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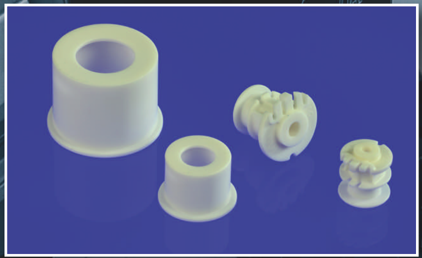
Medical Molding



- Achieving Effective Process Monitoring Through Detailed Process Development
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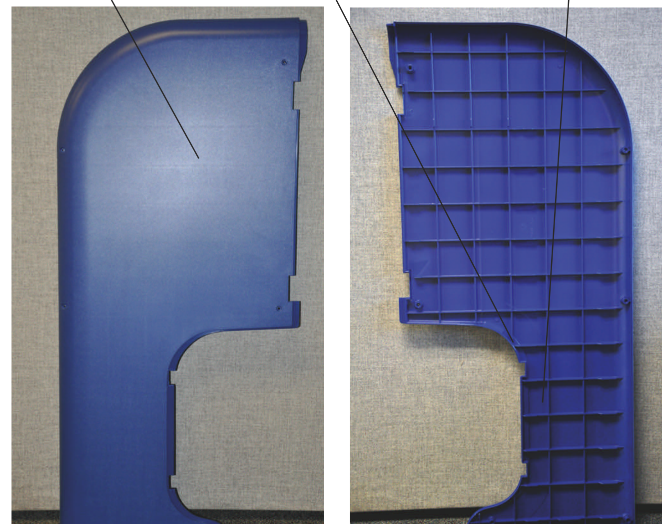
External Gas: The 'Next Generation' Gas–Assist Technique

The advantages and benefits of external gas-assisted injection molding, how it compares to internal gas-assisted injection molding, and in-roads the process is making into medical device applications will be examined in this article. In addition, critical steps that form the basis of successful external gas application will be highlighted and real-life examples provided.



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By Dr. Michael Hansen

While external gas-assisted (EGA) injection molding has been around for some time, it has only recently burst onto the scene as the "next generation" molding technique for large parts. Why? It has been proven to cut costs, lower tonnage requirements, minimize warpage, improve overall part quality, and reduce or even eliminate secondary operations. Consequently, it is now being used for more and more application areas, including medical devices.

First, review two short videos to better understand the internal and external gas-assist processes, including the sequence of steps, as well as similarities and differences (click here to view videos).

The primary difference between the two techniques is the function of the gas in developing the part. While gas is injected into the core of the melted plastic with the internal method, the external gas technique adds a micro-thin layer of nitrogen gas to the surface adjacent to the cosmetic side of the part after the cavity has been filled with resin. The nitrogen gas layer packs the part evenly across the core surfaces. The pressurized gas replaces the holding phase, produces thicker ribs without sink marks, and results in an even, low-gloss surface on the cavity side of the part. It should be noted that this process does require a gas-tight seal between the core side of the tool and the molded plastic part.

If EGA is chosen over internal gas-assist—a choice that can only be made after a thorough review of design, material, tooling, and processing considerations—there can be other significant advantages, including:

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Application	Resin	Projected area [sq-in]	Clamp Force [tons]	Tonnage [tons/sq-in]
Blender	PC/ABS	632	1,500	2.37
Boiler Cover	PC/ABS	1,200	1,500	1.25
ATM Cover	PC/ABS	195	300	1.53
Cooling Unit Base	ASA	1,760	3,000	1.70
HVAC Unit Cover	PC	930	2,000	2.15
Front Panel	PBT/PC	816	1,500	1.84

- No "shadow marks" on cosmetic surfaces
- Elimination of "fingering"—a defect resulting from gas that penetrates thinner-walled sections adjacent to the gas channels formed when using internal gas-assist
- More even gas distribution, since internal gas pressure dissipates with increasing distance from the gas channel
- No open holes for gas pin locations or over-spills
- Minimized knit lines and hesitation marks created by part design and/or flow patterns

Additionally, the external and internal gas techniques can both be used in different sections of the same part, if appropriate.

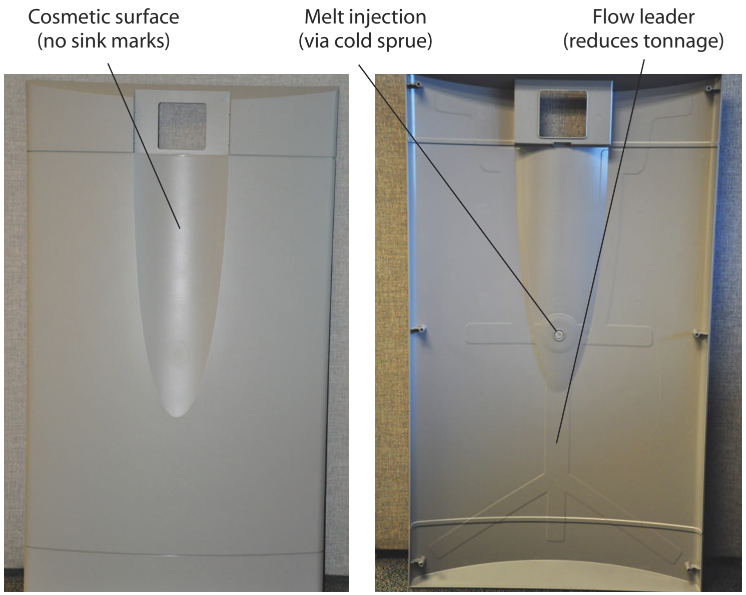
EGA offers several additional benefits, including:

- No molded-in stress and warpage
- No sink marks on visible cosmetic surfaces
- Lower clamp force requirement, resulting in significant press tonnage reduction and lower costs
- Reduced wear on molds due to lower operating pressures
- Reduced power consumption since smaller presses are used
- More freedom in part design (rib-to-wall ratio can be 1:1 or even higher)
- Consistent packing pressure

Resulting parts are very similar in appearance to compression molded parts due to the assistance of the nitrogen gas layer.

ADVANTAGES FOR MEDICAL APPLICATIONS

The previously mentioned benefits are resulting in qualitative improvements and quantitative savings in medical device applications. The process is producing flatter parts for improved



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assembly and easier sealing and mating with other plastic and metal parts. Less molded-in stress improves chemical resistance, resulting in better long-term temperature behavior and longer part lifetimes. Lower tonnage requirements translate into reduced piece-part costs. Less warpage minimizes stress-cracking and improves part behavior under cyclic external loads and pressures. Additionally, thicker rib-to-wall ratios make it possible for more structural parts to be designed in plastic.

Several critical steps must be taken to ensure the successful application of EGA:

- Single-gate, if at all possible, to avoid knit lines
- Adapt wall thickness and add flow leaders, if necessary, to fit the selected press size
- Perform warpage analysis to minimize distortion
- Select appropriate gate size and location
- Determine exact shrinkage for tool build to achieve tight dimensional specifications for assembly
- Add appropriate external gas features to both the part design and tool to allow for proper gas sealing

Examples of required sealing features include incorporating a step on the outside parting line with grooves around bosses to create an outside seal, along with small ribs around internal openings to confine gas to the back side of the part and allow gas pressure build-up. This creates a balloon effect between the core side of the tool and the back side of the part. In order to achieve the pressure build-up, all ejector pins have to be sealed as well.

The images accompanying this article are examples of applications that have recently been molded using EGA. All are used in the field unpainted. The heaviest is 15.3 lbs. The range of main wall thicknesses exceeds 0.2 in. The selected resins span the spectrum from low-to-high shrinkage amorphous resins, as well as semi-crystalline materials. The thicker gas channels in the parts are hollowed out by internal gas-assist. The general published tonnage range for the resins listed in the chart is 3 to 5 tons/sq-in. The maximum clamp force reduction for these applications ranges between 25% to just over 50% using the EGA process compared to the higher tonnage of 5 tons/sq-in in straight injection molding.

As illustrated in this article, there is growing potential for EGA in both new and redesigned applications of various sizes, wall thicknesses, and resins. If properly implemented, the process technique can advantageously impact cost, press tonnage requirements, warpage, overall part quality, and secondary operations.

Michael Hansen, PhD is the senior technical development engineer for MackMedical/Mack Molding Co. He is responsible for developing new applications using advanced resins and processing techniques assisted by 3D filling simulation programs.