patented by BATTENFELD for gas assisted injection molding. Alongside this internal gas pressure process, BATTENFELD also offers the external gas pressure process **AIRMOULD CONTOUR®**.

Different gas injection processes can be applied.

These are special mold techniques or equipment and control variants of the injection molding machine.

The type of internal gas pressure technology applied to a molded part depends on the part geometry, the raw material and the requirements on the product.

**Internal gas pressure process**

With the **AIRMOULD®** process and the **AIRMOULD®** modular system, all process variants can be executed.

The gas injection takes place, either through the **AIRMOULD®** machine nozzle or through **AIRMOULD®** injection modules, directly in the sprue or in the cavity.

After the filling is complete, the gas pressure is maintained long enough for the molded part to cool down sufficiently for dimensional stability.

Here, a uniform pressure is maintained over the whole gas channel, inhibiting volume contraction.

Before the mold is opened, the gas pressure is released and the nitrogen escapes into the environment.

In this way, molded parts can be achieved which are free of sink points and low in stress.

**The different processes are:**

- Partial filling process
- Shrinkage compensation process
- Overflow cavity process
- Melt back pressure process
- Core pull process
- Multifoam process

**AIRMOULD®** from BATTENFELD is protected by a number of patents in Germany and abroad. Whether further licences are required must be determined from case to case, depending on molded part, process and location.

### Fluid assisted injection molding

Fluids are gases and liquids. The fluid injection process is an injection molding process in which a gas or a liquid is injected into the melt.

The gas or the liquid is injected in such a way that cavities are formed in the molded part.

**With fluid injection, it is possible to manufacture molded parts offering vital advantages:**

- Quality improvement
- Avoidance of sink points
- Reduction of frozen stresses
- Reduction/avoidance of warp
- Weight reduction
- Design possibilities

Depending on the geometry of the molded parts and the desired properties, one or several of these improvements can be realised.

### | Wall thickness | **AIRMOULD®** | **AQUAMOULD®** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thick walled</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Very thick walled</td>
<td>–</td>
<td>X</td>
</tr>
<tr>
<td>Thin walled</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Thin walled with thick areas</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**AIRMOULD®** is the process developed and patented by BATTENFELD for gas assisted injection molding. Alongside this internal gas pressure process, **AIRMOULD®** also offers the external gas pressure process **AIRMOULD CONTOUR®**.

Both processes, **AIRMOULD®** and **AQUAMOULD®**, have their special advantages and complement each other.

Either the **AIRMOULD®** or **AQUAMOULD®** process is suitable, depending on the geometry of the molded parts, on the plastic and on the requirements placed on the parts.

BATTENFELD supports its customers in their choice of the process and the plant components required. For a preliminary assessment of the areas of application of the two processes, it is helpful to consider the wall thicknesses of molded parts:
The AIRMOULD® Internal gas pressure processes in detail

**The partial filling process**

The partial filling process is also known as the standard internal gas pressure process. The cavity is prefilled with melt (1), then the gas is injected (2), which displaces the melt and causes the complete filling of the cavity. The gas pressure is maintained as holding pressure (3) and is released again before the mold is opened (4). When gassing through the AIRMOULD® machine nozzle, it is possible to seal the sprue.

**The core pull process**

The melt is first injected into the mold cavity volume, reduced by the inserted cores (1). Then, at the same time as the cores are withdrawn, the nitrogen is injected into the cavity through injection modules (2). The gas pressure is maintained throughout the cooling period (3) to compensate for shrinkage and is released before the mold is opened (4).

**The shrinkage compensation process**

First, the cavity is completely filled with melt (1). Then nitrogen is injected as holding pressure (2) and acts to prevent shrinkage (3). The gas forms gas channels in the molded part, so it can still act during the cooling. The gas pressure inhibits sink marks. The gassing is carried out, depending on the molded part, through injection modules in the mold or through the AIRMOULD® machine nozzle. Before the mold is opened, the gas pressure is released again (4).

**The overflow cavity process**

First, the cavity is completely filled with melt (1). If necessary, holding pressure is applied above the melt. The nitrogen is now injected (2), displacing melt from the cavity into the overflow. The gas pressure is maintained as holding pressure throughout the cooling (3) in order to inhibit shrinkage. Before the mold is opened, the gas pressure is released (4).

**The melt back pressure process**

First, the cavity is completely filled with melt (1). If necessary, holding pressure is applied above the melt. The nitrogen is injected through an injection module into the gas channel at the end of the flow path (2), forcing melt back to the screw and barrel. Then the machine nozzle is closed. The gas pressure is maintained throughout the cooling period (3) to compensate for shrinkage and is released before the mold is opened (4).

**The multifoam process**

After injection of a specific quantity of skin material, the core material is injected. The volume, however, is not sufficient to fill the mold cavity (1). The filling is completed by the injection of nitrogen (2). The gas pressure is maintained through the cooling period (3) to compensate for shrinkage, and is released before the mold is opened (4). The gassing is carried out through an injection module directly into the mold cavity or through the AIRMOULD® machine nozzle. In this case, it is possible to seal the sprue with skin material. The multifoam process can also be combined with the mold and process techniques described above.

**The sequence of the process is as follows:**

First, the cavity is completely filled with melt (1). Then, through injection modules especially developed for AIRMOULD CONTOUR®, nitrogen is injected between the melt and the surface of the mold cavity (2). The gas pressure acts as a holding pressure cushion on the plastic, also keeping it in wall contact with the opposite side of the mold during cooling. During the cooling time (3), the nitrogen acts as holding pressure over a selected area, thus preventing the occurrence of sink marks opposite the ribbed areas on the visible side of the parts. Before the mold is opened, the gas pressure is released (4).

**AIRMOULD CONTOUR® External gas pressure**

In the conventional injection molding of ribbed molded parts, if the holding pressure is insufficient, there is a danger of sink marks occurring opposite the ribbed areas.

Here, the sink marks and warp can be inhibited with AIRMOULD CONTOUR®. Unlike AIRMOULD®, in the case of AIRMOULD CONTOUR®, the nitrogen is not injected into the centre of the melt, but between the molded part and the mold cavity.

The sequence of the process is as follows:

First, the cavity is completely filled with melt (1). Then, through injection modules especially developed for AIRMOULD CONTOUR®, nitrogen is injected between the melt and the surface of the mold cavity (2). The gas pressure acts as a holding pressure cushion on the plastic, also keeping it in wall contact with the opposite side of the mold during cooling. During the cooling time (3), the nitrogen acts as holding pressure over a selected area, thus preventing the occurrence of sink marks opposite the ribbed areas on the visible side of the parts. Before the mold is opened, the gas pressure is released (4).
The AIRMOULD® Modular System

Different molded parts, machine sizes and areas of application require different internal gas pressure systems. For optimum adaptation to individual requirements and circumstances, BATTENFELD has developed the AIRMOULD® Modular System which supports both AIRMOULD® and AIRMOULD CONTOUR®.

The AIRMOULD® Modular System is a machine independent system, which can be used both on BATTENFELD injection molding machines and on machines from other manufacturers.

The AIRMOULD® Modular System consists of 4 basic components:

— Pressure generation units
  For this process, the inert gas nitrogen is used, which does not react with the plastic. This is compressed to a sufficiently high pressure. For low gas consumption, the use of nitrogen in cylinders or cylinder batteries is the first choice.

— Nitrogen generation units
  For large volumes, either the use of liquid nitrogen or of an air separation directly on the processor’s premises is recommended. These are matched to the pressure generation units with regard to size and output.

— Gas pressure control
  Regulation of the gas pressure takes place by means of small pressure regulation modules. It is controlled either through the machine control system or by a separate control unit.

— Gas injection
  The gas is injected either through the AIRMOULD® nozzle or through gassing modules fitted directly in the mold.

All components are mutually compatible and can be used equally for AIRMOULD® and for AIRMOULD CONTOUR®.

Pressure generation units – Series DE

<table>
<thead>
<tr>
<th>Type</th>
<th>Provided quantity</th>
<th>Drive power ND</th>
<th>max. Working pressure</th>
<th>Reservoir</th>
<th>Weight*</th>
<th>Dimension (W x H x D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE 11</td>
<td>100–450 NI/min</td>
<td>6 kW</td>
<td>2.2</td>
<td>330</td>
<td>50 kg</td>
<td>410 x 750 x 1,960</td>
</tr>
<tr>
<td>DE 12/32</td>
<td>150–900 NI/min</td>
<td>9 kW</td>
<td>5.5</td>
<td>330</td>
<td>50 kg</td>
<td>410 x 940 x 1,930</td>
</tr>
<tr>
<td>DE 13/33</td>
<td>250–1.200 NI/min</td>
<td>15 kW</td>
<td>7.5</td>
<td>330</td>
<td>50 kg</td>
<td>410 x 940 x 1,930</td>
</tr>
<tr>
<td>DE 14/34</td>
<td>450–2.400 NI/min</td>
<td>27 kW</td>
<td>15.0</td>
<td>330</td>
<td>50 kg</td>
<td>1,500 x 940 x 1,830</td>
</tr>
</tbody>
</table>

The units of the DE Series are compact, noise insulated and mounted on wheels. One unit, according to output, can supply several injection molding machines with nitrogen, providing a working pressure of 300 bar.

The DE units may be installed near or at a distance from the injection molding machine. The connection to the injection molding machine is provided by high pressure gas hoses, pipes and screwed fittings.

Advantages of the DE units:

— High performance and compact construction
— Low space requirement
— One pressure generation unit can simultaneously supply several injection molding machines
— Large volume pressure reservoir

The standard units are supplied with an output of 100–450 NI/min, but other sizes are available on request.

Nitrogen generation units – Series SE

<table>
<thead>
<tr>
<th>Type</th>
<th>Provided quantity</th>
<th>Drive power ND</th>
<th>max. Working pressure</th>
<th>Reservoir</th>
<th>Weight*</th>
<th>Dimensions (W x H x D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE 12/32</td>
<td>150–580 NI/min</td>
<td>9 kW</td>
<td>5.5</td>
<td>12</td>
<td>580 kg</td>
<td>1,590 x 940 x 1,930</td>
</tr>
<tr>
<td>SE 13/33</td>
<td>250–590 NI/min</td>
<td>15 kW</td>
<td>7.5</td>
<td>12</td>
<td>590 kg</td>
<td>1,590 x 940 x 1,930</td>
</tr>
<tr>
<td>SE 14/34</td>
<td>450–650 NI/min</td>
<td>127 kW</td>
<td>15.0</td>
<td>12</td>
<td>650 kg</td>
<td>1,590 x 940 x 1,930</td>
</tr>
</tbody>
</table>

In the AIRMOULD® nitrogen generation units of the SE Series, the nitrogen is filtered from the ambient air through a multi membrane system.

The units are compactly constructed and mounted on wheels. They can be installed at any distance from the injection molding machine.

The nitrogen generation units of the SE Series are optimally matched with the DE pressure generation units.

Advantages of the SE systems:

— No compressed air required for the supply
— Nitrogen purity at least 99% (at full output)
— SE systems are exactly matched to DE systems

Combined nitrogen and pressure generation units – Series SEDE

<table>
<thead>
<tr>
<th>Type</th>
<th>Provided quantity</th>
<th>Drive power ND</th>
<th>max. Working pressure</th>
<th>Reservoir</th>
<th>Weight*</th>
<th>Dimensions (W x H x D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEDE 11</td>
<td>100–450 NI/min</td>
<td>6 kW</td>
<td>2.2</td>
<td>330</td>
<td>50 kg</td>
<td>410 x 750 x 1,960</td>
</tr>
<tr>
<td>SEDE 12/32</td>
<td>150–900 NI/min</td>
<td>9 kW</td>
<td>5.5</td>
<td>330</td>
<td>50 kg</td>
<td>410 x 940 x 1,930</td>
</tr>
<tr>
<td>SEDE 13/33</td>
<td>250–1.200 NI/min</td>
<td>15 kW</td>
<td>7.5</td>
<td>330</td>
<td>50 kg</td>
<td>410 x 940 x 1,930</td>
</tr>
<tr>
<td>SEDE 14/34</td>
<td>450–2.400 NI/min</td>
<td>27 kW</td>
<td>15.0</td>
<td>330</td>
<td>50 kg</td>
<td>1,500 x 940 x 1,830</td>
</tr>
</tbody>
</table>

The combined units each consist of one SE and one DE unit, installed together in a compact housing.

The only supply required by the SEDE units is electrical power.

The aspirated ambient air is compressed, cleaned, dried and then fed to the membrane system, which filters out the nitrogen with a purity of at least 98%.

Diagram: Modular System and injection molding machine
The gas pressure control system consists of the electrical control unit in combination with one or more pressure regulator or Monomodules.

The electrical control unit is designed for use either as a stationary or as a mobile control system.

**Stationary control unit**

**Structure of the control unit**
The stationary gas pressure control system consists of the electrical control unit integrated in the BATTENFELD machine control unit UNILOG B6 and one or more pressure regulator or mono modules.

The control system permits the operation of up to eight pressure regulator modules.

The pressure regulator modules are connected to the injection molding machine by a simple plug or piped fitting.

**Features of the stationary control unit:**
- The pressure profiles selected are displayed graphically.
- The actual value pressure curves for all pressure regulator modules can be displayed simultaneously.
- A particular advantage for the machine operator is the fact that the gas pressure curves can be displayed in one graphic, together with the machine graphs for the pressure values, distances, times etc.
- The data are saved together with the machine data.
- Data output via a USB stick.

**Mobile control unit**

**Interface and programmes**
The mobile control unit is connected to the injection molding machine via an interface. The interface used is the EM 62 interface from VDMA, which is standardised for fluid injection. The AIRMOULD® interface developed by BATTENFELD also continues in use. BATTENFELD supplies suitable converters for adaptation to both interface types.

The mobile control unit may, for example, provide the following programmes:
- Pressure monitoring programme
- Impulse programme (automatic blow-out of the injection modules)
- Control of mobile injection modules
- Control of core pull functions (directional control valves)

The signal exchange is tested with the diagnostics function. The safety functions and programme elements guarantee the faultless operation of AIRMOULD® and AIRMOULD CONTOUR®.

Through the machine interface, depending on the design of the mold, various AIRMOULD® control components can be connected:
- If the gas injection takes place at one point only through an AIRMOULD® machine nozzle or through an injection module in the mold, a Monomodule with a hand programming device, directly connected with the injection molding machine via the interface, is the least expensive solution.
- If two injection modules in the mold have to be controlled, two Monomodules with a hand programming device can be directly connected via a duplex cable and the machine interface.
- If several injection modules in the mold have to be controlled, or core pull functions or mobile injection modules have to be operated, the mobile control unit is used. It can control up to 4 pressure regulator or Monomodules.

**Advantages of the mobile control unit with touch screen operation:**
- High resolution graphic screen (VDA Colour)
- Easy operation
- Menu guided, operator friendly input
- Pressure profile input with set curve and up to nine freely programmable positions
- All time indications with 1/100 s accuracy
- Actual value graphic for pressure curves in profile form for up to four pressure regulator modules simultaneously
- Up to four pressure or mono-modules can be connected
- Compatible with all AIRMOULD® components, e.g. pressure regulator modules, Monomodules, pressure motion modules
- External data storage on diskette
- Standard with German / English
- All text characters can be displayed
- Programme for control of cores (motion valves): Software (standard), Hardware (option)
- Programme for control of mobile injection modules
- Diagnostics function (check of signal exchange)
- Manual operation function (check blow function, process injection modules and cores)
**Pressure control modules**

The gas pressure is regulated by at least one pressure control module (blue housing) or one Monomodule (yellow housing). The gas in the line between gas injection and pressure module is lost at every cycle. In order to minimise these gas losses, the connections should be as short as possible.

BATTENFELD pressure modules are small, compact units. This permits their installation and mounting near the gas injection point, on the machine or on the mold. In this way, pressure regulation is guaranteed and nitrogen consumption is minimised. The connection is provided by short, low-volume high pressure gas hoses and electrical cables.

The gas pressure is regulated by high precision valves. The valves are directly electrically controlled and need no additional compressed air or hydraulics. Thanks to the special construction of the pressure regulator modules, there is precise pressure regulation and monitoring of both small and large gas volumes.

The pressure control modules and Monomodules are fitted with intake and output filters.

In order to protect the precise pressure regulator valves against fouling by volatile gaseous substances released from the plastic on depressurisation, all pressure control and Monomodules are equipped as standard with pressure relief through a separate quick relief valve with a silencer. This quick relief is also advantageous for large gas volumes.

**Monomodules**

For many applications, gas injection at only one point is sufficient. For these applications, the Monomodules (yellow housing) have been developed. The Monomodules offer the same advantages as the pressure regulator modules. The differences are in the electrical control system. This can take place as described here:

- **Two selectable operating modes:**
  - **Operating mode 1:** Function as pressure regulator module in combination with the stationary machine control unit or the mobile control cabinet.
  - **Operating mode 2:** Function as autonomously working Monomodule. In this case, neither the stationary or the mobile control unit are required. The Monomodules are programmed by means of the hand programming device.

The connection of the Monomodules with the injection molding machine is made directly via the machine interface. Using the duplex cable, up to two Monomodules can be directly connected to the interface with one injection molding machine.

**Injection modules**

Fixed injection modules are permanently integrated into the mold. They are used when the fitting direction of the module coincides with the release direction of the molded part.

If this is not the case, these modules can be built into a moving slide or equipped with a separate drive to move them back and forth. BATTENFELD has developed injection modules for AIRM mould® with external diameters of 3, 5 and 8 mm in various standard lengths.

**Advantages:**

- **High gas throughflow**
  For internal gas pressure injection molding, the gas pressure has to be built up quickly. All BATTENFELD injection modules therefore feature high gas throughflow.

- **Gas throughflow optimisation**
  All modules are tested for gas throughflow before delivery. This ensures that all gas modules of one diameter permit the same gas throughflow.

- **Easy installation**
  The injection module is installed and sealed from the rear of the mold.

- **Easy cleaning**
  If necessary, cleaning can be carried out in a few seconds by unscrewing the module head when the mold is open.

- **Optimum choice**
  Modules with diameters of 3, 5 and 8 mm are available in standard lengths. This ensures the supply of spare parts, even at short notice.

- **Individual adjustment of immersion depth**
  For optimum adjustment of the module’s immersion depth, the adapter supplied can be ground to the required length. Any adjustment of the immersion depth necessary for optimisation is also possible by straightforward grinding down of the adapter.

- **Small aperture in the molded part**
  The aperture in the molded part corresponds with the diameter of the injection module.

**Nozzles**

For the injection of nitrogen through the machine nozzle, the AIRM mould® nozzles were conceived to introduce the nitrogen into the heart of the plastic melt. The AIRM mould® nozzles prevent nitrogen entering the screw cylinder during the gas injection.

The AIRM mould® nozzle is designed as an open nozzle. It is used when no shut-off nozzle is required for the melt. This means that it can also be easily retrofitted on existing injection molding machines. Its special advantage is its compact size.

If, for reasons related to the raw material or the molded part, however, a shut-off nozzle is necessary, the AIRM mould® nozzle head is connected with a pin or cross bolt shut-off nozzle.
AIRMOULD® Modular System: Configuration possibilities

AIRMOULD® and AQUAMOULD® – Examples
AQUAMOULD® – Water assisted injection molding

In the AQUAMOULD® process, water is injected directly into the melt.

**Advantages:**
- Short cooling times thanks to direct cooling of the plastic
- Weight reduction thanks to cavities
- Low warp molded parts
- More uniform residual wall thickness distributions
- Smooth cavity surfaces inside the molded part
- Long cavities can be realized
- Low costs for the medium, water

AQUAMOULD® Water injection technology

The process technology in the AQUAMOULD® process is similar to the internal gas pressure process AIRMOULD®. The essential difference is that, in the case of AQUAMOULD®, water is injected instead of nitrogen. With AQUAMOULD®, molded parts can be achieved which are not only free of sink points, but also low in stress.

The water injection technology is particularly suitable for the following product groups:
- Moldings in which the aesthetics dominate, e.g. handles, thick walled parts
- Functional parts for which medium conducting channels are necessary, e.g. pipes, lines carrying media

Internal water pressure process

In addition to the process of partial filling with plastic and subsequent complete filling of the cavity by the injection of water, there are other water injection processes. The type of internal water pressure technology applied to the molded part concerned depends on the part geometry, the raw material and the requirements on the product.

**Applicable process options:**
- Partial filling process
- Ancillary cavity process
- Melt back pressure process
- Multifoam process

AQUAMOULD® from BATTENFELD is protected by numerous patents in Germany and abroad. Whether further licences are required must be determined from case to case, depending on molded part, process and location.

The AQUAMOULD® Internal water pressure processes in detail

**The partial filling process**

In the partial filling process, the cavity is prefilled with melt (1), then water is injected (2), displacing the melt and causing the complete filling of the cavity. The water is injected through an AQUAMOULD® injection module into the sprue distributor or directly into the molded part. The water pressure is maintained as holding pressure (3) until the molded part has cooled down sufficiently. The water is drained off before the mold is opened (4).

1 2 3 4

**The overflow cavity process**

First, the cavity is completely filled with melt (1). If necessary, holding pressure is applied above the melt. The water is now injected (2), displacing melt from the cavity into the overflow. The water pressure is maintained as holding pressure (3) until the molded part has cooled down sufficiently. The water is drained off before the mold is opened (4).

1 2 3 4

**The melt back pressure process**

First, the cavity is completely filled with melt (1). If necessary, holding pressure is applied above the melt. The water is injected through an AQUAMOULD® injection module into the water channel at the end of the flow path (2), forcing melt back into the screw vestibule. Then the machine nozzle is closed. The water pressure is maintained as holding pressure (3) until the molded part has cooled down sufficiently. The water is drained off before the mold is opened (4).

1 2 3 4

**The multifoam process**

After injection of a specific quantity of skin material, the core material is injected. The volume, however, is not sufficient to fill the mold cavity (1). The filling is completed by the injection of water (2). The water pressure is maintained as holding pressure (3) until the molded part has cooled down sufficiently. The water is drained off before the mold is opened (4). The multifoam process can also be combined with the mold and process techniques described above.
**Advantages:**
- High performance, compact units
- Low space requirement
- Supply of two injection molding machines simultaneously (option)
- High water injection performance thanks to reservoir system

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**Pressure generation units**

The water must be compressed to a sufficiently high pressure for injection.

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**Water pressure control**

The water pressure is regulated. Regulation of the pressure takes place by means of compact pressure regulation modules. It is controlled either through the machine control system or by a separate control unit.

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**Water injection**

The water is injected through AQUAMOULD® injection modules fitted directly in the mold. All AQUAMOULD® components are mutually compatible. This means that the optimum system can be constructed for the application.

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**Pressure generation units – Series WE**

<table>
<thead>
<tr>
<th>Type</th>
<th>Final pressure</th>
<th>HD Pump</th>
<th>HD Pump</th>
<th>Heater</th>
<th>Reservoir</th>
<th>approx. Dimensions</th>
<th>approx. Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>WE 60</td>
<td>330</td>
<td>0.37</td>
<td>1.1</td>
<td>6.0</td>
<td>1 x 32</td>
<td>1,950 x 800 x 1,800</td>
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<tr>
<td>WE 100</td>
<td>330</td>
<td>0.37</td>
<td>1.5</td>
<td>6.0</td>
<td>2 x 32</td>
<td>1,950 x 800 x 1,800</td>
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<td>WE 200</td>
<td>330</td>
<td>0.37</td>
<td>3.0</td>
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<td>3 x 32</td>
<td>1,950 x 800 x 1,800</td>
<td>610</td>
</tr>
</tbody>
</table>

The pressure generation units of the WE Series for AQUAMOULD® are constructed as compact, noise-insulated units and mounted on wheels. Industrial water is used. All parts in contact with water are made either of copper (low pressure region) or stainless steel (high pressure region).

The connection to the injection molding machine is provided by stainless steel pipes, high pressure gas hoses and screwed fittings.

Standard pressure generation units for water are supplied with outputs from 60 to 200 l/h. Other sizes are available on request.

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**AQUAMOULD® Pressure control and regulation**

The injection of water is carried out with regulated pressure, which has a direct influence on the delivery volume. The water pressure control system consists of the electrical control unit in combination with one or more water pressure regulator modules.

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**Stationary control unit**

The stationary pressure control system consists of the electrical control unit integrated in the BATTENFELD machine control unit UNILOG B6 and of up to eight water pressure regulator modules. The control system permits the operation of up to eight pressure regulator modules. The pressure regulator modules are connected to the injection molding machine by a simple plug or screwed fitting.

The pressure profiles selected are displayed graphically. The actual value pressure curves for all pressure regulator modules can be displayed simultaneously. A particular advantage for the machine operator is the fact that the gas pressure curves can be displayed in one graphic, together with the machine graphs for the pressure values, distances, times etc.

The data are saved together with the machine data, with data output via a USB stick.

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**Mobile control unit**

The mobile control unit is connected to the injection molding machine via an interface. The interface used is the EM 62 interface from VDMA, which is standardised for fluid injection.

The mobile control unit provides the following programmes:
- Pressure monitoring programme
- Control of the opening and closing function of the water injection modules
- Control of core pull functions (directional control valves)

**Advantages:**
- High resolution graphic screen (VDA Colour)
- Menu guided, operator friendly input
- Pressure profile input with set curve and up to nine freely programmable positions
- All time indications with 1/100 s accuracy
- Actual value graphic for pressure curves in profile form for up to four pressure regulator modules simultaneously
- Up to four pressure or mono-modules can be connected
- Programme for control of mobile injection modules
- Compatible with all AQUAMOULD® components, e.g. pressure regulator modules, mono-modules, pressure motion modules
- External data storage on diskette
- Standard with German/English
- All text characters can be displayed
- Programme for control of cores (motion valves): Software (standard), Hardware (option)
- Diagnostics function (check of signal exchanges)
- Manual operation function (check blow function, process injection modules and cores)
Pressure control modules
The regulation of water pressures is carried out by pressure control modules. The compact construction of the AQUAMOULD® pressure control modules permits their installation in the immediate vicinity of the mold, providing very precise regulation and minimizing pressure drop and performance losses in the water injection. The water pressure is regulated in profile form. This results in an optimum influence on the water volume delivery during injection and on the water pressure during the holding and cooling phases. Leakage-free proportional valves with a water throughput of up to 500 ml/s regulate the water pressure precisely when injecting either small or large volumes of water.

As the valves are directly electrically controlled, a pressure or hydraulic oil supply is not necessary.

Water injection
AQUAMOULD® Injection modules
The water is injected directly through injection modules in the mold.

The demands on injection modules are:
- Small construction
- Large section for water flow
- Opening and closing function
- Leakage-free
- Simple assembly

Advantages:
- Safe separation between water and oil
- Position control by proximity switch
- Easy fitting

Water removal from the molded part
In order to empty the water out of the molded part with the mold closed, the following solutions have proven effective:

Gravity removal
If the geometry of the molded part and the fitting position of the mold permit, the water in the molded part can be removed from the part through the AQUAMOULD® pressure regulator module.

Blowing out with compressed gas
If a second injection module is fitted at the end of the channel formed by the water, the gas injected through this module, e.g. compressed air, can expel the water in the cavity through the AQUAMOULD® injection module.

Alternating compressed air feed
If alternating compressed air is input through the water injection module and the geometry of the molded part and the fitting position of the mold permit, the water in the molded part can be removed through the water injection aperture.

Vacuum removal
By the application of a vacuum, the water can be removed through the AQUAMOULD® injection module.

The AQUAMOULD® Modular System is optimally tuned to the requirements of the AQUAMOULD® process and has proven itself in practice.

The competence of the machine manufacturer gives the user of the AQUAMOULD® process the assistance he requires in the design and selection of the most suitable AQUAMOULD® system.

Services for AIRMOULD® and AQUAMOULD®

BATTENFELD is offering the following services:

- Support from conception to series production
- Molding design for the process
- Specification of melt and gas or water injection
- Design of injection molding machine, mold, AIRMOULD® or AQUAMOULD® Modular System, automation
- Complete production solutions, including all components required, for AIRMOULD® or AQUAMOULD®
- Trials in a BATTENFELD technical facility
- Schulungen bei BATTENFELD oder beim Kunden
- Training courses at BATTENFELD or on the customer’s premises