

PVC vs. Polyurethane: A Tubing Comparison

NewAge® Industries, Inc.

Introduction

PVC and polyurethane are thermoplastic materials that can be formed into a variety of shapes, including tubing and reinforced hose. Both materials are useful in numerous applications. But depending on factors like temperatures, chemicals, and outdoor use, one product may perform better than the other in a particular application.

This document will examine each material's benefits, drawbacks and common uses as they pertain to products available from NewAge® Industries, Inc.

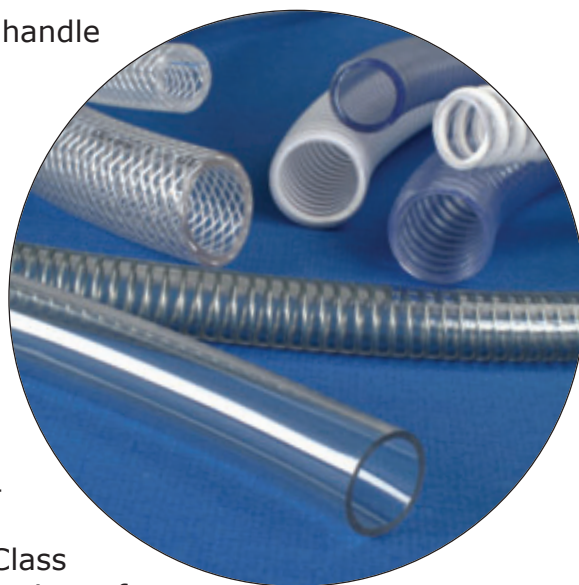
PVC

Although no plastic tubing material can universally handle all uses, PVC (polyvinyl chloride) covers one of the widest ranges of applications serviced by one type of material.

Flexible PVC tubing offers a broad range of chemical and corrosion resistance, excellent abrasion and wear resistance, rubber-like flexibility, visual contact with the flow (with clear styles), and outstanding flow characteristics.

It's strong and durable yet lightweight. These features, along with various construction options – unreinforced or with wire, spiral, or braid reinforcement – and the different formulations available (industrial, fuel and oil grade, 3-A, FDA, NSF, USP Class VI, antimicrobial), make PVC attractive for a wide variety of uses. Examples include:

- Chemical processing
- Water transfer
- Waste product lines
- Viscous fluid handling
- Wet or dry food handling
- Beverage transfer (including those containing alcohol)
- Dairy processing
- Granular material conveyance



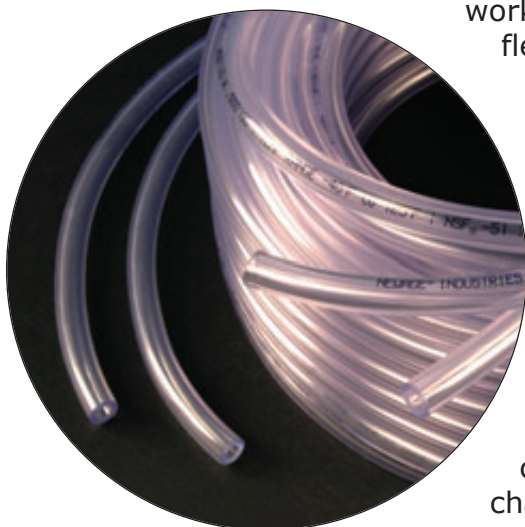
- Air and gas supply
- Medical appliance components
- Vacuum lines
- Drain lines and pump discharge
- Pneumatics
- Spray systems
- Small engine fuel lines
- Protective jacketing
- Potable water
- Irrigation systems



Some of the more unusual applications for NewAge's PVC tubing have involved toys, cows, fish, and the art world. The tubing has been used in children's sprinklers and a cow teat medication process, and as fishing lures and part of a sculpture involving live orchids.

One of PVC's disadvantages is that it may harden and become less pliable when certain fluids — concentrated acids and alkalis, for example — are transferred through it. Another drawback is that standard PVC tubing does not react well with fuels and oils; the tubing will harden and crack. However, special PVC formulations are available for fuel and oil applications, such as those involving small engines for powered lawn and landscaping equipment.

In the past, many PVC compounds used phthalates, chemical agents added to a resin to increase its workability during processing and to impart flexibility and other desired properties to the finished product. Phthalates can leach out of the end product, and in the case of tubing, be introduced to the fluid flowing within. Some studies suggest that phthalates like DEHP (Diethyl-hexyl phthalate) may be harmful. But today more and more PVC compounds, like those used to manufacture NewAge's Clearflo® 70, antimicrobial Clearflo Ag-47, and Nylobrade®, are made without phthalates, and other compounds are undergoing formulation changes to remove phthalates.



A sampling of industries that use PVC tubing includes:

Industrial

Medical and hospital

Chemical

HVAC

Pharmaceutical

Waste handling

Food service

Cleaning apparatus

Pool and spa

Agricultural equipment

Insect control

Food, beverage and dairy processing

Appliance

Laboratory

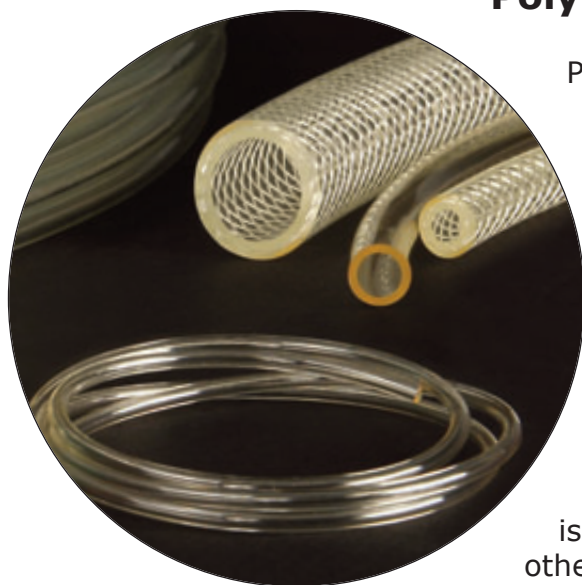
Energy

Craft beer

Packaging



Polyurethane



Polyurethane combines the best properties of plastic and rubber. Sometimes abbreviated as PU, PUR or TPU, it offers high elongation values (stretchability) like rubber and abrasion resistance that's superior to PVC. Polyurethane is naturally flexible and does not use additives for its flexural properties.

Combining good chemical resistance with excellent weathering characteristics sets polyurethane apart from other thermoplastics. It has exceptional resistance to most gasolines, oils, kerosene, and other petroleum-based chemicals and fluids, making it an ideal choice for fuel lines (although additives in today's gasoline and petroleum products warrant field testing). Polyurethane is generally more resistant to pressure and vacuum applications than corresponding sizes of PVC or rubber. It offers lower gas permeability than PVC and is also more cut and tear resistant than many other thermoplastics.

The two basic formulations of urethane, ester and ether, have some important differences. Water attacks ester-based urethane, causing a significant reduction in physical properties. Ether urethanes exhibit far superior hydrolytic stability, especially in humid environments. Ether-based materials also resist fungus growth better than ester-based materials.

Generally, polyurethane is tackier than PVC. It may stick to itself, which, in the case of tubing, can result in tangles. Additives can be mixed with the polyurethane resin at manufacture to reduce tackiness. Material combinations such as PVC/polyurethane blends can also change the surface characteristics, but PVC by itself has a naturally slipperier surface than 100% polyurethane.



Polyurethane tubing applications include:

- Pneumatic control systems
- Petroleum product transfer
- Small motor fuel lines
- Cable jacketing
- Air lines
- Vacuum equipment
- Powder and granular material transfer
- Fluid lines
- Lubrication lines
- Sleeving
- Low pressure hydraulics
- Robotics
- Oxygen and gas supply
- Medical and biological fluid transfer
- Diagnostic catheters

Like PVC, NewAge's polyurethane tubing has seen its share of unusual applications. It's been used as flexible pen barrels at a mental health facility to help prevent the pens from being converted into



weapons, and it can be found in hospital equipment designed to prevent the formation of blood clots.

A sampling of industries that use polyurethane tubing:

Agriculture

Chemical

Appliance

Recreational vehicles

Orthopedics

Undersea oil exploration

Nuclear power

Instrumentation

Medical device

Environmental

Industrial

Petroleum

Automotive

Mining

Robotics



Similarities & Differences

Characteristics that PVC and polyurethane have in common:

- Kink resistance
- Flexibility
- The ability to be opaquely colored or with tints so that the tubing or reinforced hose remains transparent
- Low gas permeability
- Custom options such as heat formed shapes, thermal bonding, overbraiding for increased pressure and/or heat resistance, manufacture in harder or softer durometers, non-stock sizes
- Specified cut-to-length pieces

Important ways in which the two materials differ:

- Low temperature use — PVC can be used at temperatures approaching $-50^{\circ}\text{F}/-45^{\circ}\text{C}$, while polyurethane can handle those near $-90^{\circ}\text{F}/-67^{\circ}\text{C}$

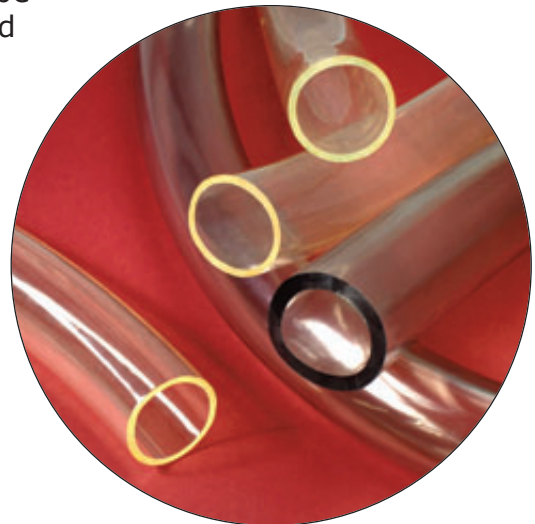


- The transfer of odors or tastes to products flowing within — polyurethane is generally regarded as odorless and tasteless; PVC is not
- Nylobrade® braid reinforced PVC hose is available in different wall thicknesses (thin, standard and high pressure) unlike Urebrade® braid reinforced polyurethane hose
 - Weather resistant properties — PVC may harden and discolor when exposed to certain conditions; polyurethane handles outdoor applications well
 - Polyurethane is naturally flexible and requires no plasticizers; certain PVC formulations use plasticizers
 - PVC generally costs less than polyurethane



Comparison Charts

The following charts compare the physical properties of several styles of PVC and polyurethane tubing. **Note:** This information pertains to properties and characteristics of PVC and polyurethane products available from NewAge® Industries, Inc. The values listed are typical for the materials used in manufacture and are meant to be used as a guide. Field testing should be performed to find the actual values for a specific application.



Comparison Chart 1: Physical Properties

	Product	Hardness, Shore A (±5)	Tensile Strength, PSI	Elongation @ Break, %	Brittle Temperature, °F	Maximum Operating Temperature, °F	Working PSI @ 70°F*
PVC	Clearflo® 70 Tubing	70	2000	400	-41	175	25 - 169
	Clearflo® Fuel & Oil Tubing	62	1980	730	-20	175	40 - 68
	Clearflo® Ag-47 Tubing	74	†	†	-40	125	37 - 236
	Nylobrade® Hose	80	2500	320	-50	175	50 - 465
	Newflex® Hose, Standard & Heavy Duty	65	1900	440	-45	150	35 - 105
	Newflex® Hose, Light Duty	70	2000	420	-42	140	n/a
	Vardex® Hose	73	2100	270	23	150	70 - 200
Polyurethane	Superthane® Ester Tubing	85	6000	550	-95	185	27 - 135
	Superthane® Ether Tubing	85	5500	580	-90	175	22 - 135
	Urebrade® Hose	85	5500	580	-90	175	40 - 250

*Dependent on tubing/hose size / †Data unavailable at this time

Comparison Chart 2: Appearance, Standards & Performance

	Product	Material	Reinforced	Standards Met by Ingredients or Tubing/Hose	Color	Weather Resistant	Made in USA
PVC	Clearflo® 70 Tubing	Clear PVC	No	FDA, NSF 51*, Class VI*	Clear	No	Yes
	Clearflo® Fuel & Oil Tubing	Transparent Yellow PVC	No	n/a	Transparent Yellow	No	Yes
	Clearflo® Ag-47 Tubing	Clear PVC	No	FDA, NSF 51*	Clear with a slight purple tint	No	No (UK)
	Nylobrade® Hose	Clear Braided PVC	Yes	FDA, NSF 51* & 61*, Class VI	Clear	No	Yes
	Newflex® Hose, Standard & Heavy Duty	Clear Spiral PVC	Yes	FDA, 3-A	Clear	No	Yes
	Newflex® Hose, Light Duty	Clear PVC with White Spiral	Yes	FDA, 3-A	Clear with white spirals	No	Yes
	Vardex® Hose	Clear PVC with Steel Wire	Yes	FDA	Clear	No	No (Italy)
Polyurethane	Superthane® Ester Tubing	Clear Ester Polyurethane	No	FDA	Transparent Amber	Yes	Yes
	Superthane® Ether Tubing	Clear Ether Polyurethane	No	FDA, NSF 61	Transparent Amber	Yes	Yes
	Urebrade® Hose	Clear Ether Braided Polyurethane	Yes	FDA, NSF 61	Transparent Amber	Yes	Yes

*Applies to the finished product

Conclusions

The deciding factor in whether to choose PVC or polyurethane tubing depends on the specifics of your application — what will flow through the tubing, what temperatures are involved, will it be used indoors or out, what pressure capabilities are needed, are leachables a concern, what hardness is required, what will the tubing come in contact with?

Communicate with your supplier to help determine which tubing material is the right one for your particular needs. Ask questions and request samples for evaluation. Perform field testing, and when the results are in, you'll be ready to make a well-educated decision.

For more information on NewAge® Industries' PVC and polyurethane tubing and hose, contact the company at 215-526-2300 or visit <http://www.newageindustries.com>.



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