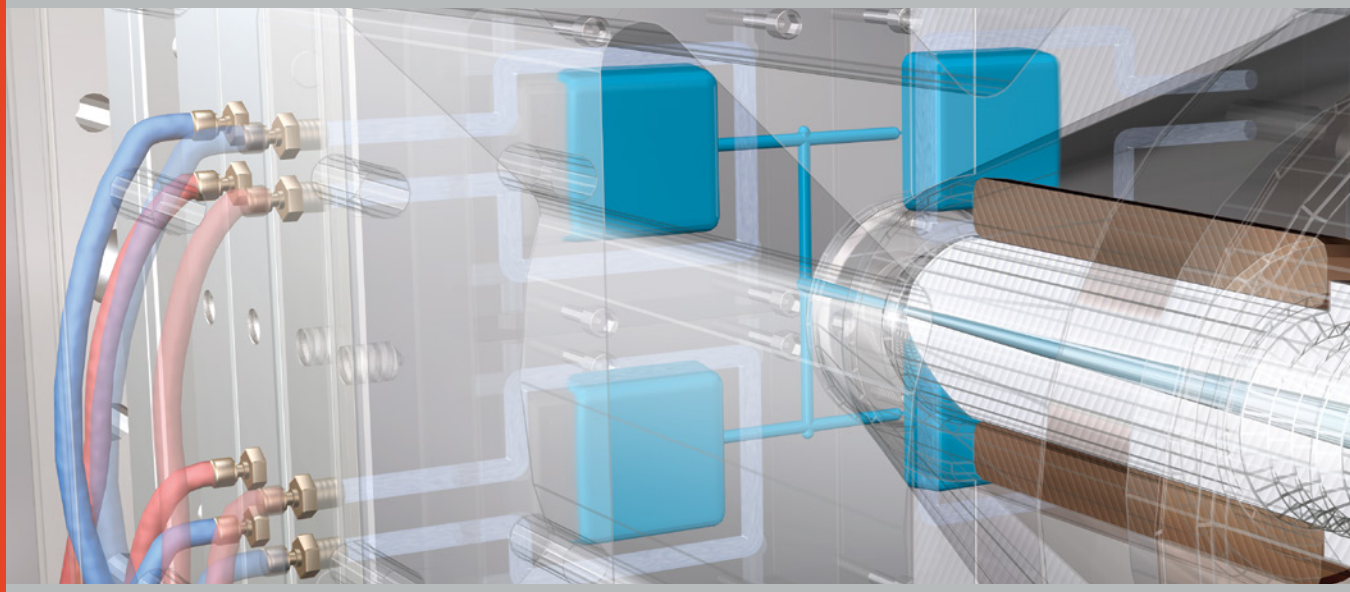
REFERENCE SERIES: DESIGN

Materials Selection in the Part Design Process



nexeo plastics

Created exclusively for **Nexeo Plastics** by Routsis Training, this free guide contains excerpts from Routsis's ***Mold & Part Design Courses***.

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MATERIALS SELECTION

Initial Materials Selection

After the initial designs have been drawn, the next step is the initial materials selection. This step involves selecting materials which are suitable for the application. With the thousands of different materials currently available, this step can be fairly difficult. When selecting a polymer for the application, there are two types of properties to consider: Properties which can, and properties which cannot be changed by design.

Properties which can be changed by design are typically those associated with the mechanical properties of the material. Although mechanical properties — such as the Tensile, Flexural, and Impact properties are dependent on the material, these properties can also be enhanced by the design of the part.

For example, many rigid polymers tend to be brittle. A more ductile polymer may exhibit similar strength but provide greater impact strength through changes in design.

Properties which typically cannot be changed by design are properties such as chemical resistance, coefficient of thermal expansion, ultraviolet stability, and optical properties.

These properties are usually inherent to the chosen polymer. However, alterations to the polymer such as adding fillers, reinforcements, colorants, or coatings can alter the properties of the polymer. Polymer candidates should be chosen first by the properties which cannot be changed by design. Material candidates should not be limited to virgin materials, but also include those with fillers, additives, and reinforcements when applicable.

Material suppliers provide material property information to aid in material selection. Some materials suppliers even provide designers with samples of the material to test for applicable properties. When finished with the initial materials selection, you should have at least three to six viable materials for the application.

In order to simplify the example, we will choose three material candidates for the hose nozzle:

- Polypropylene
- Polyethylene
- Nylon

Conform the Part Design to Material Properties

After the initial material selection has been completed, the next step is to design the part in accordance to the selected materials' properties. This step involves designing the part for each of the materials initially selected. This results in a different part design for each of the materials chosen during initial materials selection.

At this stage, the part designer is concerned with designing parts which conform to the desired end use requirements. Through this stage, the different part designs will have various geometries, thicknesses, and features in order to meet the strength an performance requirements — limited by the inherent properties of the material.

Final Materials Selection

With the part designs and initial material selections completed, the next step is the final materials selection. If several acceptable part designs cannot be made, then it may be necessary to repeat the initial materials selection, and investigate alternative materials or design approaches.

While designing the hose nozzle, three different part designs have resulted. The polypropylene and polyethylene parts have larger wall thicknesses than the nylon part, and require strengthening ribs to maintain adequate strength.

At this point, there are few remaining material candidates — and any one of these could be acceptable for the application. For this reason, thorough materials evaluation is critical.

One method of evaluating a process is through a strict cost analysis. This requires calculating all of the manufacturing aspects of the process to determine the actual price per part.

When evaluating the materials used for our nozzle, there are many aspects to consider. Polypropylene and polyethylene are less expensive materials volumetrically, but the parts require more material to maintain the same structural integrity as the Nylon version. Furthermore, the extra part thickness of the polypropylene and polyethylene parts require extra cooling and filling time. These result in longer processing times and greater expense.

Another, more comprehensive way to evaluate materials is to rate the materials using a comparison chart. Material properties and characteristics are rated on a scale from one to ten for each material. The importance of these properties are then rated relative to each other. For example, creep resistance may be twice as important as impact resistance — depending on the application.

Price, strength, performance, processability, and many other concerns can be addressed and prioritized in the comparison chart.

Material Comparison Chart

		Material		
Property	**Importance**	**HDPE**	**PP**	**Nylon**
Impact	**2**	**9**	**7**	**6**
Creep	**1**	**2**	**5**	**8**
Price per Part	**3**	**8**	**7**	**6**
Strength	**3**	**4**	**6**	**8**
Processability	**2**	**9**	**7**	**5**
Performance	**3**	**4**	**6**	**8**
	Total:	**86**	**90**	**96**