PVC Chemical Resistance Guide







Thermoplastics: Polyvinyl Chloride (PVC)



Chemical Resistance Guide

Polyvinyl Chloride (PVC)

1st Edition

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ABOUT IPEX

At IPEX, we have been manufacturing non-metallic pipe and fittings since 1951. We formulate our own compounds and maintain strict quality control during production. Our products are made available for customers thanks to a network of regional stocking locations from coast-to-coast. We offer a wide variety of systems including complete lines of piping, fittings, valves and custom-fabricated items.

More importantly, we are committed to meeting our customers' needs. As a leader in the plastic piping industry, IPEX continually develops new products, modernizes manufacturing facilities and acquires innovative process technology. In addition, our staff take pride in their work, making available to customers their extensive thermoplastic knowledge and field experience. IPEX personnel are committeed to improving the safety, reliability and performance of thermoplastic materials. We are involved in several standards committees and are members of and/or comply with the organizations listed on this page.

For specific details about any IPEX product, contact our customer service department.

INTRODUCTION

Thermoplastics and elastomers have outstanding resistance to a wide range of chemical reagents. The chemical resistance of plastic piping is basically a function of the thermoplastic material and the compounding components. In general, the less compounding components used the better the chemical resistance. Thermoplastic pipes with significant filler percentages may be susceptible to chemical attack where an unfilled material may be affected to a lesser degree or not at all.

Some newer piping products utilize a multi-layered (composite) construction, where both thermoplastic and non-thermoplastic materials are used for the layers. Layered composite material pipe may have chemical resistance that differs from the chemical resistance of the individual material. Such resistance however, is a function both of temperatures and concentration, and there are many reagents which can be handled for limited temperature ranges and concentrations. In borderline cases, it will be found that there is limited attack, generally resulting in some swelling due to absorption. There are also many cases where some attack will occur under specific conditions, but for many such applications, the use of plastic will be justified on economic grounds when considered against alternative materials. Resistance is often affected (and frequently reduced) when handling a number of chemicals or compounds containing impurities. For this reason, when specific applications are being considered, it may be worthwhile to carry out tests using the actual product that will be encountered in service. The listing that follows does not address chemical combinations.

The information is based on immersion tests on unstressed coupons, experiments and, when available, actual process experience as well as data from tests inclusive of stress from temperature and pressure. The end user should be aware of the fact that actual service conditions will affect the chemical resistance.

Chemicals that do not normally affect the properties of an unstressed thermoplastic may cause completely different behavior (such as stress cracking) when under thermal or mechanical stress (such as constant internal pressure or frequent thermal or mechanical stress cycles). Chemical resistance data from immersion tests cannot be unconditionally applied to thermoplastic piping components subjected to continuous or frequent mechanical or thermal stresses.

When the pipe will be subject to a continuous applied mechanical or thermal stress, or to combinations of chemicals, testing that duplicates the expected field conditions, as closely as possible, should be performed on representative samples of the pipe product to properly evaluate plastic pipe for use in this application.

RATINGS

Ratings are according to the product and suppliers.

The absence of any class indication for any given materials, signifies the absence of data for such material(s) with respect to the specific chemical(s), temperature(s) and concentration(s).

Note: Chemical resistance data is found in a laboratory setting and cannot account for all possible variables of an installed application. It is up to the design engineer or final user to use this information as guidance for a specific application design.

If a material is chemically resistant to the concentrated form of a specific chemical, it should be resistant to the diluted form of that same chemical.

All Chemical Resistance data for Polyvinyl Chloride (PVC) contained within this manual has been provided, with written consent, by Uni-Bell.

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Notes

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POLYVINYL CHLORIDE (PVC)

All Chemical Resistance data for Polyvinyl Chloride (PVC) contained within this manual has been provided, with written consent, by Uni-Bell.

A pipe system may be subject to a number of aggressive chemical exposures, accidental or otherwise. Resistance of PVC pipe to attacks by chemical agents has been determined through years of research and field experience, demonstrating the capability to endure a broad range of both acidic and caustic environments.

Factors Affecting Resistance

Chemical reactions can be very complex. There are so many factors affecting the reaction of a piping system to chemical attack that it is impossible to construct charts to cover all possibilities. Some of the factors affecting chemical resistance are:

- 1. Temperature
- 2. Chemical (or mixture of chemicals) present
- 3. Concentration of chemicals
- 4. Duration of exposure
- 5. Frequency of exposure

PVC Pipe and Fittings

The chemical resistance information for PVC pipe provided in the following tables is based on short-term immersion of unstressed strips of PVC in various chemicals (usually undiluted), and may be useful in assessing the suitability of PVC under unusual or specific operating environments. Results of this type of test can be used only as a guide to estimate the response of PVC. These tables provide guidance to industrial users of pipe for conveying the chemicals listed, rather than design criteria for sewers that may experience occasional exposures or when diluted by other wastewater discharges.

An additional source of information on the chemical resistance of PVC pipe is the National Association of Corrosion Engineers publication entitled, "Corrosion Data Survey, Nonmetals Section." For critical applications it is recommended that testing be performed under conditions that approximate the anticipated field conditions.

In applications where exposure to harmful chemicals is frequent, of long duration or in high concentrations, further testing is recommended.

The following chemical resistance legend is used in the following PVC tables:

R	Generally resistant
С	Less resistant than R but still suitable for some conditions
Ν	Not resistant

1

Chemical	23℃ (73℉)	60°C (140°F)
Α		
Acetaldehyde	Ν	Ν
Acetaldehyde, aq 40%	С	Ν
Acetamide	-	-
Acetic acid, vapor	R	R
Acetic acid, glacial	R	N
Acetic acid, 25%	R	R
Acetic acid, 60%	R	N
Acetic acid, 85%	R	N
Acetic anhydride	N	N
Acetone	N	N
Acetylene	Ν	Ν
Acetyl chloride	N	N
AcetyInitrile	Ν	N
Acrylonitrile	N	N
Acrylic acid	Ν	N
Adipic acid	R	R
Alcohol, allyl	R	С
Alcohol, amyl	N	N
Alcohol, benzyl	Ν	N
Alcohol, butyl (n-butanol)	R	R
Alcohol, diacetone	Ν	N
Alcohol, ethyl (ethanol)	R	R
Alcohol, hexyl (hexanol)	R	R
Alcohol, isopropyl (2-propanol)	R	R
Alcohol, methyl (methanol)	R	R
Alcohol, propyl (1-propanol)	R	R
Alcohol, propargyl	R	R
Allyl chloride	N	N
Alums	R	R
except Aluminim fluoride	R	N
Ammonia, gas	R	R
Ammonia, liquid	N	N
Ammonium salts	R	R
except Ammonium Dichromate	R	N
Ammonium fluoride, 10%	R	R
Ammonium fluoride, 25%	R	С
Amyl acetate	Ν	Ν
Amyl chloride	N	N
Aniline	Ν	Ν

Chemical	23°C (73°F)	60°C (140°F)
Aniline chlorohydrate	N	N
Aniline hydrochloride	Ν	Ν
Anthraquinone	R	R
Antimony trichloride	R	R
Anthraquinone sulfonic acid	R	R
Aqua regia	С	Ν
Arsenic acid, 80%	R	R
Aryl-sulfonic acid	R	R
В		
Barium salts	R	R
except Barium nitrate	R	N
Beer	R	R
Beet sugar liquor	R	R
Benzaldehyde, 10%	R	Ν
Benzene (benzol)	Ν	N
Benzene sulfonic acid, 10%	R	R
Benzene sulfonic acid, $> 10\%$	Ν	Ν
Benzoic acid	R	R
Black liquor – paper	R	R
Bleach, 12% active chlorine	R	R
Bleach, 5% active chlorine	R	R
Borax	R	R
Boric acid	R	R
Brine	R	R
Bromic acid	R	R
Bromine, aq	R	R
Bromine, liquid	Ν	Ν
Bromine, gas, 25%	R	R
Bromobenzene	Ν	Ν
Bromotoluene	Ν	Ν
Butadiene	R	R
Butane	R	R
Butynediol	R	Ν
Butyl acetate	Ν	N
Butyl stearate	R	Ν
Butyl phenol	R	Ν
Butylene, liquid	R	R
Butyric acid	R	Ν

R - Generally Resistant

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C - Less resistant than R but still suitable for some conditions

POLYVINYL CHLORIDE (PVC) CHEMICAL RESISTANCE DATA

Chemical	23⁰C (73⁰F)	60°C (140°F)	Chemical
C			Chromic acid, 50%
Cadmium Cyanide	R	R	Chromium potassium sulfate
Calcium salts	R	R	Citric acid
except Calcium bisulfide	N	N	Coconut oil
Calcium hypochlorite, 30%	R	R	Coffee
Calcium hydroxide	R	R	Coke oven gas
Calcium Nitrate	R	R	Copper acetate
Calcium Oxide	R	R	Copper salts, aq
Calcium Sulfate	R	R	Corn oil
Camphor	R	N	Corn syrup
Cane sugar liquors	R	R	Cottonseed oil
Carbon disulfide	N	N	Cresote
Carbon dioxide	R	R	Cresol, 90%
Carbon dioxide, aq	R	R	Cresylic acid, 50%
Carbon monoxide	R	R	Croton aldehyde
Carbitol	R	Ν	Crude oil, sour
Carbon tetrachloride	R	Ν	Cupric Salts, aq
Carbonic Acid	R	R	Cyclohexane
Castor oil	R	R	Cyclohexanol
Caustic potash, (potassium hydroxide), 50%	R	R	Cyclohexanone
Caustic soda, (sodium hydroxide), < 40%	R	R	
Cellosolve	R	Ν	
Cellosolve acetate	R	Ν	D
Chloral hydrate	R	R	Detergents, aq
Chloramine, dilute	R	N	Dextrin
Chloric acid, 20%	R	R	Dextrose
Chlorine, gas, dry	С	N	Dibutoxyethyl phthalate
Chlorine, gas, wet	N	Ν	Diesel fuels
Chlorine, liquid	N	N	Diethylamine
Chlorine water	R	R	Diethyl Ether
Chloracetic acid, 50%	R	R	Disodium phosphate
Chloroacetyl Chloride	R	N	Diglycolic acid
Chlorobenzene	N	N	Dioxane -1,4
Chlorobenzyl chloride	N	Ν	Dimethylamine
Chloroform	N	N	Dimethyl formamide
Chloropicrin	N	N	Dibutyl phthalate
Chlorosulfonic acid	R	N	Dibutyl sebacate
Chromic acid, 10%	R	R	Dichlorobenzene
Chromic acid, 30%	R	R	Dichloroethylene
Chromic acid, 40%	R	С	

(73⁰F) (140°F) Ν Ν R Ν R R R R R R R R R Ν R R R R R R R R Ν Ν Ν Ν R R Ν Ν R R R R Ν Ν Ν Ν Ν Ν R R R R R R Ν Ν R R Ν Ν R Ν R R R R Ν Ν R R Ν Ν Ν Ν R Ν Ν Ν Ν Ν

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60°C

23°C

EEtherEthyl etherEthyl halidesEthylene halidesEthylene glycolEthylene oxideFFatty acidsFerric saltsFish OilEluorine, dry gas	23℃ (73℉)	60°C (140°F)	Chemical	23°C (73°F)	(1
Ether Ethyl ether Ethyl halides Ethyl halides Ethylene halides Ethylene glycol Ethylene oxide F Fatty acids Ferric salts Fish Oil Ethylene dry gas			Н		
Ethyl etherIEthyl halidesIEthylene halidesIEthylene glycolIEthylene oxideIFIFatty acidsIFerric saltsIFish OilIFluorine, dry gasI	Ν	Ν	Heptane	R	
Ethyl halides [Ethylene halides [Ethylene glycol [Ethylene oxide [F F F F F F F F F F F F F F F F F F F	Ν	Ν	Hexane	R	
Ethylene halidesIEthylene glycolIEthylene oxideIFIFatty acidsIFerric saltsIFish OilIEluorine, dry gasI	Ν	Ν	Hexanol	R	
Ethylene glycol Ethylene oxide F F Fatty acids Ferric salts Fish Oil Eluorine, dry gas	Ν	Ν	Hydraulic Oil	R	
Ethylene oxide	R	R	Hydrobromic acid, 20%	R	
F Fatty acids Ferric salts Fish Oil Fluorine, dry gas	Ν	Ν	Hydrochloric acid	R	
F Fatty acids Ferric salts Fish Oil Fluorine, dry gas			Hydrofluoric acid, 30%	R	
F Fatty acids Farric salts Fish Oil Fluorine, dry gas Fish Oil			Hydrofluoric acid, 50%	R	
Fatty acids Ferric salts Fish Oil Fluorine, dry gas			Hydrofluoric acid, 100%	N	
Ferric salts Fish Oil Fluorine, dry gas	R	R	Hydrofluosilic acid	R	
Fish Oil Fluorine, dry gas	R	R	Hydrocyanic acid	R	
Eluorine, dry gas	R	R	Hydrogen	R	
	R	Ν	Hydrogen cyanide	R	
Fluorine, wet gas	R	Ν	Hydrogen fluoride	Ν	
Fluoboric acid	R	R	Hydrogen phosphide	R	
Fluosilicic acid, 50%	R	R	Hydrogen peroxide, 50%	R	
Formaldehyde	R	R	Hydrogen peroxide, 90%	R	
Formic acid	R	Ν	Hydrogen sulfide, aq	R	
Freon - F11, F12, F113, F114	R	R	Hydrogen sulfide, dry	R	
Freon - F21, F22	Ν	Ν	Hydroquinone	R	
Fructose	R	R	Hydroxylamine sulfate	R	
Furfural	Ν	Ν	Hydrazine	Ν	
			Hypochlorous acid	R	
G					
Gallic acid	R	R	1		
Gas, coal, manufactured	N	N	lodine, aq, 10%	N	
Gas, natural, methane	ĸ	R			
Gasolines	C	C			
Gelatin	R	R	J		
Giucose	R	К	Jet tuels, JP-4 and JP-5	C	
Giue, animal	ĸ	R			
Glycerine (glycerol)	R	R			
Glycolic acid	R	R	K	_	
Glycols	R	R	Kerosene	R	
Grape Sugar	R	R	Ketones	N	
Green liquor, paper	R	R	Ketchup	R	
			Kraft paper liquor	R	

R - Generally Resistant

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C - Less resistant than R but still suitable for some conditions

POLYVINYL CHLORIDE (PVC) CHEMICAL RESISTANCE DATA

Chemical	23℃ (73℉)	60°C (140°F)	Chemical	23°C (73°F)	60°C (140°F)
L			Methylene chloride	N	N
Lactic acid, 25%	R	R	Methylene iodide	Ν	N
Lactic acid, 80%	R	Ν	Milk	R	R
Lard oil	R	R	Mineral oil	R	R
Lauric acid	R	R	Molasses	R	R
Lauryl acetate	R	R	Monochloroacetic acid	R	R
Lauryl chloride	R	R	Monochlorobenzene	Ν	N
Lead salts	R	R	Monoethanolamine	Ν	Ν
Lime sulfur	R	Ν	Motor oil	R	R
Linoleic acid	R	R			
Linoleic oil	R	R			
Linseed oil	R	R	N		
Liqueurs	R	R	Naphtha	R	R
Lithium salts	R	R	Naphthalene	Ν	Ν
Lubricating oils	R	R	Natural Gas	R	R
			Nickel acetate	R	N
			Nickel salts	R	R
Μ			Nicotine	R	R
Magnesium salts	R	R	Nicotinic acid	R	R
Maleic acid	R	R	Nitric acid, 0 to 40%	R	R
Malic acid	R	R	Nitric acid, 50%	R	С
Manganese sulfate	R	R	Nitric acid, 70%	R	N
Mercuric salts	R	R	Nitric acid, 100%	Ν	N
Mercury	R	R	Nitrobenzene	Ν	N
Methane	R	R	Nitroglycerine	Ν	N
Methoxyethl oleate	R	Ν	Nitrous acid, 10%	R	R
Methyl acetate	N	Ν	Nitrous oxide, gas	R	N
Methyl amine	Ν	Ν	Nitroglycol	Ν	Ν
Methyl bromide	N	Ν			
Methyl cellosolve	Ν	Ν			
Methyl chloride	N	Ν	0		
Methyl chloroform	Ν	Ν	Oleic acid	R	R
Methyl ethyl ketone	N	Ν	Oleum	Ν	N
Methyl isobutyl carbinol	Ν	Ν	Olive oil	R	R
Methyl isobutyl ketone	N	Ν	Oxalic acid	R	R
Methyl isopropyl ketone	N	Ν	Oxygen, gas	R	R
Methyl methacrylate	R	Ν	Ozone, gas	R	R
Methyl sulfate	R	Ν			
Methyl sulfuric acid	R	R			
Methylene bromide	N	Ν			

R - Generally Resistant

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5

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Chemical	23℃ (73℉)	60°C (140°F)	Chemical
Р			S
Palmitic acid, 10%	R	R	Salicylic a
Palmitic acid, 70%	R	N	Salicylalde
Paraffin	R	R	Selenic ac
Pentane	С	С	Silicic aci
Peracetic acid, 40%	R	N	Silicone o
Perchloric acid, 15%	R	N	Silver salt
Perchloric acid, 70%	R	N	Soaps
Perchloroethylene	С	С	Sodium sa
Perphosphate	R	N	exc
Phenol	R	N	exc
Phenylhydrazine	N	N	exc
Phosphoric anhydride	R	N	Stannic cl
Phosphoric acid	R	R	Stannous
Phosphorus, yellow	R	N	Starch
Phosphorus, red	R	Ν	Stearic ac
Phosphorus pentoxide	R	N	Stoddard
Phosphorus trichloride	N	Ν	Succinic a
Photographic chemicals, aq	R	R	Sulfamic
Phthalic acid	С	С	Sulfate &
Picric acid	N	N	Sulfur
Plating solutions, metal	R	R	Sugars, ad
Potash	R	R	Sulfur dio
Potassium amyl xanthate	R	N	Sulfur dio
Potassium salts, aq	R	R	Sulfur tric
except Potassium iodide	R	N	Sulfur tric
Potassium permanganate, 10%	R	R	Sulfuric a
Potassium permanganate, 25%	R	N	Sulfuric a
Propane	R	R	Sulfuric a
Propylene dichloride	N	N	Sulfurous
Propylene oxide	N	N	
Pyridine	N	N	
Pyrogallic acid	R	N	Т
			Tall Oil
			Tannic aci
R			Tanning li
Rayon coagulating bath	R	R	Tar
			Tartaric ac
			Terpineol
			Tetrachlor

Chemical	23⁰C (73⁰F)	60°C (140°F)
S		
Salicylic acid	R	R
Salicylaldehyde	N	N
Selenic acid, aq.	R	R
Silicic acid	R	R
Silicone oil	R	N
Silver salts	R	R
Soaps	R	R
Sodium salts, aq	R	R
except Sodium chlorite	N	Ν
except Sodium chlorate	R	N
except Sodium hypochlorite	R	N
Stannic chloride	R	R
Stannous chloride	R	R
Starch	R	R
Stearic acid	R	R
Stoddard solvent	N	N
Succinic acid	R	R
Sulfamic acid	N	N
Sulfate & Sulfite liquors	R	R
Sulfur	R	R
Sugars, aq	R	R
Sulfur dioxide, dry	R	R
Sulfur dioxide, wet	R	N
Sulfur trioxide, gas, dry	R	R
Sulfur trioxide, wet	R	Ν
Sulfuric acid, up to 80%	R	R
Sulfuric acid, 90 to 93%	R	Ν
Sulfuric acid, 94 to 100%	N	N
Sulfurous acid	R	R
т		
Tall Oil	R	R
Tannic acid	R	R
Tanning liquors	R	R
Tar	N	N
Tartaric acid	R	R
Terpineol	С	С
Tetrachloroethane	С	С

6

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R - Generally Resistant C - Less resistant than R but still suitable for some conditions

POLYVINYL CHLORIDE (PVC) CHEMICAL RESISTANCE DATA

Chemical	23⁰C (73⁰F)	60°C (140°F)
Tetraethyl lead	R	N
Tetrahydrofuran	Ν	Ν
Tetralin	Ν	N
Tetra sodium	R	R
Thionyl chloride	Ν	Ν
Thread cutting oils	R	Ν
Titanium tetrachloride	С	Ν
Toluene	Ν	Ν
Tomato juice	R	R
Transformer oil	R	R
Tributyl phosphate	Ν	Ν
Tributyl citrate	R	Ν
Trichloroacetic acid	R	R
Trichloroethylene	Ν	Ν
Triethanolamine	R	Ν
Triethylamine	R	R
Trimethyl propane	R	Ν
Trisodium phosphate	R	R
Turpentine	R	R
	D	D
	R	P
onne	N	IX.
V		
Vaseline	N	N
Vegetable oils	R	R
Vinegar	R	R
Vinyl acetate	Ν	N
W		
Water, deionized	R	R
Water, distilled	R	R
Water, salt	R	R
White Liquor	R	R
Whiskey	R	R

Chemical	23℃ (73⁰F)	60℃ (140℉)
Wines	R	R
X		
Xylene	Ν	Ν
Z		
Zinc salts	R	R

Source: PPI TR-19 Plastics Pipe Institute Wayne, NJ, 1991; Uni-Bell Handbook of PVC Pipe

These tables are meant to aid the designer in decisions as to transporting/conveyance of undiluted chemicals. Chemical resistance data is provided as a guide only. Information is based primarily on immersion of unstressed strips in chemicals and to a lesser degree on field experience.

R - Generally Resistant

C - Less resistant than R but still suitable for some conditions

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SALES AND CUSTOMER SERVICE

Canadian Customers call IPEX Inc. Toll free: (866) 473-9462 www.ipexinc.com

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- Electrical systems
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- Municipal pressure and gravity piping systems
- Plumbing and mechanical piping systems
- PE Electrofusion systems for gas and water
- · Industrial, plumbing and electrical cements
- Irrigation systems

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