Material Selection for a plastic injection molded product

hti PLASTICS

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Material selection is critical to all aspects of the finished product. When deciding upon the right resin for the product or component, several factors must be considered. Along with material selection, there are three other areas that are considered during the project evaluation: part design, mold design and the production process.

The resin is the base of the plastic product or component; the most essential element of the final product that will have impact on its cost, production time, usage and life cycle. In determining the ideal resin, understanding how the end-user will use the product, what exterior elements will the product be exposed to and are there desired aesthetic qualities. These are a few of the questions that need answered during the project evaluation.

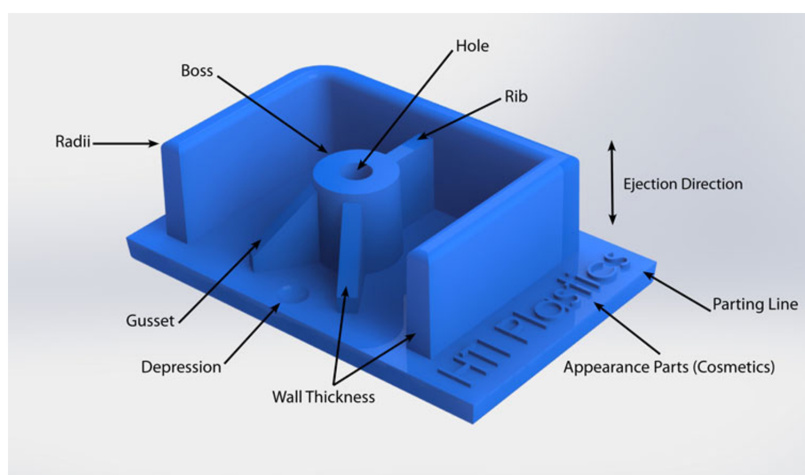
Part Design

There are many aspects to designing parts—from desired final appearance to determination of a product's life cycle. Does the part need to be durable? Will it be disposable or be used many times? What external elements will it be exposed to—a harsh environment, solvents or aggressive chemicals, for example?

Product engineers determine mechanical characteristics according to the amount of stress the part is expected to bear. Plastic often shifts and gives with use, so its dimensional stability is an important consideration.

Resin considerations are reviewed during the design phase of the part; to determine what a product will look like and how it will be molded. Different raw plastics have different end results, each of which can affect:

- Wall thickness
- Parting line and ejection
- Appearance parts
- Ribs and gussets
- Bosses
- Holes and depressions
- Radii, fillets, and corners

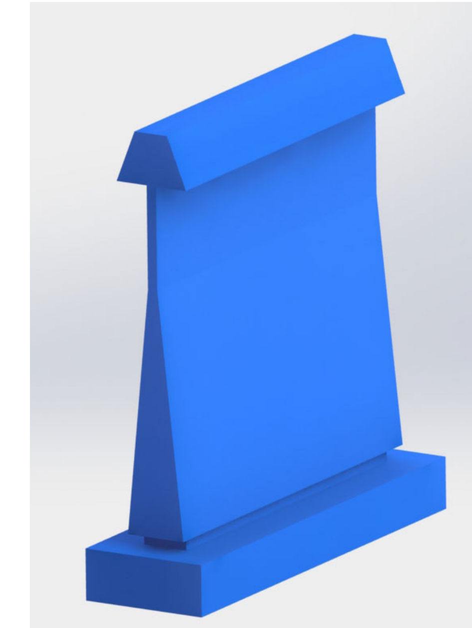


For example, we had a current customer approach us about a new product to add to its current product line. The design had incorporated a process that was patented by another company. We were asked to design a way to achieve the same result but without utilizing the current patented overmolding process.

Our engineers dug in and reviewed all the possibilities, and settled on a process that chemically bonded the TPE (thermoplastic elastomer) to base polypropylene part. They tested the performance of the bonding which required designing fixtures to secure the two components. The new process performs as well as the patented overmolding process and the customer avoids paying any royalties for use of the patented process.

Mold Design

When engineers design a mold, they must consider many factors that go into the production process and the final product. These include flow characteristics of the resin, varying wall thickness, how the plastic cools both in the mold and following release (creating dimensional stability), shrinkage, and gate dimensions and locations. Each finished part must meet requirements as expected, every time. Specific testing of a part's manufacturability is ongoing during every stage of the process. Aspects such as critical tolerances, maximum displacement, strength, and material comparisons are constantly evaluated and updated.

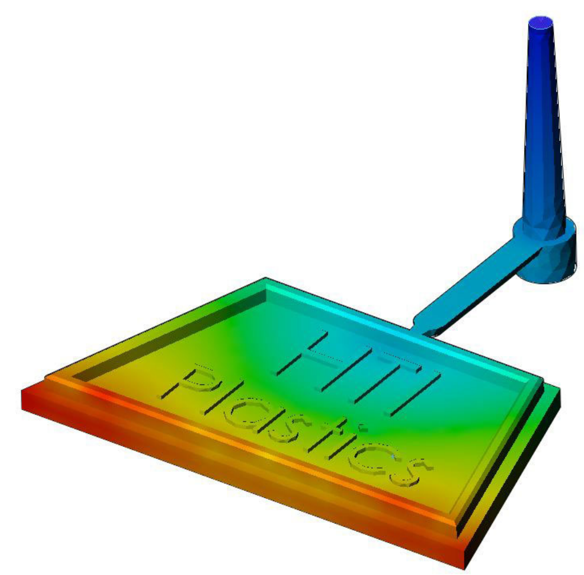


Once all of these factors have been evaluated, the economics of the design must be evaluated to determine if the mold is feasible within a desired budget. Any modification to the design requires a thorough computation of its impact on the three F's of the plastic molding: Form (size, shape, balance, etc.), Fit (interaction with other components), and Function (applied purpose) of the part. An experienced injection molder ensures that these criteria are met while maintaining speed and efficiency.

Production Process

Each resin has unique processing characteristics, so both the resin and the mold design must be evaluated for fill rate, energy content, melt viscosity, stability at melt temperature, and shrinkage. Material handling techniques, such as drying temperature, also will impact the outcome.

The melt viscosity test identifies the maximum and minimum fill rates permissible for the mold with a specific plastics material. The theory behind using high speed injection rates is to take advantage of the decreased viscosity which results when plastics are subjected to high shear rates. The mold viscosity test should be performed on the correct size press, for which the mold was designed.



Melt temperature has a significant influence on the behavior of the polymer and the final properties of the material regardless of part design. Melt temperature is the actual temperature of the polymer as it exits the nozzle and enters the mold. The barrel set points represent the tools we use to arrive at the desired melt temperature, but they are not the same thing.

The mechanical work imparted to the material, the residence time, and the condition of the screw and barrel all play a significant role in determining the actual melt temperature. We can examine the effects on the properties of the polymer. It is generally understood that melt temperature has an effect on viscosity. It also has an influence on the final molecular weight of the polymer in the molded part.

Shrinkage is inherent in the injection molding process. Shrinkage occurs because the density of polymer varies from the processing temperature to the ambient temperature. During injection molding, the variation in shrinkage both globally and through the cross section of a part creates internal stresses. These so-called residual stresses act on a part with effects similar to externally applied stresses. If the residual stresses induced during molding are high enough to overcome the structural integrity of the part, the part will warp upon ejection from the mold or crack with external service load.

Moisture in plastic resins can spell trouble for manufacturers because it can cause defects in injection molded products that even if not visible will sooner or later result in degraded performance. High-performance resins must be dried to the correct moisture level in order to avoid potentially costly product failures down the line. Plastic parts manufacturers may also employ drying ovens just prior to molding.   A moisture analyzer serves parts manufacturers three ways.

1. To confirm that their raw material is delivered "as advertised"
2. To do a quick analysis of the product after storage to determine the extent, if any, drying is required and
3. To provide a QC check on their drying oven performance.

Resin Selection

With these factors in mind, cost and availability of the selected resin then can be considered.
Using an established process of resin selection that consists of four logical steps:

1. Establish products' end-use requirements.
End-use requirements address forces the part will be subjected to, such as load rate and duration, impact forces, and vibration. The environment to which the part will be exposed is considered as well. This might include prolonged outdoor exposure and weather conditions, as well as temperature ranges and chemicals. Often, secondary operations come into play, such as assembly techniques, maintenance, and end-of-life procedures.

2. Rank the product's requirements.
The established requirements are then ranked in order of priority, so the design team can identify which areas to fulfill first.

3. Evaluate resin options within the scope of the product's requirements.
Now the team can examine which resin types fulfill these requirements while remaining within desired cost range. Resin type with specs that fall completely or partly outside of this range must undergo a risk assessment.

4. Conduct end-use testing.
The part is subjected to testing that simulates normal use and storage, either in a laboratory or in the real-life environments where it will be used. This testing process is developed to specifically address each of the part requirements established in step 2. The process might include stress analysis, photo elasticity testing, and an environmental chamber to test for temperature or humidity, or any of myriad other methods to ensure the component satisfies specifications.

All of these considerations are invaluable in delivering a superb final product every time. The choices early in product development determine the project outcome, so we weigh them heavily and are always careful to make the right choice. Ill-advised material selection would result in an inferior process and possibly and inferior product, adding cost, time, and headaches to the process. Working with an experienced team of design and industrial engineers along with a plastics specialist who understands injection molding will get the desired results for the customer every time.

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