Effects of the MuCell® Molding Process

Molding MuCell versus Solid

- Shot size is reduced
- Final mold fill is completed with cell growth
- Little or no Hold Time or Pressure
  - Reduced molded-in stress
    - Less warp and bow
  - Lower clamp tonnage
    - Less tool wear
  - No need to size runner/gates for pack pressure

Designing for the MuCell® Process

- The MuCell® process allows for shorter cycle times and lighter parts as well as less molded in stress
- In order to take full advantage of these benefits attention needs to be paid to the mold design:
  - Reduced polymer mass in the sprues and runners
  - Optimized mold filling patterns
  - Increased venting
    - Perimeter
    - Blind pockets
  - Uniform cooling

Hot Sprues

- Valve gated hot sprue is preferred to cold sprues
  - Moves point of nucleation from the nozzle tip to the tip of the hot sprue
    - Improved control of cell structure
  - Best for minimizing cycle time
  - Must be able to withstand 3500 psi pressure when closed
  - Gate sizing should reflect reduced viscosity
  - Typical sizes: 1mm to 5mm in diameter
  - Non-valve gated hot sprues can not be used with the MuCell process

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Hot Sprues and Runners

- Valve gated hot runner systems are preferred
  - Must stay closed against 3500 psi pressure
  - Need to be naturally flow balanced
  - Individual control of valve gates provides best control
- The following systems have been used successfully with the MuCell process
  - DME
  - Mold Masters
  - Incoe
  - Husky
  - Synventive

Do Not Use Non Valve-Gated Runner Systems

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Cold Sprues and Runners

- Cold sprue and runner diameters need to be sized to fill the part with acceptable injection pressure
  - Account for reduced polymer viscosity
  - Account for potential faster injection velocity
- Sprue and runner diameters do not need to be sized for packing plastic through the runner and into mold during the hold phase
  - Cell growth replaces the traditional pack/hold phase of the molding process
  - This should allow for significant reduction in runner diameter
- Potentially size reduction up to 50%

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Cold Sprues

- Minimize the mass of the material in the sprue
  - Directly linked to cycle time
- The length of cold sprues should be minimized:
  - < 50 mm if possible
  - Need to take into consideration nozzle penetration length and nozzle diameter
- Typical Shut-Off Nozzle Dia.: 3 mm
  - Sprue can be Nozzle ID plus 0.8 to 1.5 mm
  - Standard draft angle - 2-6 degrees inc. angle
- Increase strength at the intersection of the sprue and runner by:
  - Adding 2- 3 mm radius at base
  - Add gussets, 1.5mm X 5 mm up the sprue and along the runner

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Cold Sprues

Options for Improved Cooling for Large Sprues:

- Use a high thermal conductivity sprue bushing
- Put a water circuit in or near the sprue bushing
- Extend cooling pin into the sprue to minimize material mass
    - This pin should also be made of a high conductivity material
    - Eject with sleeve

Mold Design - Gating

- Gate Designs
  - Sub-gating into ribs or ejector pins can help hide gate blemishes
    - Traditional designs OK-
    - Add radii at runner
    - Tab gates, pin gates and fan gates work well
    - Start with 1 mm land
  - Direct sprue gating typically results in surface blemish around the sprue

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Mold Design - Gating

- Gating should be located to provide a uniform fill pattern
  - Lowest cavity pressure
  - Maximum weight reduction
- Preferred Gate Location- flow from thin to thick sections
  - Maximum weight reduction
- The MuCell process is more likely to cause blemish around the gate
  - Venting and texture improve
  - Possible to improve with process- this will affect weight reduction

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Mold Design - Venting

- Areas of gas trap in solid parts may be worse with MuCell®
  - Typically faster injection rates
  - Need to vent air in the cavity plus gas liberated during the molding process
- Cavity Perimeter Vents
  - Widths should be doubled
  - Depths can be 50% to 75% deeper
  - Length should be as short as possible
  - Generous relief channels
- Runner Vents at all transitions

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Mold Design - Venting

- Venting of thin deep ribs
  - Use existing ejector pins for venting
  - Add venting ejector pins or blades to ribs and bosses
  - Increase rib thickness to 80% to 100% of adjacent wall
    - Prevents backflow into the rib or gusset that can trap gas
    - The MuCell process eliminates sink marks
  - Venting Bosses
    - Use flats, sized to material supplier recommendations
    - Clean periodically

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Mold Design - Cooling

- As with solid molding, the ability to remove heat dictates cycle time
  - With shorter cycles, cooling hot spots become more critical
- Insufficiently cooled MuCell® parts may display post blow
  - If the part temperature remains near the Tg the part is susceptible to post blow
  - Areas where this occurs are:
    - Thick sections
    - Hot spots in mold
    - Uncooled core pins
- Standard cooling practices should be followed to obtain uniform mold temperatures

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Mold Design - Cooling

- Cooling recommendations to optimize cycle times
  - Mold Inserts should be cooled
    - Direct water lines
    - Cooling pins can be used to draw away heat
    - These should be tied into water lines
- Standing steel, with H/W ratios greater than 3:1 should be cooled
    - Adjacent water line
    - Bubblers, baffles or thermal pins
- Slides should have water lines

Mold Design - Mold Finish

- The MuCell® process will not provide a high gloss part
  - Highly polished molds will not result in a high gloss finish with the MuCell process
- Ribs and bosses should be draw polished
- Textures will improve surface finish
  - Reduce surface cell distortion effects
  - Improves venting of liberated gas

Mold Design - Materials of Construction

- No corrosive gases added in MuCell process
  - No special steels required
- With highly filled materials, we recommend considering specialty steel coatings/treatments
- Reduced clamp tonnage allows for the potential use of softer metals
  - Pre-hardened steels
  - Faster machining/lower cost
  - Aluminum
  - Significant cooling improvements
- Selective use of high heat conductivity materials

Part Design - Wall Thickness

- There are few limitations to wall thickness with the MuCell® process
  - Parts produced anywhere from 0.3 mm to 30 mm
  - Focus is on parts at 4.0 mm or less
  - Parts with wall thicknesses above 4 mm could have a longer cycle time than for solid parts due to post blow
- The MuCell process will also allow for :
  - Greater variations in wall thickness across a part
  - Longer flow lengths

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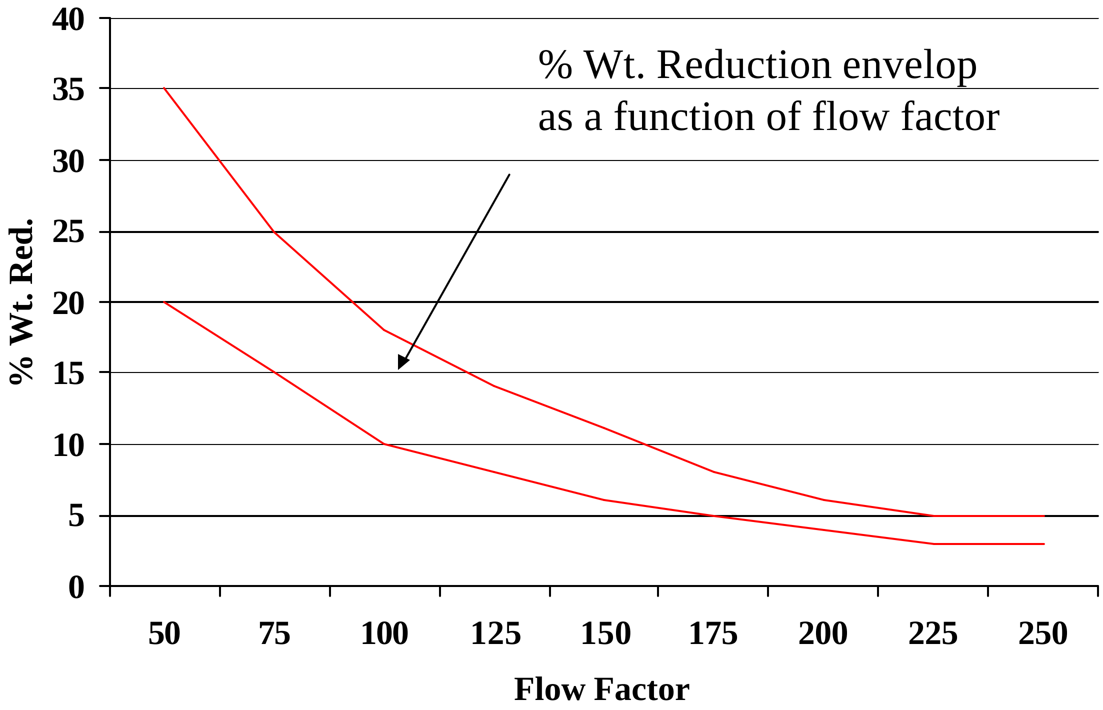
Part Design - Wall Thickness

- Weight reduction is highly dependent on flow factor - Ratio of Flow Length to Part Thickness
- Weight reduction also dependent on
- Part Thickness
- Material
- Gate Location



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