AIRMOULD®
Internal gas pressure technology

world of innovation
Fluid-assisted injection molding is a process in which a gas (usually nitrogen) or a liquid is injected into a mold cavity partly or completely filled with melt. The pressurized gas forms a bubble at the center of the melt, which counteracts shrinkage and thus removes sink marks. By reducing the quantity of plastic material and enlarging the cavity, targeted production of light-weight parts with excellent surface quality can be achieved with short cycle times. Due to its high heat conductivity and high degree of incompressibility, water is used primarily as a flexible piston to produce complex hollow structures, such as three-dimensional media duct systems. Both processes open up extensive scope for parts designers to realize complex molded components in one piece and with smooth surfaces. For the sake of completeness it should be mentioned that in both processes most of the “fluids” can be restored to the environment after the parts have been formed.

The advantages
» Quality improvement
» Elimination of sink marks
» Elimination of warpage due to shrinkage
» Reduction of the required clamping force
» Reduction of cycle time
» Weight reduction
» Additional scope for design
Internal gas pressure technology is used in several different process variants, depending on the parts geometry, the plastic material used and the specific requirements for the product. Basically, a distinction is made between the "partial filling process", the "spill-over cavity process" and the "shrinkage compensation process". The three processes differ from each other by their specific mold technologies and the equipment and control system variants of the injection molding machine. All three process variants can be realized with the modular AIRMOULD® gas supply systems.
» Partial filling process
Partial filling is the standard process. The cavity is partially filled with melt [1]. Next, gas is injected. It forms a gas bubble inside the hotter core area with lower viscosity and displaces this part of the melt until the cavity is completely filled [2]. The gas pressure is maintained as holding pressure for shrinkage compensation [3] and finally removed prior to mold opening [4]. Gas injection through the AIRMOULD® nozzle of the machine serves to seal the sprue.

» Spill-over cavity process
As process step No. 1, the cavity is completely filled with melt [1]. If necessary, holding pressure is applied to the melt. Then the spill-over cavity (overflow) is opened and nitrogen injected [2]. The gas displaces melt from the core area of the plastic material into the overflow. Subsequently, the gas pressure is maintained as holding pressure throughout the entire cooling period [3] and thus counteracts shrinkage. The gas pressure is removed prior to opening the mold [4].

» Shrinkage compensation process
First, the cavity is completely filled with melt [1]. Then nitrogen is injected [2] and supplies the holding pressure to counteract shrinkage [3]. The gas forms channels inside the molded part, in which gas pressure is maintained throughout the cooling period and thus counteracts shrinkage. Depending on the molded part, the gas is injected either through aggregates inside the mold or the AIRMOULD® nozzle of the machine. The gas pressure is removed prior to mold opening [4].
Different molded parts, machine sizes and fields of application require different internal gas pressure equipment. For optimal adjustment to all types of requirements and conditions, WITTUMANN BATTENFELD has developed the AIRMOULD® module system.

AIRMOULD® internal gas pressure technology is independent of machine models and can also be used on machines of other brands.

» Pressure generator
   Nitrogen is used as pressure medium, since it does not form any chemical bond with the plastic material. In the pressure generator, the nitrogen is compressed to an appropriate pressure level. For low gas consumption, the use of nitrogen bottles or gas cylinder manifolds is recommended. For equipment with a high nitrogen consumption, the pressure generator can be combined with a nitrogen generator from the AIRMOULD® module system and extract the nitrogen from the ambient air directly next to the machine.

» Process control
   The AIRMOULD® process can be monitored and controlled via the machine’s control system, or alternatively via the touch screen of a separate control cabinet or a manual control unit.

» Gas pressure control
   To control the gas pressure, individual pressure control modules are used which can be mounted close to the mold to ensure an optimal, cost-efficient process by keeping the gas pipes as short as possible.

» Gas injection
   The gas is injected either through the AIRMOULD® machine nozzle or via gas valves located directly inside the mold.
**GAS SUPPLY UNITS**
Powerful, for one or several machines

**Pressure and nitrogen generators**
The nitrogen and pressure generation equipment developed and manufactured by WITTMANN BATTENFELD is available in different sizes and with varying capacities, either to supply individual machines or as central systems to supply several machines.

**Control system**
The control system of the pressure generators is self-explanatory. All important information from the pressure generators and, as an option, from the nitrogen generators are displayed clearly and in a simple way. The equipment’s control system can be integrated into the corporate network. In this way, all parameter settings and signals of the equipment can be transmitted to any network-compatible PC.

**Advantages**
» Self-explanatory, clear and simple
» 5.7” color TFT display with touch screen
» Network-compatible
» Protection by password against unauthorized operation
PRESSURE AND GAS GENERATION
With three output levels

DE pressure generator
The pressure generators compress the nitrogen to a sufficient pressure for all AIRMOULD® applications. Depending on its capacity, one unit can supply either one or several machines. With the help of a modern control system, the pressure generators can be operated by remote control via the corporate network. With its modular design, every pressure generator can be retrofitted with a nitrogen generator at any time.

Advantages
» Retrofit with a nitrogen generator possible at any time
» Modern control system with remote control function
» Small footprint
» Compact, sound-insulated unit

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<th>Type</th>
<th>Output</th>
<th>Drive power ND</th>
<th>Max. working pressure</th>
<th>Storage capacity</th>
<th>Weight</th>
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SE Nitrogen generator
With the nitrogen generator extension modules of the SE series, every pressure generator can be converted into a self-sufficient appliance. Special filter membranes are used to extract the nitrogen from the ambient air. The extension modules are adapted to fit the matching pressure generators of the DE series and can easily be retrofitted at any time.

Advantages
» Independent operation, no logistic expense to replace nitrogen bottles
» Nitrogen purity of at least 98 %
» One control system for the entire equipment
» Compact, sound-insulated unit

<table>
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<tr>
<th>Type</th>
<th>Output</th>
<th>Drive power ND</th>
<th>Max. working pressure</th>
<th>Storage capacity</th>
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PROCESS CONTROL
Integrated in the machine’s control system

» Integrated control system
With WITTMANN BATTENFELD machines, it is possible to integrate process control into the machine to 100%. Via the UNILOG B6 or B8 control systems, all parameters can be set and visualized. Up to eight pressure control modules can be controlled by the machine.

Advantages
» The selected pressure profiles are shown as curves.
» The actual value pressure curves for all pressure control modules can be displayed simultaneously.
» Simultaneous display of gas pressure curves and machine-relevant process curves in one chart.
» The data are saved together with the machine data.
» Data output is effected via a USB flash drive.
Mobile gas pressure control

» Mobile UNILOG B6 control unit
A centralized mobile control unit is used to operate the pressure control units and core pulls. Its core component is a UNILOG B6 control system. It is connected with the machine via the standardized VDMA EM 62 interface for fluid injection and can therefore basically be combined with injection molding machines of all brands. Up to eight pressure control modules and eight core pulls can be controlled.

The mobile control system offers, for instance, the following programs:
- Pressure monitoring
- Impulse program (automatic free-blowing of injection elements)
- Operation of core pull functions (control valves)

Advantages
» Up to eight pressure or mono modules can be connected
» Program to operate core pulls (control valves)
» Parts counter with good parts/rejects analysis
» 15" TFT color screen with touch screen functionality for operation and display
» Access control via USB flash drive or password
» Log book with filtering function
» Internal data recording via USB port or network
» Pressure profile entry with nominal curve and up to nine freely programmable positions
» Actual values display for pressure curves in the form of profiles simultaneously for up to eight pressure control modules
GAS PRESSURE REGULATION
Pressure control modules

» Control module
Gas pressure regulation takes place via at least one pressure control module (blue housing) or one mono module (yellow housing). The gas inside the pipe between the gas injection aggregate and the pressure module is lost in every cycle. To minimize this gas loss, short connection paths are desirable.

The compact design of the control modules enables their positioning close to the point of gas injection, either on the machine or on the mold. In this way, precise pressure regulation is ensured, and the nitrogen consumption minimized as well. Short, small-volume high-pressure tubes are used to make the connection.

The gas pressure is regulated via high-precision valves. The valves are directly operated with electric power and need no additional compressed air or hydraulics. Thanks to the special design of the control modules, precise regulation and monitoring of the gas pressure is ensured for both large and small gas volumes. The pressure control modules and mono modules are equipped with input and output filters.

The pressure regulation modules are operated either via a control unit integrated in the injection molding machine or, alternatively, via a mobile control unit.

Mono module standard equipment package
» Parameter setting facility for five different gas pressure levels and times
» Impulse program for cleaning of gas injectors at regular intervals
» Pressure monitoring program to detect leakages on molded parts
» Freely selectable ramp functions for pressure changes
» Standardized EUROMAP 62 interface
» Memory capacity for 64 data sets
» Input pressure monitoring

The mono modules can be operated as independent units directly on the machine. Up to two mono modules can be operated directly via the Euromap 62 interface without a control unit. Parameter setting in the modules is effected via a manual operating device.
**GAS INJECTION**
Nozzles and injection elements

» **Nozzles**
Special AIRMOULD® nozzles have been designed to inject the nitrogen through the nozzle of the machine. The AIRMOULD® nozzles prevent the nitrogen from entering the barrel during gas injection. The nozzle’s connection dimension is identical with that of a standard nozzle, so that it can easily be retrofitted to any machine.

» **Injection elements**
Via an injection element, the nitrogen is injected into the mold. The elements are available in different lengths and diameters, so that a suitable element can be chosen for every application.

**Advantages**
» The injection element is inserted and sealed from the rear of the mold.
» Easy cleaning: where necessary, cleaning can be effected within a very short time by unscrewing the element head from the open mold.
» Small apertures in the mold: the aperture in the mold corresponds to the diameter of the injection element.
» **Mobile AIRMOULD® internal gas pressure unit**

If desired, the WITTMANN BATTENFELD components can be assembled into a mobile unit. This makes it possible to use internal gas pressure technology on different machines without great expense. The equipment of the unit is freely configurable. In addition to the standard AIRMOULD® internal gas pressure modules, a separate hydraulic aggregate is available. This enables operation of additional core pulls independent of the machine using the control cabinet and the hydraulic aggregate.

$\text{ projectile insertion \hspace{1cm} melt injection \hspace{1cm} partial filling with melt \hspace{1cm} gas injection \hspace{1cm} gas injection \hspace{1cm} removal of gas pressure }$

» **Projectile injection process**

With this fluid injection technology, a displacement body (projectile) is driven under gas pressure through the previously injected melt. The projectile displaces plastic melt and thus forms a cavity with a uniform diameter. This process is particularly recommended for pipes and media conduits. Handles and other parts with sizeable hollow spaces of uniform diameter can also be produced with projectile injection technology.
Gas injection system

- Nitrogen generators SE extension modules
- Nitrogen bottles
- Compressor units DE
- DE compressor unit fitted with SE extension module
- Pressure regulator module
- Manual control unit
- Control unit for up to 2 modules
- Control system for up to 8 regulator modules and 8 core pull functions
- Mobile 96 control unit
- AirMould* integrated control system for up to 8 regulator modules and 8 core pull functions
- Machine interface
  - Euroshop 52
  - JSMF 03
AIRMOULD®
Application examples

Automotive

Excellent moldings are achieved with internal gas pressure technology in the production of premium-class door handles, operating levers and handholds for vehicles and the automotive sector, which also meet the industry’s requirements for high-quality surfaces. In addition to weight reduction, high productivity is achieved with internal gas pressure technology through short cycle times using the “partial filling process” or the “spill-over cavity process”.

Packaging

The carrying comfort of beverage crates is improved by a targeted wall thickness increase in the gripping areas. Sink marks in these areas are prevented by the “shrinkage compensation process” using internal gas pressure technology.

Pipes and media supply lines

For pipes and media supply lines, cavities can be created at predefined points by combining the projectile injection process with the “spill-over cavity process”.

Exterior door handle – WITTE Automotive

Beer crate – Oberland MV

Media supply line
Building construction

In addition to reductions in part weights and cycle times resulting from the “partial filling process”, the internal gas pressure process creates added advantages in using the products. The lighter weight ensures easier handling for products used in building construction, such as rubbing boards.

Products for daily use

With the help of internal gas pressure technology, the scope for added criteria can be extended in designing parts like the coat-hanger shown in the picture. The design can be realized with internal gas pressure technology. In addition to reducing both the part weight and the cycle time, warpage is also minimized by using the “partial filling process”.

Sports and leisure products

This hockey stick, manufactured with internal gas pressure technology in the “partial filling process” provides sportsmen with a lightweight piece of equipment adapted to their requirements.