Gas Assist and Microcellular (MuCell®) Molding Process

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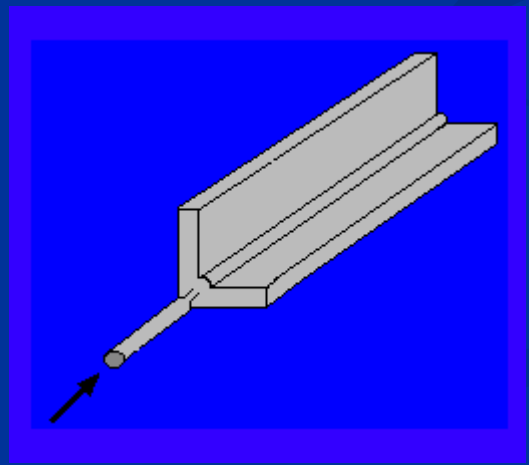
Consultek

What is Gas Assist Injection Molding?

Gas Assist injection molding is a process enhancement to conventional injection molding, involving the injection of high pressure nitrogen gas into the resin melt stream immediately after injection of the resin. The intent is not to cause mixture of nitrogen and resin, but for the nitrogen to displace resin in gas channels and thicker sections of the molded product. The process is a high speed, low pressure injection method, enabled by short shooting the tool, and completing the resin filling phase by nitrogen gas, at a much lower pressures as compared to convention injection molding.



Advantages of Gas assist Molding

- Cycle time reduction and lower production costs
  - Lower clamp tonnage
  - Lower Injection pressures
  - Faster cycle due to hollow sections vs. solid section
  -
- Design Freedom
  - Large ribs possible and permissible
  - Long flow lengths without multiple drops
- Quality Improvement
  - Lower stress within the part
  - Better dimensional stability and part to part size variations
  - Elimination of sink marks and warpage and voids
  - Greater strength and rigidity
  - Reduced knit lines (No multiple drops necessary)
- Material savings through weight reduction
  - Hollow parts
- Simplification of Tooling
  - Elimination of lifters and undercuts

Disadvantages or Limitations

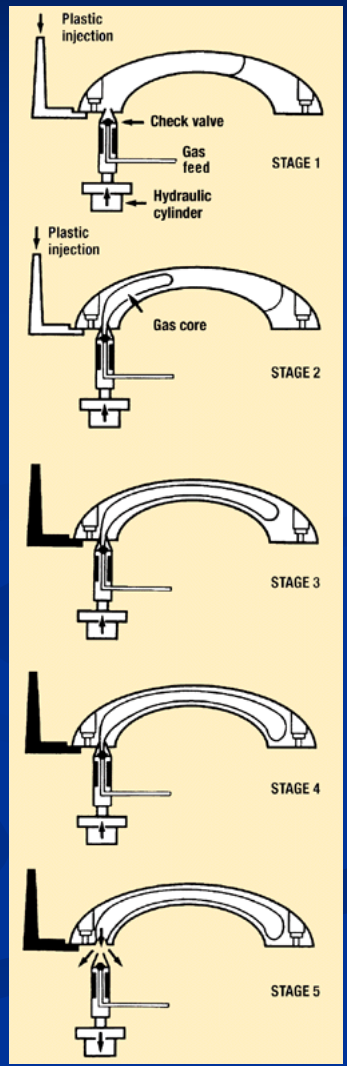
- Race Tracking of Polymer Through Gas Channels
- Fingering (The penetration of the gas from gas channel into the thinner sections of the part)
- Gas Blow-Through
- No fully being able to Control where the Gas goes
- More Expensive than Standard Injection Molding

Gas Assist Process Basics

- **Short-shot molding.** A process in which certain features such as ribs or thick walls are cored out with gas in an otherwise solid molded part. This process gets its name from the method of only partially filling the cavity during the polymer injection phase of the cycle and then relying on the gas injection phase to fill out the remainder of the cavity with the material the gas bubble is displacing from the core.

- **Full-shot molding.** A process in which the mold is completely filled during the plastic injection phase. Gas is introduced into the cavity in this case only to provide local packing and to compensate for the effects of polymer volumetric shrinkage as the part cools.

- **Hollow molding.** A process in which all or nearly all of the part is cored out by the gas, in effect making the part itself the gas channel. This is the method most often used to make parts with large cross sections such as rods, tubes, and handles.



Source: MD&DI April 1998 article

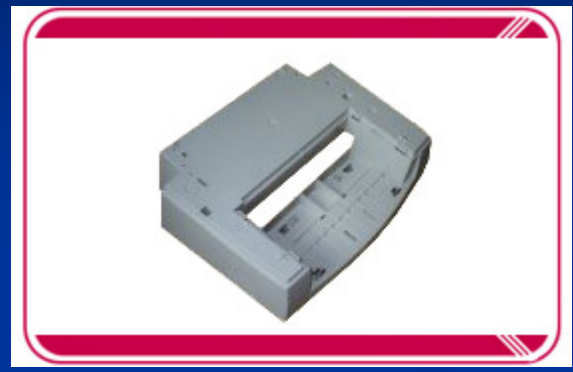
Applications: Automotive

Wing Mirror Housing
ABS/PC
Without gas 181 grms
With gas 154 grms
Saving 15%

Interior Handle
Talc Filled PP
Without gas 73 grms
With gas 52 grms
Saving 29 %

Applications: TV, Computers & Office Machines

21" TV cabinet
HIPS



Cabinet Base Molding
HIPS
5% reduction in cycle time
No sink marks or distortion

Copier Cover
ABS

Without gas 487g
With gas 460g
Saving 5.6%

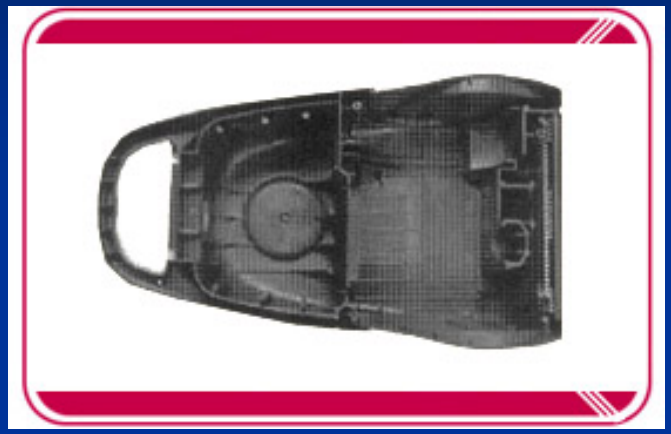
Sinks &
Warpage
elimination

Applications: Furniture

Chair Arm Rest
PP

Without gas 1414g
With gas 919g
Saving 35%

Applications: Appliances



Vacuum Cleaner Base

HIPS

Total cost saving $1.50 per piece
Dimensional stability improvement
Surface finish improvement - eliminated sink marks
Inclusion of thicker internal rib sections with no sink marks

Applications: Miscellaneous

Baby Carriage Handle

PP

Without gas 524 grms
With gas 414 grms
Saving 31%

Hollow Bathroom Handrail

Typical Gas Assist Process Cycle

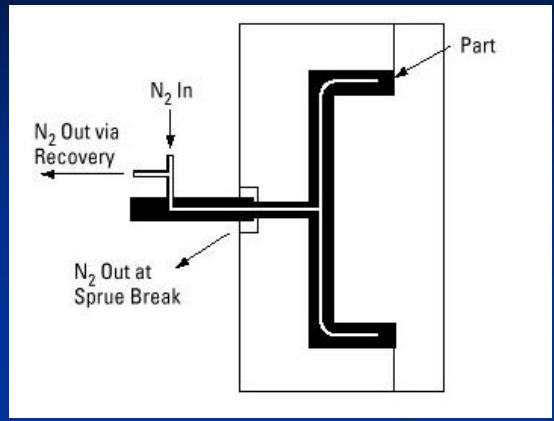
1. Mold closes and reaches clamp tonnage
2. Resin is Injected into cavity as short shot
3. Gas is introduced in to the hot melt
4. Gas pressure maintained during cooling cycle
5. Gas pressure is released
6. Mold opens and part ejects

Gas Injection Methods

- Injection through Nozzle

Pro: Minimum tool Modification

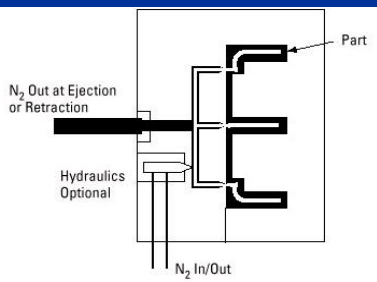
Con: Limited control of gas placement and process variables

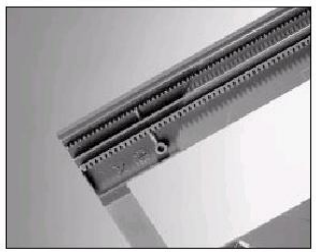


- Injection through Gas Pins

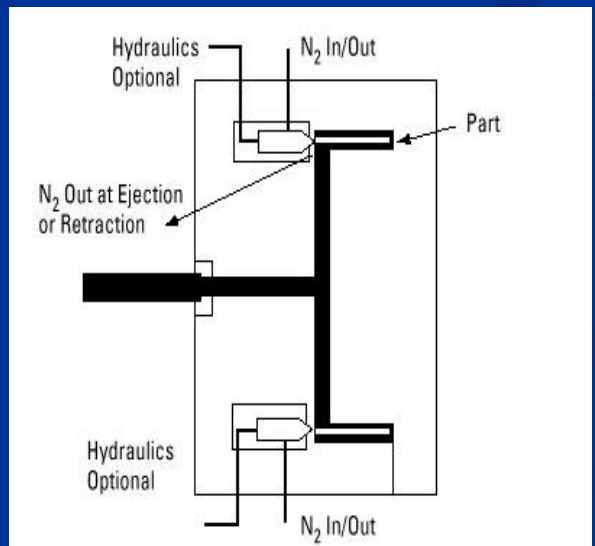
Sprue or Runner

Cavity





A narrow gas channel is created in a CD tray made from CYCOLAC® resin to improve flatness and dimensional tolerance capacity.



Pro: Gas Placement where needed

Con: Additional tooling cost

Gas Delivery System

- Nitrogen Bottles
- Nitrogen Generators
- Central Nitrogen Systems

Molding Machine Requirements

No special requirements……
No special adaptations or modifications…..

Works well with smaller size machines also…

Stand alone systems available

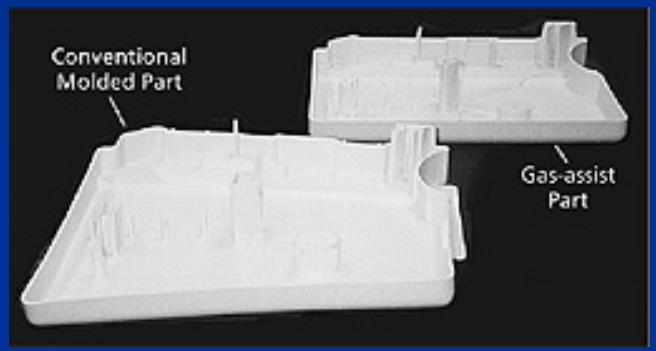
Integrated systems from IMM manufacturers

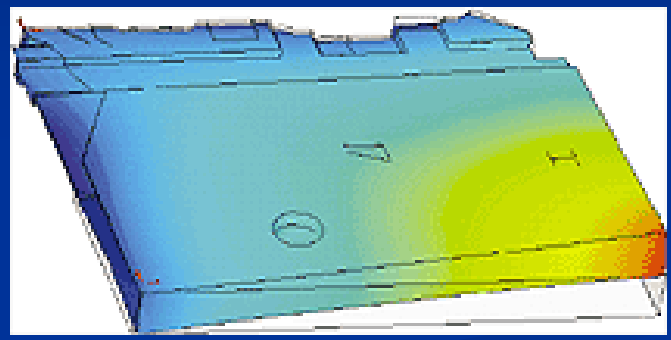
Part Design for Gas Assist

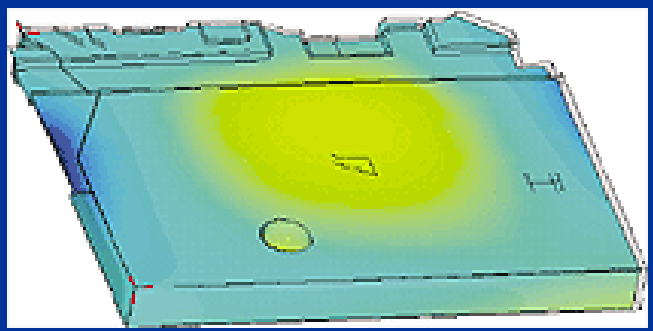
- • Sizing of gas channels
- • Gas channel layout
- • Location of gas injection point(s)

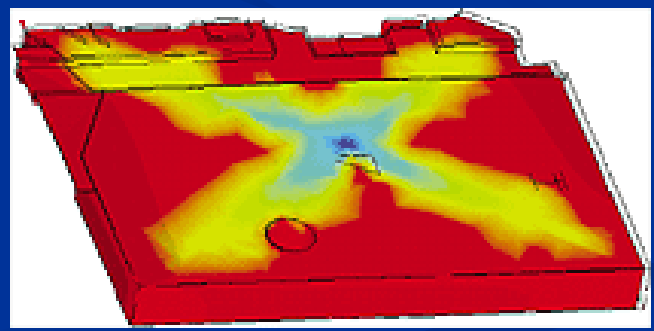
Part design: Moldflow® Simulation

Moldflow Plastics Insight™ 3.0









Tooling Considerations

New Tooling

Injecting Through nozzle

Sprue gate preferred
Gate size and location is critical
Cannot use hot runner system

Injecting in Runner/part

Hot runner ok… Gas pin location very critical

Converting Existing tooling

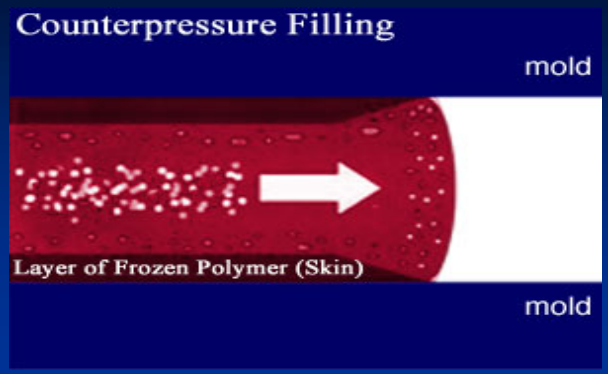
Conventional Tooling — Same considerations as new tooling

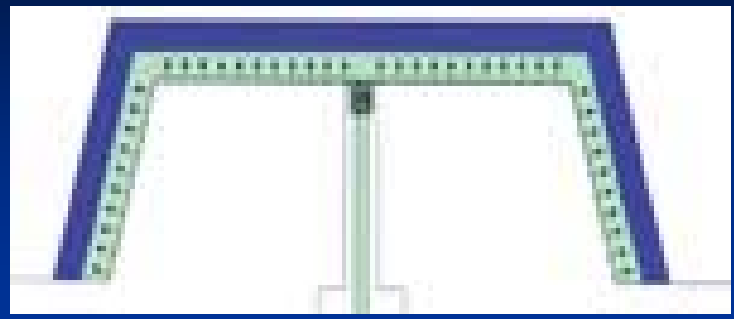
Hot Runner Tooling — A) Inject gas through pins

B) Eliminate hot runner

Venting, Cooling Shrinkage……..No special considerations

Gas Counter Pressure & External Gas Molding





- **Gas Counterpressure**
- ConMet uses a process that includes a pressurized mold cavity that is injected with nitrogen gas to counteract the expansion of the gas within the melt. As the counterpressure is released, the gas bubbles that would conventionally break through the surface are trapped inside, creating a smooth skin.

  During the conventional structural foam molding process, the melt enters the unpressurized mold and immediately begins to foam, generating bubbles of gas that break through the surface and create swirl marks. While offering you all the advantages of low-pressure foam with low-clamp tonnage requirements, gas counterpressure eliminates surface swirl marks while forming a tougher outer skin.

  Using this gas counterpressure process, your product can provide longer-lasting physical properties: flexural modulus, impact resistance, and tensile strength. The smooth surface also means that very little, if any, painting is required, giving you lower finishing costs.
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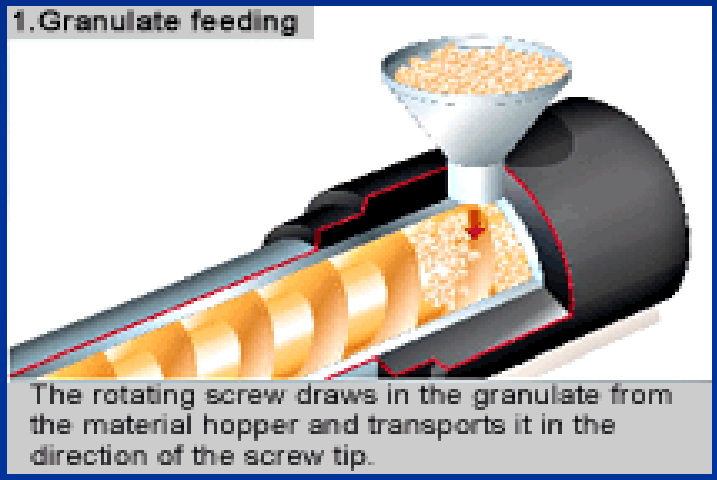
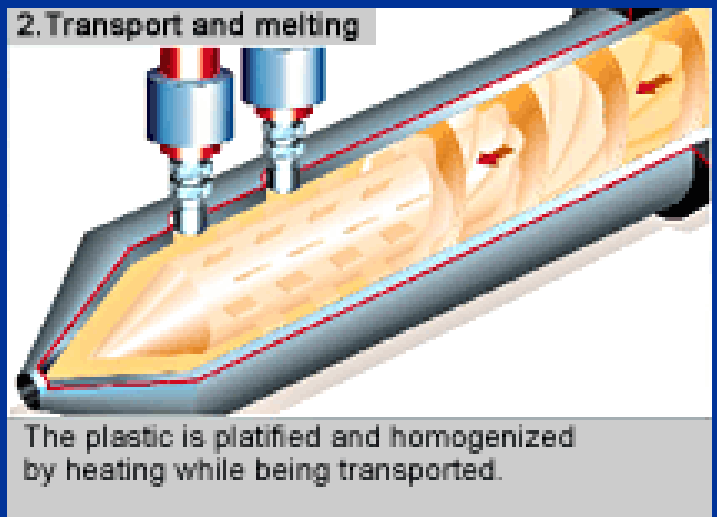
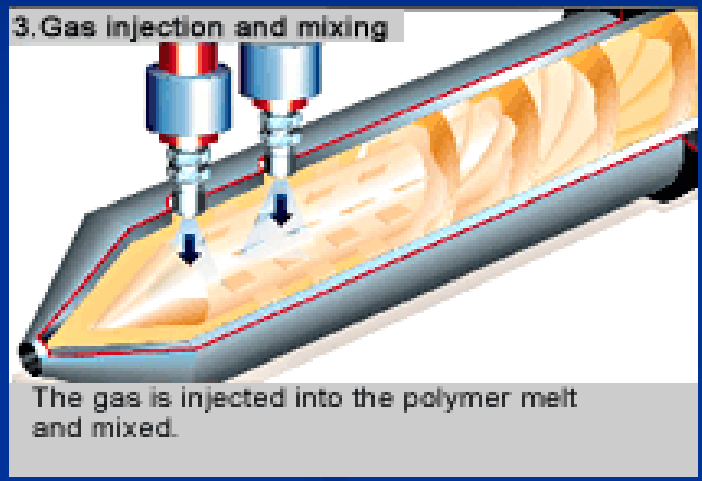
Source: www.conmet.com

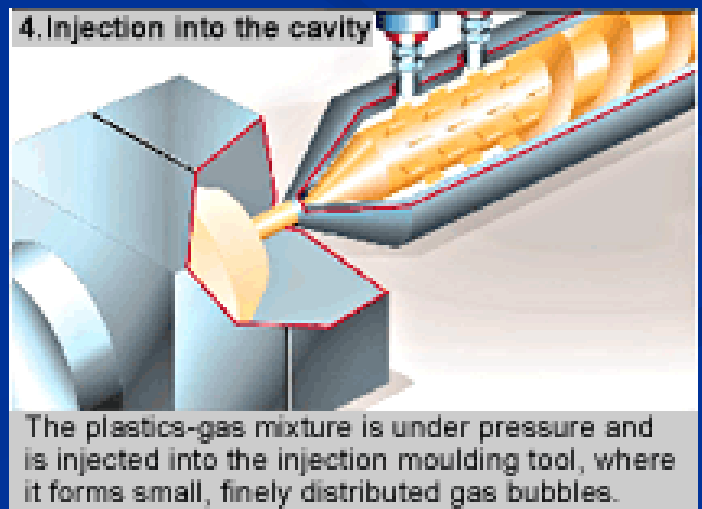
Mucell® Microcellular Technology

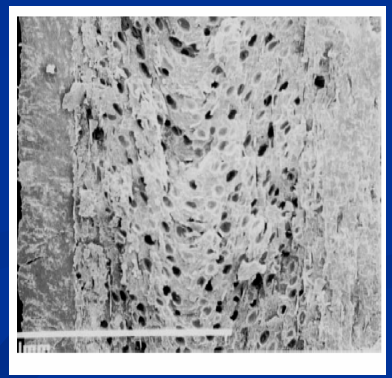
- MuCell is the trade name of microcellular polymeric foam produced by Trexel's proprietary MuCell microcellular foam process. The MuCell process uses supercritical fluids (SCFs) of atmospheric gases--not chemical blowing agents to create evenly distributed and uniformly sized microscopic cells throughout a thermoplastic polymer











Micrograph showing average cell size of 10 microns (.0004 Inches)

Mucell® Vs. Gas Assist

- Surface Appearance Poor
- Microcellular Foam Process (gas is used to produce microcellular structure)
- Gas introduced in the barrel

- Surface same as conventionally molded parts
- Gas assist process (gas is used to assist filling and packing)
- Gas introduced in the nozzle or in Sprue/runner/part

Effects of the MuCell® Molding Process

Molding MuCell versus Solid

- Shot size is reduced
- Final mold fill with cell growth
- Little or no Hold Time or Pressure
  - More uniform shrinkage
  - Reduced molded-in stress
  - Lower clamp tonnage
  - No need to size runner/gates for pack pressure
    - 50% Size reduction is typical

Applications

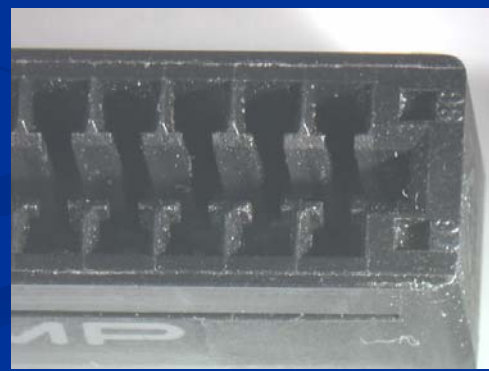
Weight reduced 10%
Cycle time - 20% - 30%
Machine size reduction up to 50%

HP Printer Chassis
Cycle time - 27%
Weight reduced - 8.5%

Cycolac CRT 3370 ABS - glass filled

In-Mold decoration

Conventional

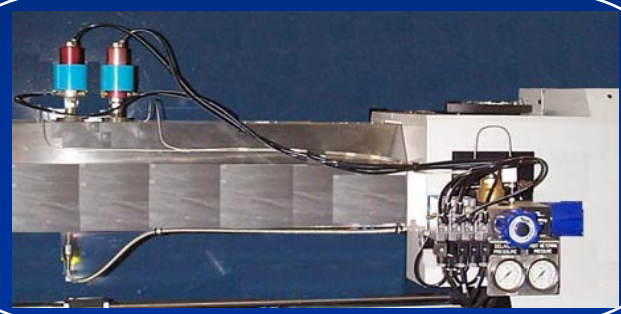


Mucell

MuCell Injection Molding Machine

- Runs in both solid and MuCell molding

MuCell Interface Kit



SCF Delivery System

MuCell® Modular Upgrade

A simple, fast and low cost solution to upgrade existing molding machines to the MuCell Process

Injection Module and MuCell Interface Kit

Series II SCF System

The MuCell Modular Upgrade converts a standard electric or hydraulic injection molding machine into a fully capable MuCell molding machine. The upgrade consists of two distinct modules: a new injection module that is designed as a drop-in replacement of the existing injection module, and the Series II SCF module.

Equipment Manufacturers

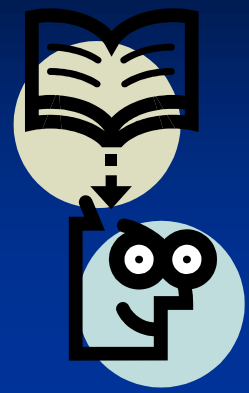
Table 2. Gas-assist injection molding licensing information[1]

	Manufacturing license fee	"Gas injection" equipment	Additional costs "royalties"
Airmold (Battenfeld)[6]	None	Single Machine, Single Injection Point, Base Price $110 000, Expandable[7]	None
Cinpres[5]	$60,000	Single $35,000, Multiple $58 - 95,000	Based on: Material Usage or Tooling Fee or Flat Fee for Parts
Epcon	-	Single $55,000 Multiple $77,500	None
GAIN	Per mold $1.5 -15,000/yr per facility $25 - 250,000/yr[2]	Single $25 - 50,000 Multiple $35 - 85,000	None
HELGA (Hettinga)[3]	None	HELGA Package $70 - 75,000	None
Johnson Controls Multinozzle/ Sequential Gas Assist[4]	None	Integrated into machine controls $30 -50,000	None
Nitrojection	$25,000	$45 - 85,000	None

Molders

- APW www.apw.com
- Preproduction plastics www.ppiplastics.com
- Cambro www.cambro.com

Where to find more information…..



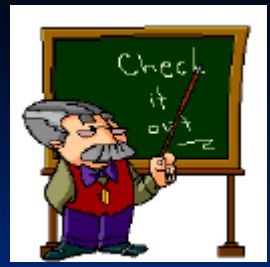
Books

- Gas Assist Injection Molding: Principles and Applications
  Edited by Jack Avery, GE Plastics — www.hansergardner.com
- Gas Assist Injection Molding — www.cancombookstore.com
  Paul Dier and Richard Goralski
- Microcellular Processing — www.hansergardner.com
  Kevin Okamoto

Technical literature

- Injection Molding: Gas Assist Technology Guide — GE Plastics — www.geplastics.com
- Article - External Gas Molding Squeez out sinks — http://www.plasticstechnology.com/articles/200111fa3.html
- Article – Microcellular Molding Takes off — http://www.plasticstechnology.com/articles/200009fa1.html
- Innovative Injection Molding Techniques — http://www.devicelink.com/mddi/archive/98/04/009.html
- Molding with Counterpressure — http://www.caropresoassociates.com/paper3.html
- Molders Perspective: Mucell Technology — http://www.kaysun.com/ps/index.htm
- New Methods Expand Roles of Gas Assist Molding — http://www.plasticstechnology.com/articles/200206cu1.html

Education



- **Gas Assist for Injection Molding**
  Penn State Erie Continuing Education http://www.pserie.psu.edu/cde/pt/pt.htm

- ***Course Title*: Gas Assist Part and Mold Design** http://www.lightspeedu.com/syllabus/gasassist.htm

  LightSpeed University online courses

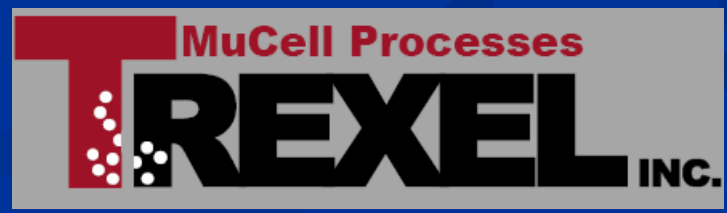
- Caropreso Associates, Chester MA Training Seminars http://www.caropresoassociates.com/seminars.html

- Bauer Plastics Technology Group http://www.bauerptg.com
  Technical Seminars
  Assessment of Processing Capabilities
  Theory and Practical Applications of Gas Assist Molding
  Pros and Cons of Gas Assist Molding
  Implementation of Gas Assist Molding
  Designing for Gas Assist Molding

- Trexel Mucell Process Seminars http://www.trexel.com

Special thanks to……

- GE Plastics
- Cinpres
- Gain Technologies
- Bauer
- Trexel



GAS Assist Process Movie