How to Accomplish Low Stress While Molding Polyester BMC
Goal of Presentation

Our goal is:

• To present correct gate placement that gives us the lowest stress

I will accomplish this by:

• Focusing on stress of the polyester using von mises
• Analyzing results to help locate the best gate location with minimal stress
Agenda

1. Results by Type of Analysis – Sigmasoft Thermoset Part (From GrabCAD)
   - Von Mises – What is it?
   - Analyzing stress
   - Analyzing fibers
   - Simulation set up
   - Results and discussion
Von Mises

Let’s start out explaining what Von Mises is. Von Mises stress is a measure of the total amount of stress acting on a material at a given point.

Von Mises stress is a theoretical stress that represents a measure of the total amount of stress acting on a material at a given point. However, von Mises stress does not take into account any material failure criteria, such as ultimate tensile strength, or fracture toughness. These failure criterias are the limiting factors that determine the material's ability to withstand stress before failure occurs. Therefore, while von Mises stress can provide insight into the state of stress in a material, it cannot predict the exact point at which failure will occur.
Analyzing Pump Cover
Analyzing Stress – Von Mises

- Arrows represent Von Mises stress in the part. This specific area might be of interest if you screwing a bolt in.
• Arrow represent high stress areas in the part. This represents high stress areas in the part especially on the bottom of the part.
Analyzing Fiber X Direction

- Arrows represent fiber flow in X direction. Blue areas represent low % of orientated fibers where red areas represent high % of orientated fibers. Scale is set from 40-95%.
Analyzing Fiber Y Direction

- Arrows represent fiber flow in Y direction. Blue areas represent low % of orientated fibers where red areas represent high % of orientated fibers. Scale is set from 40-95%.
Max. Eigenvalue – Measurement orientation of fibers in the flow direction. Scale represents percentage on how many fibers are orientated in a specific area.
Analyzing Fibers Using Max. Eigenvalue

Max. Eigenvalue – Measurement orientation of fibers in the flow direction. Scale represents percentage on how many fibers are orientated in a specific area.
Analyzing Fibers in Sigmasoft

Flow

X-Flow

% Shrinkage & Warpage

13,187 MPa

5,141 MPa
Tool Setup in Sigmasoft

While simulating polyester material I used heatmed for my mold material at a temperature 140°C. Heatmed gives consistent heating throughout the simulation. It’s telling the program to hold 140°C throughout the simulation instead of varying the temperature.
Material Used

- 20% glass fiber reinforced polyester BMC
- 40% glass fiber reinforced polyester BMC
Gate Location and Design Variables
Setup

I placed gate locations at thick and thin areas on the part. That way we can lean how this effects stress in our part.
## Gate Location and Design Variables Setup

### Design Variables

<table>
<thead>
<tr>
<th>Design Variable</th>
<th>Dataset List</th>
<th>Dependency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Material Class - Material Data</td>
<td>User/BMC_Particle&lt;br&gt;User/BMC_REG</td>
<td>&lt;None&gt;</td>
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</tbody>
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| Geometry geometry_exchange_001 - Activated item | 1 | Gate 1  
2 | Gate 2  
3 | Gate 3  
4 | Gate 4  
5 | Gate 5  
6 | Gate 6 | <None>     |
Gate Location and Design Variables Setup

### Design Variables

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<table>
<thead>
<tr>
<th>Design Variable</th>
<th>Selection</th>
<th>Dependency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometry geometry_exchange_001 - Activated Item</td>
<td>Gate 1, Gate 2, Gate 3, Gate 4, Gate 5, Gate 6</td>
<td>&lt;None&gt;</td>
</tr>
</tbody>
</table>
Gate Location - Results and Discussion

Stress is higher on particle 40 glass filled polyester vs. low filled
Gate Location - Results and Discussion

- Gate 1 (Design 1) has the worse overall air entrapment and stress
- Gate 6 (Design 12) is the best choice because of the low voids, stress
## Gate Location - Results and Discussion

<table>
<thead>
<tr>
<th>Rank</th>
<th>Design</th>
<th>Part Material Class - Material Data (-)</th>
<th>Geometry geometry_exchange_001...</th>
<th>Air Entrapment (-)</th>
<th>Stress1 (-)</th>
<th>Voids (-)</th>
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<tbody>
<tr>
<td>Rank</td>
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<td>Gate 1</td>
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<tr>
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<td>Gate 2</td>
<td>31.7</td>
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<td>Rank</td>
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<td>Rank</td>
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<td>Gate 4</td>
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<td></td>
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<td></td>
<td>Gate 12</td>
<td>272.41</td>
<td>1.92</td>
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</tbody>
</table>

**Best gate:**

**Worse gate:**
Scenario 1 – Customer Dictates Where Gate Will be Located
Optimizing Worse Gate Location

Goal - Minimum Stress, Voids and Air Trap
## Design Variables

<table>
<thead>
<tr>
<th>Design Variable</th>
<th>Lower Limit (s)</th>
<th>Upper Limit (s)</th>
<th>Step (s)</th>
<th>Dependency</th>
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</thead>
<tbody>
<tr>
<td>Filling - Filling Time</td>
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<td>20.0</td>
<td>5.0</td>
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<td>Permanent Mold Class - Initial Temperature</td>
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<td>150.0</td>
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<td>Part Material Class - Initial Temperature</td>
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<td>Inlet Control - Time</td>
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<td>Mold Open Step - Permanent Mold ID 1 - Time</td>
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<td>170.0</td>
<td>10.0</td>
<td>&lt;None&gt;</td>
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</tbody>
</table>
Stress vs. Material Temperature, Mold Temperature and Pack Time
Air Entrapment vs. Fill Time, Material Temp., Mold Temp and Pack Time
So, which design gives us the lowest stress?
- Design 60 – Lowest stress with below design settings
- 10 second filling time
- 60°C Material Temperature (When injected)
- 130°C Mold Temperature
- 170 Seconds Mold Open
- 9 Second Pack Time
Curing Degree of Design 60
Filling Temperature of Design 60
- Von Misses Design 60 (Lowest Stress) vs. Design 12 (highest Stress)

- Design 12 – Highest stress with below design settings
- 10 second filling time
- 60°C Material Temperature (When injected)
- 150°C Mold Temperature
- 160 Seconds Mold Open
- 10 Second Pack Time

**Design 60**

**Design 12**
Shrinkage & Warpage Design 60 vs. Design 12

v08_d60
Cycle 1, Cooling after Eject, Displacement X
Ambient, 100.00 %
X-Ray: off

v08_d12
Cycle 1, Cooling after Eject, Displacement X
Ambient, 100.00 %
X-Ray: off
Optimizing Best Gate Location

Goal - Minimum Stress, Voids and Air Trap
Gate location
Stress vs. Filling time, Mold Temperature, Mold Open Time and Pack Time

Correlation

- 1.00
- 0.875
- 0.750
- 0.625
- 0.500
- 0.375
- 0.250
- 0.125
- 0.000
- -0.125
- -0.250
- -0.375
- -0.500
- -0.625
- -0.750
- -0.875
- -1.00

Voids vs. Mold Temperature °C
- Design 34 – Lowest stress with below design settings
- 15 second filling time
- 50°C Material Temperature (When injected)
- 130°C Mold Temperature
- 150 Seconds Mold Open
- 5.5 Second Pack Time
Von Misses Design 34 (Lowest Stress) vs. Design 7 (highest Stress)

- Design 7 – Highest stress with below design settings
  - 10 second filling time
  - 70°C Material Temperature (When injected)
  - 150°C Mold Temperature
  - 170 Seconds Mold Open
  - 10 Second Pack Time
Shrinkage & Warpage Design 34 vs. Design 7

Design 34

Design 7
Remarks

- Data suggests that analyzing von mises and specific process parameters can lead to low stress while molding thermoset polyester. Fill time, mold temperature, pack time and material temperature effect stress with thermoset polyester.
Questions