Cellmould

Foam injection molding for light-weight parts

world of innovation

CELLMOULD
Physical foaming with many advantages

Cellmould is a process developed by WITTMANN BATTENFELD for manufacturing structured foam parts by direct gas injection into the melt with a physical foaming agent. Structured foam parts are characterized by a compact outer layer and a foamed core. With Cellmould light-weight technology, extremely light molded parts can be produced with high rigidity and without sink marks.

WITTMANN BATTENFELD has had many years of experience in structured foam technology and has numerous systems in operation. Direct gas injection into plastic melt as a proprietary process has been practiced for 20 years.

The aim of Cellmould light-weight technology is to produce both thick-walled and thin-walled structured foam parts with a fine, even foam structure and reduced weight.

Advantages

» Weight reduction
» Elimination of sink marks
» Reduction of warpage
» Reduced parts costs
» Lower tolerances
» Higher rigidity with the same weight
» Longer flow paths through reduced viscosity
» New design options
» Lower internal mold pressure
» Lower clamping force requirements

Cellmould is a foaming process in which a pressurized gas, normally nitrogen, is injected into the plastic melt inside the barrel of an injection molding machine and also finely distributed. Due to the high pressure of up to 330 bar, the nitrogen is supplied in liquid form and subsequently dissolves in the plastic melt as a supercritical liquid. When injected into the (vented) cavity of the mold, the pressure is released into the melt. The plastic/nitrogen blend separates again. Simultaneously, the supercritical liquid returns to its gaseous state, forming a fine bubble structure based on its homogeneous distribution. Its actual structure depends on the conditions in the injection molding process. These include the melt viscosity of the plastic material, the injection speed (the higher the speed, the finer the foam structure), and finally the quantity of material (the less plastic, the more space is available for the formation of a foam structure with material reduction). The latter is achieved either by appropriately lower dosing for a fixed cavity or by completely filling the cavity and subsequently opening it by a pre-determined high-precision stroke.

Effect of the filling time (injection time) on the foam structure of PC parts:
(A high injection speed leads to a short injection time.)

» **Filling time = 0.3 s**

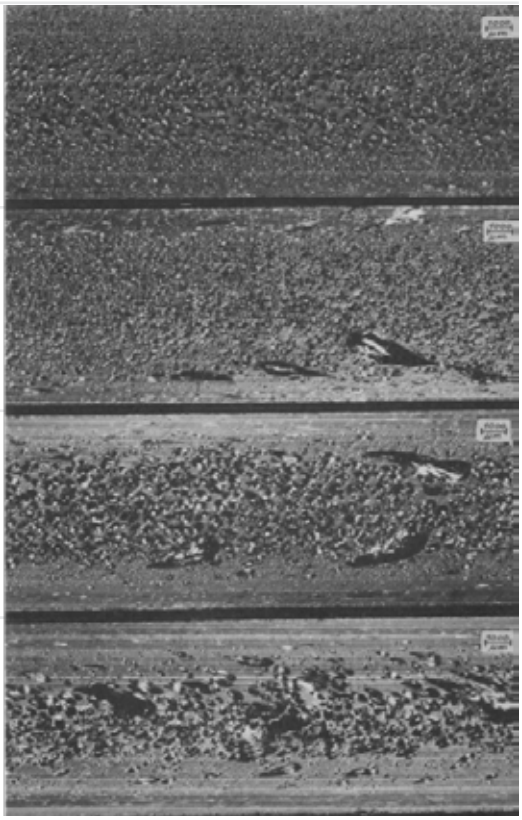
Outer layer: thin
Cell structure: fine

» **Filling time = 0.6 s**

» **Filling time = 1.2 s**

» **Filling time = 1.5 s**

Outer layer: thick
Cell structure: coarse

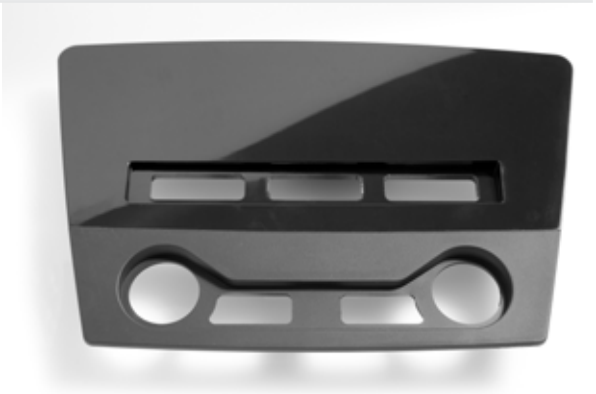


CELLMOULD
Process technology options

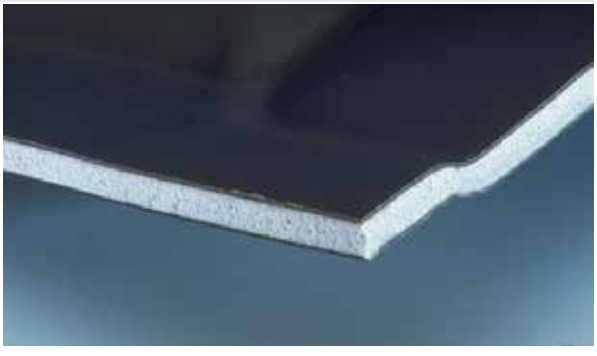
» **Standard foaming**
In the standard process, nitrogen is injected into the plastic melt in a special plasticizing unit behind a needle shut-off nozzle, then finely distributed and dissolved in the melt. Following injection into the temperature-controlled, non-pressurized mold cavity, the gas is released from the solution and forms fine bubbles. Some of the gas bubbles reach the surface of the polymer melt and become visible in the form of striations on the molded part surface. Improvement of the surface is possible in combination with additional process modules.

» **Variothermic foaming**
Where foamed parts must have a high-quality surface, it is necessary to combine the standard process with additional process technology equipment around the mold.

For example:
- reverse embossing technology (HiQ Opening), by which the mold is completely filled and allows foaming of the core only after withdrawal of a mold insert or by high-precision opening of the clamping unit.
- additional variothermic heating/cooling of the mold cavity by WITTMANN temperature controllers with Variotherm devices (WITTMANN TEMPRO plus Vario).



» **Co-injection foaming**
By installing Cellmould technology on one of the two plasticizing units of a co-injection molding machine, molded parts can be produced with a light-weight foamed core made of either virgin or recycled plastic material surrounded by a compact covering layer. The core and covering layer need not necessarily consist of the same material.

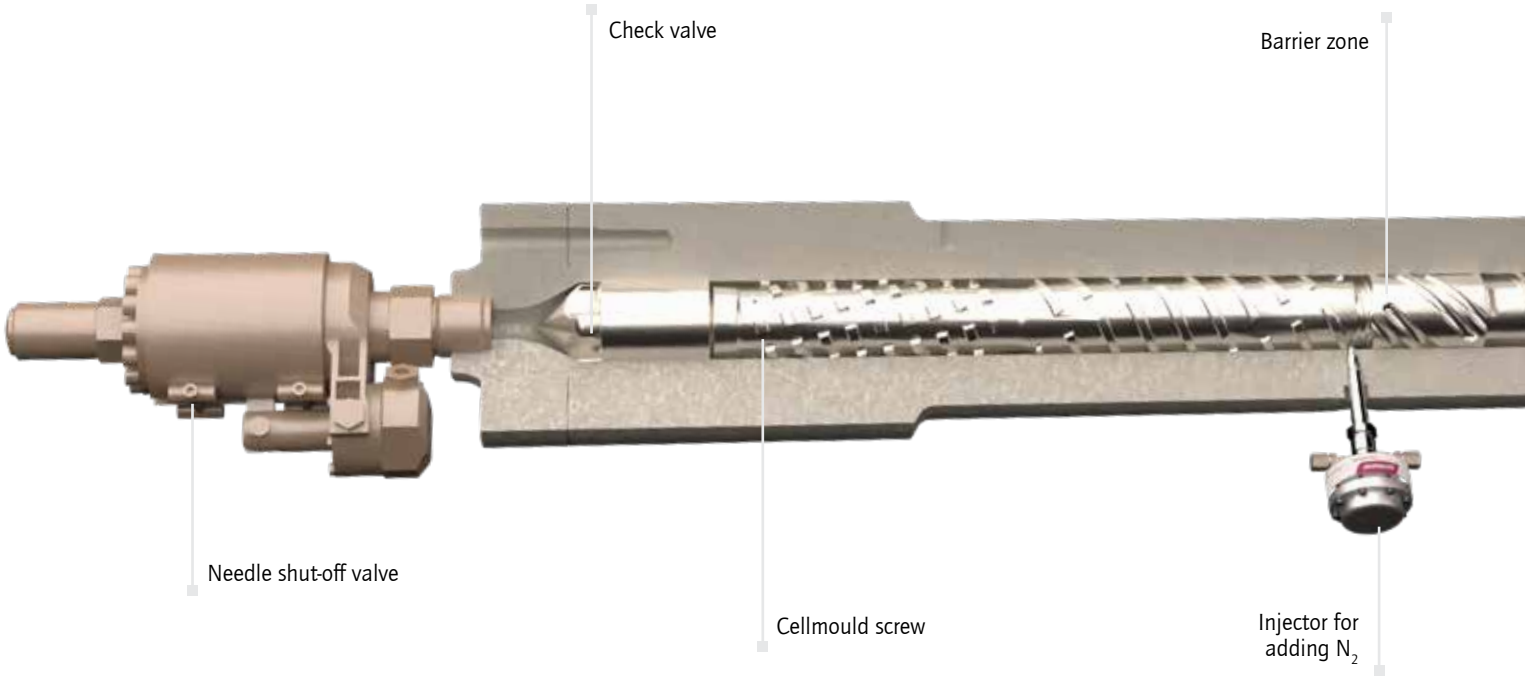


PLASTICIZING UNIT
20 years of in-house development

The WITTMANN BATTENFELD specific feature of Cellmould technology is the separation of the plasticizing section from the gas injection section of the 25 D Cellmelt screw by an exchangeable barrier segment of the screw.

The 2021 screw design, in particular the barrier segment, is protected by patent under EP 3 338 992 B1. With this new protected design, the back pressure can be adjusted over a larger process window. Added to this is an increase in plasticizing performance of up to 10 %[1].

The general design of the screw in three parts consisting of a plasticizing section, a barrier zone and a blending zone enables quick exchange of individual sections without having to replace the entire screw if there is a need for adjustment.



1) Compared to the predecessor, with the same material and identical process settings.

CELLMOULD SYSTEM
Everything from a single source

For manufacturing Cellmould parts, every WITTMANN BATTENFELD injection molding machine from the EcoPower, SmartPower and MacroPower series can be combined with the necessary additional equipment.

» **Compressor units (DE)**
Nitrogen is used as foaming agent. It can be supplied from commonly available pressurized bottles or from the ambient air via a nitrogen generator (also available as an extension module for every compressor unit). In the compressor unit, the nitrogen is compressed to an operating pressure of up to 330 bar and transported through pipelines to a gas flow regulator and from there to the gas injector on the barrel.

» **Gas flow regulator**
The gas flow regulator is installed between the compressor unit and the gas injector. It serves to set the quantity of gas injected into the barrel and the gas pressure measured on the injector. These parameters are set on the corresponding screen page of the machine's Unilog B8 control system.

» **Gas injector**
The gas injector is a device developed in-house by WITTMANN BATTENFELD. It is screwed into the barrel, and its function is to add liquefied nitrogen to the plastic melt.

Compressor unit DE fitted with an SE nitrogen generator extension module

Nitrogen generators – extension modules SE

Nitrogen bottles

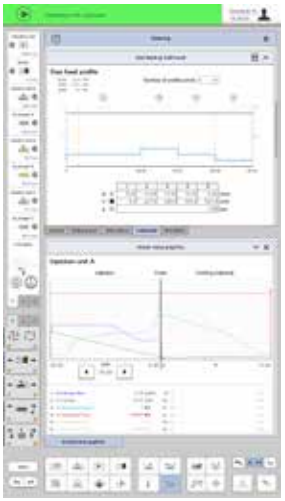
DE compressor unit

» **Increased injection speed**
Since the formation of the cell structure can be significantly influenced by the injection speed, a pressure accumulator to accelerate the injection stroke is an essential part of every Cellmould equipment package for machines with a hydraulic drive system. In all-electric machines, an injection drive with increased servo motor output functions as pressure accumulator.

» **Cellmould set-up via B8 control system**
Within the B8 machine control system, a separate screen page is available for entering parameter settings for the process. The control system not only controls the gas supply, but also all process-relevant pressure/time parameters.

All data can be saved together with the product information. It is also possible to monitor quality-related trends of selected process parameters via the machine's control system.

Parameter setting via B8



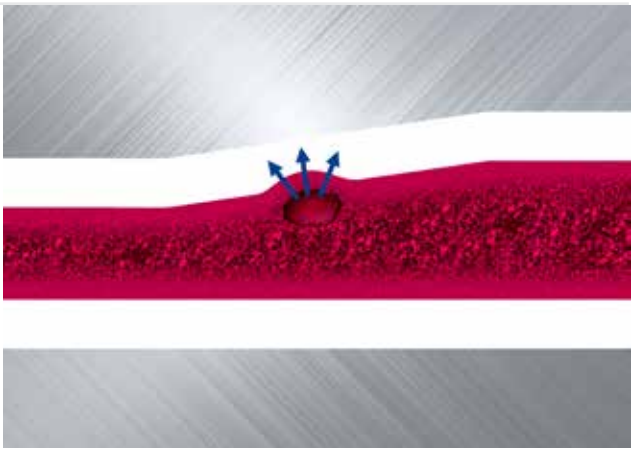
Injector and gas flow regulator

Injection molding machine

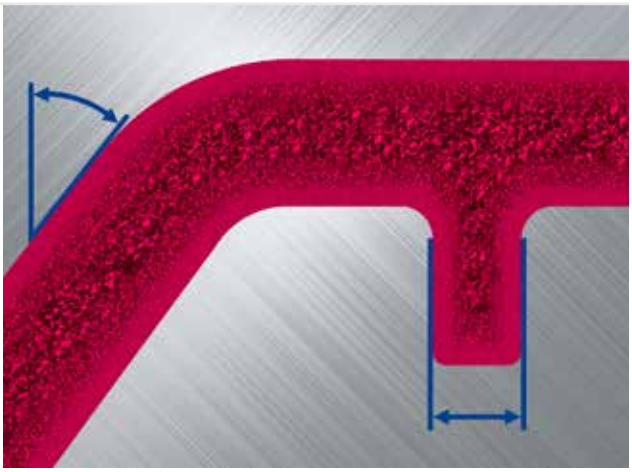
MOLDED PARTS AND MOLD DESIGN
Details for success

Foam injection-molded parts offer many advantages, but require specially adapted part design and an appropriate mold concept for optimal results.

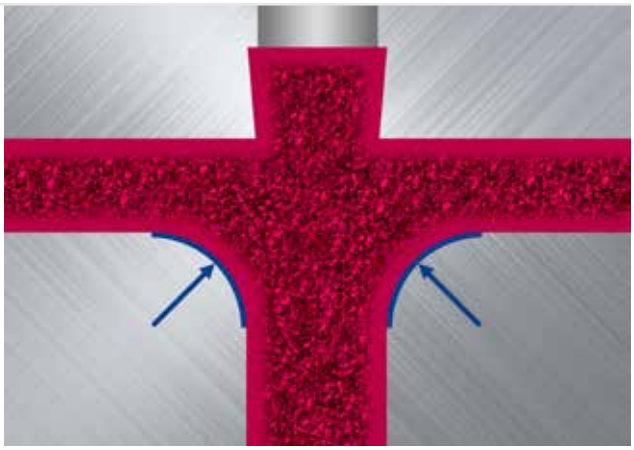
» **Adjust the part design**
- The more even the wall thickness distribution, the better the foam distribution that can be achieved. Therefore it is important to avoid large differences in wall thickness as far as possible.
- The overall wall thickness should be chosen to fill the cavity completely with the lowest possible pressure.
- Local material accumulations are "hot spots" which lead to secondary foaming during the cooling process after demolding. They should be avoided.



» **Make allowances for lower shrinkage**
The shrinkage rate of foamed parts is considerably lower than that of compact parts. This must be taken into account in the detailed layout of both the molded part and the mold with:
- normally a minimum draft angle of 0.5 to 1 degree
- sand paper polishing in demolding direction, especially on ridges and screw bosses
- increased strength of every screw boss base by reducing the local wall thickness to a maximum of 70 to 90 per cent of the overall wall thickness and insertion of radii (min. 1 mm) at the transition point between ridges and the base surface
- increase of the draft angle for textured surfaces to at least 1.5 degrees
- avoidance of excessive ridge thicknesses of more than 1.3 times the overall wall thickness, since these involve the risk of "hot spots", where secondary foaming may occur

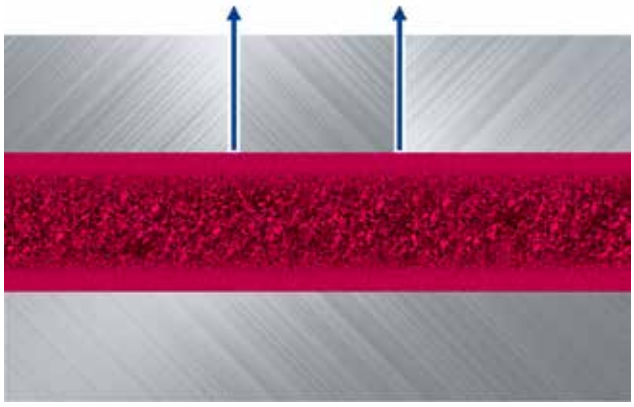


» **Optimize cold gating system**
- Keep the length of runners to a minimum to minimize pressure loss
- Provide all branching points of the runner system with a radius of at least 1.5 mm
- Do not use tunnel gating (filling pressure required too high)



» **Use exclusively needle shut-off hot runners**
- As the plastic/nitrogen blend must be kept under pressure prior to injection, only a hot runner system with a needle shut-off device may be used.
- The needle shut-off valve must be able to withstand a pressure of at least 250 to 300 bar.
- Effective heat insulation must be provided between the hot runner valves and the cavity of the mold to prevent the formation of "hot spots", where secondary foaming may occur.

» **Provide efficient cavity venting**
To enable relatively fast injection of the low-viscosity plastic/nitrogen blend, the air present inside the cavity must be driven out as quickly as possible. This can be effected by:
- Provision of venting ducts as large and as numerous as possible, starting from the flow lines and/or the conflux lines of the melt
- Separate venting of blind holes, ridges and thin spots, for example via pin inserts with a vacuum system



CELLMOULD
Application examples

» **Motorcycle seat**
- Weight reduction
- Material: PA6+GF

» **Mounting plate**
- Minimization of warpage
- Material: PP with 30 % glass fiber

» **Wheels**
- Insert technology
- Material: PP

PRESSURE AND GAS GENERATION
Powerful, for one or several machines

DE pressure generator
The pressure generators compress the nitrogen to a sufficient pressure for all Cellmould 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

Type	Output		Drive power ND	Max. working pressure	Storage capacity	Weight	Dimensions (D x W x H)
	Nl/min	Nm³/h	kW	bar	ltr	kg	mm
DE 250	250	15	5.5	300	50	690	1734 x 789 x 2077
DE 450	450	27	7. 5	300	50	710	1734 x 789 x 2077

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

Type	Output		Drive power ND	Max. working pressure	Storage capacity	Weight	Dimensions (D x W x H)
	Nl/min	Nm³/h	kW	bar	ltr	kg	mm
SE 250	250	15	11	6	20	800	1580 x 900 x 1980
SE 450	450	27	18.5	6	40	950	1737 x 1010 x 2050

WITTMANN BATTENFELD GmbH
Wiener Neustädter Strasse 81
2542 Kottingbrunn | Austria
Tel.: +43 2252 404-0
info@wittmann-group.com

www.wittmann-group.com

Cellmould | Article number: BPK00000033 | (English) | 2022/08 | Subject to change. | Printed in Austria.