**POLYMER EXTRUSION**

Polymer extrusion is the process of forcing a melted plastic through a die to create a long part. The cross section of the part is dictated by the die exit shape.

**DESIGN CHALLENGES**

- Combat high pressure and temperature
  - Barrel Temp: 300-500 °F
  - Back Pressure: 300-5,000 psi
- Minimizing material leakage or provide adequate leak path away from part
- Provide smooth die land during actuation to prevent turbulence
- Flat exit plane to prevent part curling
- Prevent material from entering die joints
- Material should not prevent actuation
- Device must be constructible with typical machining processes

**BASED ON SHAPE-CHANGE MECHANISMS**

**PROPOSED JOINT CONCEPTS**

- **CRESCENT JOINT**
  - Approximated revolute motion
  - Prevents material leakage
  - Inexpensive components

- **CORNER JOINT**
  - True revolute motion created from line on surface contact
  - Die gap opens close to contact line

- **INTERLACING JOINT**
  - Approximated revolute motion
  - No gaps or leak points open during actuation
  - Expensive components

- **RECESSED JOINT**
  - True revolute motion created
  - No die gaps are exposed
  - Flow must recover from obstruction
  - Expensive components

- **SLIDE JOINT**
  - Prismatic motion is achieved
  - No gaps open during actuation
  - Can provide curved or straight prismatic motion
  - Can be integrated with previous joints to achieve complex motion

**EXPERIMENTAL DIE & TEST**

A 4 crescent joint design which moves between rectangle and parallelogram was tested. The purpose of this die was to evaluate leakage, material response, longevity and overall performance of the variable-geometry concept.

**TEST RESULTS**

<table>
<thead>
<tr>
<th>PVC: No Def</th>
<th>PVC: Half Def</th>
<th>PVC: Full Def</th>
<th>TPV: No Def</th>
<th>TPV: Full Def</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC: No Def</td>
<td>PVC: Half Def</td>
<td>PVC: Full Def</td>
<td>TPV: No Def</td>
<td>TPV: Full Def</td>
</tr>
<tr>
<td>Area of Die (in²)</td>
<td>1.02</td>
<td>0.99</td>
<td>0.92</td>
<td>1.02</td>
</tr>
<tr>
<td>Area of part (in²)</td>
<td>0.97</td>
<td>0.94</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>Reduction (%)</td>
<td>4.86</td>
<td>4.99</td>
<td>9.44</td>
<td>19.21</td>
</tr>
</tbody>
</table>

A PVC and TPV material were tested. Cross sections were taken from extruded parts and compared with the actual profile of the die.

**FUTURE RESEARCH & TESTS**

Two new dies have been designed to display different joint types. Both dies incorporate a corner joint. The die on the left utilizes a fixed length link while the die on the right incorporates a curved slide joint. The slide joint is actuated with a rack and pinion.

Future dies will grow in complexity and flexibility. This concept die could be used to extrude a contoured knife handle. The handle which this die would produce can be seen in the top left of this poster.