Material Selection Guide
Polyurethane (Non-Foam) Molding Compounds

Polyurethane can be formulated from a variety of raw chemicals. Polyurethane casting resin can be a good material choice for many applications, but it is important to know how to choose the right formulation for your particular application. Also, each polymer, including polyurethane, has limitations as well as advantages over other types of polymer raw materials. This document provides some guides to product developers thinking about using polyurethane casting resin as their products.

High-Performance Formulations vs. Room-Temp-Cure Formulations

In general, Room-Temperature-Cure formulas are easier to handle comparing to High-Performance formulas.

Room-Temp-Cure formulas typically allow long working times (pot-life) so you can manually hand-mix, degas, and cast into the mold. Often, they can be processed without heating the raw materials or mold. However, the physical strengths of room-temperature-cure materials are limited. Room-Temperature-Cure formulations are often not strong enough for many heavy duty applications.

On the other hand, High-Performance formulations provide necessary strength to heavy duty applications; however, it needs heat to process. Often one of the components needs to be heated to about 180 ˚F. The mold also needs to be heated. Post-curing at about 180 ˚F for a few hours to overnight is often required to yield the optimum performance from the molded part. Because of the heated process, pot life of a typical High-Performance formulation is short; it's is usually less than 3 minutes. This limits the size and type of parts you can process manually. Often, you need to use a proper meter-dispenser to process this type material.

Northstar Polymers can custom-formulate a polyurethane casting resin that is the optimum "happy medium" formulation. Some applications need better physical properties than a room-temp-cure formula but the processing limitation prohibits from the user to use a High-Performance formula. We can custom formulate a compound that can be processed with a limited processing capacity, and still satisfies the minimum material strength requirements for the customer's particular application.

Polyester vs. Polyether

Within the High-Performance formulations, you need to choose either polyester base or polyether base polyurethane formula.

Polyester based formulas in general have better tensile strength, cut-and-tear resistance, and better stability against oily materials in contact. Polyester based polyurethane formulas are used in many industrial applications. Polyester based polyurethane undergoes hydrolysis in aqueous conditions.

When the molded parts are constantly in contact with water or in a high humidity condition, parts made of polyester based polyurethane do not last for a long time.

Polyether based formulations have high-rebound and much better stability against water and acidic/basic chemicals comparing to polyester based counterparts. Due to the lower surface energy level, it resists dirt, slurry, concrete, and other water-born substances to stick. Roller skate wheels, various balls used for sports and recreation, and many marine applications use polyether based polyurethane formulations. Spandex and other resilient fabrics contain polyether base polyurethane materials. The cut-and-tear properties of polyether based polyurethane are not as good as polyester based polyurethane.

Room-Temperature-Cure Polyether vs. PTMEG Polyether Polyurethane

Many Room-Temperature-Cure polyurethane formulas are polyether based formulations. The polyether raw materials used in Room-Temperature-Cure polyurethane formulas are typically polypropylene glycol (PPG). As mentioned above, Room-Temperature-Cure materials do not have very strong physical properties in general. PTMEG (Poly Tetra Methylene Ether Glycol) is also a polyether based polyurethane raw material, and High-Performance polyether polyurethane formulas are often formulated using PTMEG. Comparing to Room-Temperature-Cure polyether polyurethane formulas, PTMEG based High-Performance polyether polyurethane formulas have better overall physical properties as well as water resistance property. Typically, PTMEG based formulations are slightly more expensive.

Polyurethane vs. Other Casting Resins

Aside from polyurethane, there are other polymer resins that may be more appropriate for your application. Polyurethane resins in general have some limitations.

Typically, the upper limit operation temperature of a polyurethane product is about 180 ˚F. Some High-Performance class polyurethane formulations can be used up to about 200 ˚F. If you need a part that can be used above this temperature range, polyurethane may not be a proper raw material. For softer hardness range parts, silicone rubber will be the most common alternative material for high-temperature applications. For harder parts, epoxy may be a good alternative. There are other polymers that can withstand higher temperature, but many of those are not castable liquid resins.

> Note: Please consult your suppliers of epoxy and silicone compounds for the operation temperature ranges and other properties of their products. Northstar Polymers does not carry epoxy or silicone resins.

Comparing to other casting resin compounds, polyurethane is generally more sensitive to moisture while the liquid components are being processed and stored. If the resin casting operation needs to take place in a wet or high-moisture condition, you may need to use a different polymer.

Polyurethane does not stand well against strong chemicals. Polyether polyurethane can withstand well against week to moderate acid and basic materials. Polyester polyurethane can withstand well against aliphatic hydrocarbon and oils. However, either type of polyurethane will not stand well against aromatic hydrocarbon, ketones, strong acid/base, as well as other strong solvents. An epoxy compound

specially formulated for chemical resistant coatings may be a more appropriate choice for such an application.

Polyurethane can be used as a mold-making material. When you are making molds for concrete products, polyurethane is one of the most effective and least expensive mold-making materials. However, if the material is processed at an elevated temperature, polyurethane mold may not work well sometimes. The heat conductivity of polyurethane mold is not very good, and it could have issue with varied expansion of mold material at different regions. Filled epoxy and silicone mold-making compound addresses this issue by improving heat properties of the mold-making resin material.

Shore Durometer 70D to 80D hardness polyurethane resin materials are rigid, and the hardness of those materials is similar to many plastic materials. However, polyurethane resin materials in these rigid ranges are very easy to soften with heat. It can become quite flexible just above 120 ˚F. When making parts that need to hold loading weight at an elevated temperature range, this property of polyurethane resins may become an issue. Epoxy resins can hold their hardness better in a high temperature range.

Aliphatic Urethane vs. Aromatic Polyurethanes

Most of our polyurethane casting resin products is aromatic polyurethane. Aromatic polyurethanes discolor from UV lights. After a molded product is used for a while, its color can changes to dark yellow. If the stability of material color is very important to the product, aliphatic polyurethane is often used. Aliphatic polyurethanes also come with much lower color. However, aliphatic polyurethane compounds are typically more expensive. Curing patterns for aliphatic polyurethane formulations are more difficult to control comparing to the aromatic polyurethanes. Even aliphatic polyurethanes can change color from other causes such as oxidation of polyol component and anti-oxidant content. Except for high-end automotive coating applications, optical applications, and other specialty applications, aromatic polyurethanes compounded with UV stabilizer additives together with pigments are used to mask the colors of resins and stabilize the product color long enough for the marketability.

Thermosetting Polyurethane vs. Thermoplastic Polymers

Most of our products are raw material components for thermosetting polyurethane systems. Thermoset materials are liquid state resins designed to turn into solid by chemical reactions. It is more like pancake batter heated to turn into solid. It would not be turned back to liquid once it becomes solid. Thermoplastic materials are heated to be liquid, and cooled back to be solid. It is more like chocolate. It can change between liquid and solid states many times.

Polyurethane liquid thermoset resins need some time to turn into solid by some chemical reactions. Depending on how long you need to leave the resin in the mold before demolding dictates your mold-cycle rate. If you need to make many parts within a limited time, you want to cycle your mold as many times as you can. Otherwise, you must have many mold cavities to meet the required production rage.

We can increase the reaction rate by addition of catalyst(s). However, there is a limit. Adding catalyst(s) also reduces pot-life, so the curing rate can only be increased to the point you have minimum pot life for your process. With thermoset resins, your mold-cycle rate is limited.

Thermoplastic materials can be molded in much shorter time. Thermoplastic compounds are heated to have flow, injected to the mold with high pressure, and cool it to demold. The mold-cycles for thermoplastic process are typically much faster than those of thermoset materials including polyurethane casting resins.

Typically, thermoplastic materials are molded with the injection molding process. The injection machines and molds for injection molding are quite expensive. Often, the injection molders ask for a large minimum order quantity. If your requirement is very large, injection molding process with thermoplastic material(s) may be more effective. Polyurethane casting resin, on the other hand, requires much smaller initial investment on molds and setups, though your production rate may be low. If you are making a specialty product in small quantity, polyurethane casting resin can be more suitable material than thermoplastic materials.

Types of Polyurethane Products We Do Not Carry

Northstar Polymers carry many different polyurethane formulations, which cover a wide range of applications. However, we are a resin raw material manufacturer, and we do not make retail products. In many cases, our products are not suited for a private use by consumers.

- We do not sell our products in retail size packages except when we are under a private labeling contract or for a wholesale contract with the applicable minimum quantity. The minimum quantity for retail packaging contract is typically 1,000 units or more.

- We do not make polyurethane based retail products such as wood coating materials including polyurethane varnish, water based floor coating materials, polyurethane sealant, aerosol-can contained gap filling foam, and other retail consumer products. We supply polyurethane prepolymers as a precursor raw material for manufacturers of those products.

- We do not supply any sheet stock, die, parts, or any other molded products except for custom contracted supply of granules or other random shaped solids used as a custom resin raw material.

- We do not carry TPU (thermoplastic polyurethane) granules or pellets. We can custom-formulate TPU resins as precursor material for coating and adhesives and supply them in non-specific size sheets and blocks.

Please feel free to contact Northstar Polymers for any question.

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