Assessing Shape Repeatability in Variable Geometry Polymer Extrusion Dies

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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.

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

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

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

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>
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<td>R</td>
<td>111</td>
<td>141</td>
<td>276</td>
<td>0.18</td>
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<tr>
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<td>P</td>
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<td>242</td>
<td>0.16</td>
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<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

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)

Acknowledgements

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