INTERSTATE SPECIALTY PRODUCTS
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Die Cutting Tolerances

Introduction

Part tolerances are allowable variations in the dimensions of manufactured components. They are expressed as plus or minus values, or as a range of measurements (typically inch-based). If a part is out of tolerance, performance can suffer. For example, if a rubber enclosure gasket is out of tolerance, the gasket may not perform as designed.

Die cutting is a manufacturing process that produces precision-cut gaskets and other components from non-metallic materials with varying degrees of precision. Tight tolerances are achievable, but product designers may need to balance die cutting tolerances with die cutting costs. It's also important to understand how die cutting tolerances are determined by multiple factors.

What Determines Die Cutting Tolerances?

Die cutting tolerances are a function of material type, part features, tool type, and production technique. Tool costs, turnaround times, and specific design and manufacturing advantages are also important to consider. The following table shows how die cutting tolerances vary.

Die Cutting Technique	**Precision Die Cutting**			**Rotary Die Cutting**	**Digital Die-Less Cutting**
Tool Type	**Steel Rule Die**	**Solid Milled Die**	**Male/Female Die**	**Rotary Die**	**Digital Knife**
Part Features					
1" to 12"	.010"	.005" to .010"	.001" to .005"	.010"	.010"
12" to 24"	.015"	N/A	N/A	.015"	.020"
Punched Holes	.010"	.005"	.001" to .005"	.005"	.010"
Hole Position	.015"	.015"	.005"	.010"	.015"
Radii .062" to .50"	.030"	.015"	.010"	.015"	.020"
Other Considerations					
Tool Cost	$	$$$	$$$$	$$$$	N/A
Turnaround Time	2 days	2 to 3 weeks	4 to 6 weeks	2 to 3 weeks	N/A
Advantage	Cost/ turnaround	Accuracy/ reliability	Accuracy/ reliability	High speed/ reliability	Cost/ turnaround

The next sections examine the role of material types, part sizes, tool types, and production techniques.

Material Types

Interstate Specialty Products die cuts custom gaskets and other specialty products from the following types of non-metallic materials:

- Electrical insulation
- EMI/RFI shielding materials
- Membranes
- Plastics and films
- Porex
- Poron foam
- Pressure sensitive adhesives
- Silicone membranes
- Solid elastomers
- Sponge and foam

For elastomeric materials, the Rubber Manufacturers Association (RMA) publishes tolerance tables based on material type, thickness, width, length, and other variables (such as wall thickness for tubing). Different types of elastomeric materials belong to different RMA classes. For example, RMA Class ATH1 defines die cutting tolerances for open-cell sponge materials.

Designer engineers also need to consider that different types of materials have different properties, and that these properties can contribute to changes in part size. Environmental variables and the die cutting process itself can both affect the physical dimensions of die cut parts.

Environment

Changes in temperature, moisture content, or relative humidity can affect the dimensions of some die cut parts. For example, parts made of closed cell sponge may shrink during storage or shipping at elevated temperatures. Die cut parts made of rigid plastics exhibit greater dimensional stability than flexible rubber and foam materials. Pressure-sensitive adhesives with carriers can add stability.

Processing

Material distortions can also occur during die cutting operations. In addition to concavities and other cut-edge irregularities, die cut materials can exhibit beveling and edge distortion. Typically, beveling occurs with soft, pliable materials that conform to applied forces. Specifically, beveling happens when a die cutting tool flexes outward from the cavity. However, with proper bevel design in the blade, there are production techniques that can control or minimize beveling.

Part Sizes

Die cutting tolerances also vary by part size. As a rule, die cutting tolerance increases as part size increases.

Part Size	Tolerance
Under 5”	± 0.005"- ± 0.010"
5” – 12”	± 0.010"
Over 12”	± 0.015"

Die cutting tolerances can also vary with part features such as punched holes, or with the position or radius of the hole. Different types of die cut parts can also have different part tolerances.

In addition to custom gaskets, Interstate die cuts these non-metallic components.

- Acoustic mesh barriers
- Filter media
- Insulation components
- Membrane filters/ vents
- Shims and spacers
- Washers
- Wicks

For product designers, it's important to understand how material type and part size affect die cutting tolerances. Tooling types and production techniques also affect die cutting tolerances.

Tooling Types and Production Techniques

Interstate die cuts custom gaskets and other specialized products using steel rule and rotary die cutting machines, high tonnage beam presses, high-speed punches, and specialty shears. Depending on the die cutting equipment and your application requirements, the following types of tooling are used:

- Steel rule dies
- Solid milled dies
- Male/female (matched metal) dies
- Etched dies
- Rotary dies
- Digital knives

Each type of tool offers distinct advantages and disadvantages. The following sections describe die types and die cutting techniques with regard to both part tolerances and costs.

Steel Rule Dies

While less expensive, steel rule dies don't offer the accuracy of solid milled dies and matched metal dies. However, they're a great option for parts that do not demand such tight tolerances. With steel rule dies, typical close-tolerance tooling is guaranteed to be within ±.010". Final part tolerances are typically between ±.010" and ±.015". Die cutting accuracy also depends upon the base material and die cutting method.

When production is complete, parts that are stamped with steel rules are ejected mechanically from the die cavity. Ejection rubber, springs, pins, or stripper plates minimize stress on the part and ensure that it's ejected cleanly from the tooling. Proper selection of ejection rubber can improve edge quality, an important consideration for some designs.

Solid Milled Dies

Solid milled dies or custom machined punches may achieve typical final parts tolerances of ±.005" to ±.010". Heat-treated and made of solid steel, these metal dies offer a more consistent, reliable, and repeatable result. Solid milled dies also cause less flexing and distortion during die cutting than steel rule dies. Solid milled dies cost more, but they provide greater accuracy.

Male/Female (Matched Metal) Dies

Male/female or matched metal dies can achieve typical final parts tolerances of ±.001" to ±.005". They are significantly more expensive than steel rule or solid milled dies, but are recommended for applications where extremely tight tolerances are required. For part sizes between 1" and 8", die cutting with male/female dies supports tighter tolerances than digital die less cutting, a technique that's also highly accurate.

Rotary Dies

Rotary dies can achieve die cutting tolerances of ±.010". The depth of the cut can be controlled precisely to facilitate kiss cutting, and the cuts are consistent since the dies are machined from a single piece of tool steel. Rotary die cutting is more commonly used with rolls or webs and is more suitable for thin materials and films less than 0.062" and in high volumes.

Digital Knives

Digital cutting that uses knives instead of dies can achieve tight tolerances with exceptional edge quality. There are no tooling charges and, unlike other cutting techniques, there's no water contamination or heat-affected zones. Digital die-less cutting is suitable for a wide range of materials, including sponge and various elastomers. Depending on material, part size, and geometry, critical tolerances can be achieved.

Conclusion

Die cutting is a manufacturing process that produces rubber gaskets and other non-metallic parts with varying degrees of precision. Tight tolerances are achievable, but product designers may need to balance die cutting tolerances with die cutting costs. By understanding all of the factors that determine die cutting tolerances, designers can make the best choices for their projects.