Assessing Shape Repeatability in Variable Geometry, Polymer Extrusion Dies

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**Assessing Shape Repeatability in Variable Geometry Polymer Extrusion Dies**

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**Advisors: David Myszka, Ph.D., Andrew Murray, Ph.D.**

**Project Objective:** To successfully produce shape changing extrusion dies for practical application in the real world. Examining shape repeatability of prototyped dies is a large factor to determine whether or not the design performs effectively.

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**Introduction/Motivation**

- **Extrusion:** Manufacturing process that uses pressure to force melted plastic through a die
- Current dies define parts with uniform cross section
- Varying cross section allows for innovative parts
- Two batches of prototypes have been produced and tested to examine profile comparison

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**Computational Analysis Method**

- Starrett Profile360 In-Line Profile Measurement System used laser to scan 6 profiles
- Matlab used to examine profiles and compare one another
- Outliers removed, profiles linearized, rotated, and centered before stacked and compared

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**Results**

<table>
<thead>
<tr>
<th>Test</th>
<th>Shape</th>
<th>d</th>
<th>Std(d)</th>
<th>95% CI</th>
<th>ΔA/A (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-1</td>
<td>P</td>
<td>114</td>
<td>139</td>
<td>272</td>
<td>0.2</td>
</tr>
<tr>
<td>T-1</td>
<td>R</td>
<td>106</td>
<td>132</td>
<td>257</td>
<td>0.05</td>
</tr>
<tr>
<td>T-2</td>
<td>P</td>
<td>134</td>
<td>66</td>
<td>161</td>
<td>0.02</td>
</tr>
<tr>
<td>T-2</td>
<td>R</td>
<td>111</td>
<td>141</td>
<td>276</td>
<td>0.18</td>
</tr>
<tr>
<td>T-3</td>
<td>P</td>
<td>135</td>
<td>124</td>
<td>242</td>
<td>0.16</td>
</tr>
<tr>
<td>T-3</td>
<td>R</td>
<td>148</td>
<td>97</td>
<td>272</td>
<td>0.09</td>
</tr>
</tbody>
</table>

- Similar results for Corner Die
- Average d = 150 microns
- Much larger deltas for prismatic die
- Direct result of the meshing issues and leakage

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**Conclusions/ Future Considerations**

- 4 Bar Crescent Joint Die and Corner Die exhibited good shape repeatability
- 4 Bar Prismatic Die has since been improved to eliminate issues with first prototype
- 2nd batch of prototypes have been created and tested
- Focuses on sliding prismatic with more drastic area change with a practical application (car weather stripping)

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**Acknowledgements**

- Creative Extruded Products
- Kevin Giaier, M.S.

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**Testing**

- Dies were bolted to extruder
- Prototyped dies were tested at different line speeds with varying actuation patterns
- 4 Bar Prismatic had issues with leakage due to stacked clearances and had issues with gear meshing

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**Measurements**

<table>
<thead>
<tr>
<th>Measurements</th>
<th>PVC</th>
<th>Santoprene</th>
<th>TPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Speed (RPM)</td>
<td>64</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Barrel Set Temperature (°F)</td>
<td>310</td>
<td>370</td>
<td></td>
</tr>
<tr>
<td>Melt temperature (°F)</td>
<td>296</td>
<td>341</td>
<td></td>
</tr>
<tr>
<td>Back Pressure (PSI)</td>
<td>530</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Line speed (ft/min)</td>
<td>5.6</td>
<td>4.0</td>
<td></td>
</tr>
</tbody>
</table>