

Flexalen® PB service pipes

Chemical resistance

Flexalen® PB service pipes can be used with no restrictions for:

- Heating applications
- Potable water (within allowed chlorine contents)
- Geothermal water
- Sea – / Salt water

The chemical resistance of polybutene service pipes (PB) is similar to that of other polyolefin plastics material, such as PE and PP, and is depending on the operating temperature and the system pressure.

For heating application please make sure that the heating water complies with the local regulations and guidelines for Water treatment for heating systems.

In general glycol-mixtures are no problem but antifreeze agents do also contain other chemicals which should be checked.

PB is not resistant to oxidizing acids, halogens, alkaline, softening solvents.

Oil resistance: depending on their concentration, mineral oils, oils containing esters and oils with fractions of aromatic amines have negative effects on the service life of plastics. We do not recommend the usage of all types of oil (crude oil, vegetable oil, etc.).

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Chemical resistance - Glycol

Flexalen® PB service pipes can be used with no restrictions for:

(Mono-) Ethylene Glycol	commonly used as freeze agent
(1,2-) Propylene Glycol (also known as 1,2-Propandiol)	commonly used as freeze agent
Diethylene Glycol	

A glycol contains two hydroxyl groups (OH). However, propylene glycol (C₃H₈O₂) has one more carbon atom than ethylene glycol (C₂H₆O₂) toxicity and viscosity of the glycols is different

Glycol mixtures / Antifreeze agents

	Ethylene Glycol 30% mixture - freeze point ± -15 °C Pressure drop increases with the % of mixture.
Pressure drop	In case of required pressure drop calculation please contact the engineering department.

Examples

Liquid	Description	Content	Suitability
Mono ethylene glycol		20 - 34%	no problem
Propylene glycol	1,2-Propylene glycol with corrosion inhibitors	33%	no problem
Propylene glycol		40%	no problem
Ethanol		60%	no problem
Monopropylene glycol	no corrosive impact	38%	no problem
Ethylene glycol		50%	no problem

Antifreeze agents

Antifreeze agent	Antifreeze agents for lowering the freezing point; need to be checked if other chemical components are in the mixture what could cause weaken the PB material.
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Chemical resistance - Chlorine

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- Heating applications
- Potable water (within allowed chlorine contents)
- Geothermal water

Possible disinfectant

Sodium hypochlorite (NaOCl) CAS no. 7681-52-9 Liquid with free active chlorine, commonly used.
Calcium hypochlorite (Ca(ClO)₂)

Chlorine concentrations

Chlorine is present in most disinfected drinking-water at concentrations of 0.2 – 1 mg/L (WHO).

PB life time - chlorine concentration

Water - chlorine concentrations influences the life time expectancy of PB material.

We do not recommend higher chlorine content than 2 ppm!

Drinking water application with up to 0.5 ppm NaOCl, have a reduced lifetime of 25 years
(standard is 70 °C / 10 bar / 50 years)!

Drinking water application with 0.5 ppm up to 2 ppm NaOCl, have a reduced lifetime of 25 years + reduced pressure rating
over all temperatures of 80 %

PB life time - shock chlorination

Maximum mixture temperature of 30 °C

100 mg/L for 1 hour

The maximum number of recommended disinfection processes is depending on operating conditions of the piping system
and the pressure / temperature during the disinfection, as well as from the used disinfection liquid.

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• Heating applications

The information provided in the following pages is confined to the effects that various products have on Polybutene-1, not the other way round.

Whilst indicative of the general resistance of Polybutene-1 to various products, the data were obtained by laboratory methods which may or may not be representative of the actual conditions of use encountered in specific end-use applications.

For any application where the intention is to use products made from Polybutene-1, it is recommended that further tests to simulate the end-use application are carried out.

In the assessment presented here, chemical resistance has been evaluated through several observations on a test sample:

- The surface is visually analysed for evidence of oxidative attack, environmental stress cracking, staining and dimensional distortion.
- Any weight gain in the sample is evidence of swelling caused by solvent absorption.
- The sample is tested for signs of physical deterioration, such as embrittlement, softening, decreased yield stress and increased yield elongation.

The following tables, overall chemical resistance is evaluated through the use of three rating symbols, S, M and U.

They have the following significance:

- **S, Satisfactory**; little or no noticeable effect with no indication that serviceability has been impaired.
- **M, Marginal**; noticeable effect, but not necessarily indicating a lack of serviceability or useful life. Further testing is strongly recommended to determine suitability in a specific application.
- **U, Unsatisfactory**; severe effect and not recommended for service applications.

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Acetaldehyde	M	U
Acetate solvents - crude	S	M
Acetate solvents - pure	S	M
Acetic acid 0-10%	S	S
Acetic acid 10-20%	S	S
Acetic acid 20-30%	S	S
Acetic acid 30-60%	S	M
Acetic acid 80%	S	-
Acetic acid - glacial	M	U
Acetic acid vapours	S	M
Acetic anhydride	U	U
Acetone	S	S
Acetylene	M	U
Adipic acid	S	M
Alcohol (see type)	-	-
Allyl alcohol 96%	S	S
Allyl chloride	S	S
Alum	M	U
Aluminium chloride	S	S
Aluminium fluoride	S	S

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Aluminium hydroxide	S	S
Aluminium oxychloride	S	S
Aluminium nitrate	S	S
Aluminium sulphate	M	U
Ammonia - dry gas	S	S
Ammonia - liquid	S	M
Ammonium bifluoride	S	S
Ammonium carbonate	S	S
Ammonium chloride	S	S
Ammonium fluoride 25%	S	M
Ammonium hydroxide 28%	S	S
Ammonium metaphosphate	S	S
Ammonium nitrate	S	S
Ammonium persulphate	S	S
Ammonium phosphate (ammoniacal)	S	S
Ammonium phosphate neutral	S	S
Ammonium sulphate	S	S
Ammonium sulphide	S	S
Ammonium thiocyanate	S	S
Amyl acetate	S	-
Amyl alcohol	S	S
Amyl chloride	M	M
Aniline	M	M
Aniline chlorohydrate	U	U
Aniline hydrochloride	U	U
Anthraquinone	M	U
Anthraquinonesulphonic acid	M	U
Antimony trichloride	S	S
Aqua regia	U	U
Arsenic acid 80%	S	S
Asphalt	S	S
Barium carbonate	S	S
Barium chloride	S	S
Barium hydroxide	S	S
Barium sulphate	S	S
Barium sulphide	S	S
Beer	S	S
Beet - sugar liquor	S	S
Benzaldehyde	M	U
Benzene	U	U
Benzoic acid	S	S
Benzol	U	U
Bismouth carbonate	S	S
Black liquor (paper industry)	S	S

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Bleach - 12,5% active chlorine	S	S
Borax	S	S
Boric acid	S	S
Boron trifluoride	S	S
Breeder pellets - deriv. fish	S	S
Brine	U	S
Bromic acid	M	S
Bromine - liquid	U	U
Bromine - water	M	U
Butane	U	U
Butanol - primary	S	-
Butanol - secondary	S	-
Butyl acetate	M	U
Butyl alcohol	S	S
Butyric acid 20%	S	M
Calcium bisulphite	S	S
Calcium carbonate	S	S
Calcium chlorate	S	S
Calcium chloride	S	S
Calcium hydroxide	S	S
Calcium hypochlorite	S	S
Calcium nitrate	S	S
Calcium sulphate	S	S
Cane sugar liquors	S	S
Carbon bisulphide	U	U
Carbon dioxide (aqueous solution)	S	S
Carbon dioxide gas (wet)	S	S
Carbon monoxide	S	S
Carbon tetrachloride	U	U
Carbonic acid	S	S
Casein	S	S
Castor oil	S	S
Caustic potash	S	M
Caustic soda	S	M
Cellosolve	S	S
Chloracetic acid	U	U
Chloral hydrate	U	U
Chlorine gas (dry)	U	U
Chlorine gas (moist)	S	U
Chlorine water	U	S
Chlorobenzene	M	U
Chloroform	U	U
Chlorosulphonic acid	S	U
Chrome alum	S	S

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Chromic acid 10%	S	S
Chromic acid 25%	S	S
Chromic acid 30 %	S	S
Chromic acid 40%	S	-
Chromic acid 50%	S	-
Citric acid	S	S
Coconut oil	S	S
Copper chloride	S	S
Copper cyanide	S	S
Copper fluoride 2%	S	S
Copper nitrate	S	S
Copper sulphate	S	S
Core oils	S	S
Cottonseed oil	S	S
Cresol	U	U
Cresylic acid 50%	U	U
Crude oil - sour	M	U
Crude oil - sweet	M	U
Cyclohexanol	S	M
Cyclohexanon	U	U
Demineralized water	S	S
Dextrin	S	S
Dextrose	S	S
Diazo salts	S	S
Diglycolic acid	S	S
Dimethylamine	U	U
Diethylphthalate	M	U
Disodium phosphate	S	S
Distilled water	S	S
Ethers	U	U
Ethyl acetate	M	U
Ethyl alcohol 0-50%	S	S
Ethyl alcohol 50-98%	S	S
Ethyl ether	M	U
Ethylene bromide	U	U
Ethylene chlorohydrin	U	U
Ethylene dichloride	S	S
Ethylene glycol	S	S
Fatty acids	S	S
Ferric chloride	S	S
Ferric nitrate	S	S
Ferric sulphate	S	S
Ferrous chloride	S	S
Ferrous sulphate	S	S

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Fish solubles	S	S
Fluorine gas - dry	M	U
Fluorine gas - wet	M	U
Fluoroboric acid	S	S
Fluorosilicic acid	S	S
Food products such as milk, molasses and salad oils	S	S
Formaldehyde	S	S
Formic acid	S	S
Freon-12	S	S
Fructose	S	S
Fruit pulps and juices	S	S
Fuel oil (containing sulfuric acid)	U	U
Gallic acid	S	S
Gas - coke oven	S	S
Gas - manufactured	S	S
Gas - natural (dry)	S	S
Gas - natural (wet)	S	S
Gasoline - refined	U	U
Gasoline - sour	U	U
Gelatine	S	S
Glucose	S	S
Glycerine (glycerol)	S	S
Glycol	S	S
Glycolic acid 30%	S	S
Green liquor (paper industry)	S	S
Heptane	U	U
Hexane	U	U
Hexanol, tertiary	S	S
Hydrobromic acid 20%	S	S
Hydrochloric acid 0-25%	S	S
Hydrochloric acid 25-40%	S	S
Hydrocyanic acid or hydrogen cyanide	S	S
Hydrofluoric acid 4%	S	S
Hydrofluoric acid 10%	S	S
Hydrofluoric acid 48%	S	S
Hydrofluoric acid 60%	S	S
Hydrofluorosilicic acid	S	S
Hydrogen	S	S
Hydrogen peroxide 30%	S	S
Hydrogen peroxide 50%	U	U
Hydrogen peroxide 90%	U	U
Hydrogen phosphide	S	S
Hydrogen sulphide - aqueous solution	S	S
Hydrogen sulphide - dry	S	S

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Hydroquinone	S	S
Hypochlorous acid	S	S
Iodine (in alcohol)	S	U
Isopropylalcohol	S	S
Kerosene	M	U
Kraft liquor (paper industry)	S	S
Lactic acid 28%	S	S
Lard oil	S	M
Lauryl chloride	S	M
Lead acetate	S	S
Lime sulphur	S	S
Linoleic acid	S	M
Linseed oil	S	S
Liquors	S	S
Lubricating oils	S	S
Magnesium carbonate	S	S
Magnesium chloride	S	S
Magnesium hydroxide	S	S
Magnesium nitrate	S	S
Magnesium sulphate	S	S
Maleic acid	S	S
Malic acid	S	S
Mercuric chloride	S	S
Mercuric cyanide	S	S
Mercurous nitrate	S	S
Mercury	S	S
Methyl alcohol	S	S
Methyl chloride	U	U
Methyl ethyl ketone	S	M
Methyl sulphuric acid	S	S
Methylene chloride	S	M
Milk	S	S
Mineral oils	M	U
Molasses	S	S
Naphthalene	M	U
Nickel acetate	S	S
Nickel chloride	S	S
Nickel nitrate	S	S
Nickel sulphate	S	S
Nicotine	S	S
Nicotine acid	S	S
Nitric acid 10%	M	U
Nitric acid 20%	U	U
Nitric acid 35%	U	U

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Nitric acid 40%	U	U
Nitric acid 60%	U	U
Nitric acid 68%	U	U
Nitric acid (anhydrous)	U	U
Oils and fats	S	S
Oleum	U	U
Oxalic acid	S	S
Perchloric acid 10%	M	U
Perchloric acid 70%	U	U
Phenol	S	M
Phosphoric acid - 0-25%	S	S
Phosphoric acid - 25-50%	S	S
Phosphoric acid - 50-75%	S	M
Photographic chemicals	S	S
Picric acid	S	M
Potassium acid sulphate	S	S
Potassium bicarbonate	S	S
Potassium bichromate	M	U
Potassium borate 1%	S	S
Potassium bromate 10%	S	S
Potassium bromide	S	S
Potassium carbonate	S	S
Potassium chlorate	S	S
Potassium chloride	S	S
Potassium chromate 40%	S	S
Potassium cuprocyanide	S	S
Potassium cyanide	S	S
Potassium dichromate 40%	S	S
Potassium ferricyanide	S	S
Potassium fluoride	S	S
Potassium hydroxide 10%	S	S
Potassium hydroxide 20%	S	S
Potassium nitrate	S	S
Potassium perborate	S	S
Potassium perchlorite	S	S
Potassium permanganate 10%	S	S
Potassium persulphate	S	S
Potassium sulphate	S	S
Potassium sulphide	S	S
Potassium thiosulphate	S	S
Propane	S	-
Propyl alcohol	S	S
Rayon coagulating bath	S	S
Salt water	S	S

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Selenic acid	S	S
Silicic acid	S	S
Silver cyanide	S	S
Silver nitrate	M	U
Silver plating solutions	S	S
Soaps	S	S
Sodium acetate	S	S
Sodium acid sulphate	S	S
Sodium antimonate	S	S
Sodium arsenite	S	S
Sodium benzoate	S	S
Sodium bicarbonate	S	S
Sodium bisulphate	S	S
Sodium bisulphite	S	S
Sodium bromide	S	S
Sodium carbonate (soda ash)	S	S
Sodium chlorate	S	S
Sodium chloride	S	S
Sodium cyanide	S	S
Sodium dichromate	S	S
Sodium ferricyanide	S	S
Sodium ferrocyanide	S	S
Sodium fluoride	S	S
Sodium hydroxide 10%	S	S
Sodium hydroxide 35%	S	S
Sodium hydroxide saturated	S	S
Sodium hypochlorite	S	S
Sodium nitrate	S	S
Sodium nitrite	S	S
Sodium phosphate - acid	S	S
Sodium silicate	S	S
Sodium sulphate	S	S
Sodium sulphide	S	S
Sodium sulphite	S	S
Sodium thiosulphate (hypo)	S	S
Stannic chloride	S	S
Stannous chloride	S	S
Stoddards solvent	S	S
Stearic acid	S	S
Sulphur	S	S
Sulphur dioxide gas - wet	S	M
Sulphuric acid 0-10%	S	S
Sulphuric acid 10-30%	S	S
Sulphuric acid 30-50%	S	S

Reagent <i>Solids in saturated solution unless indicated otherwise</i>	Chemical exposure performance Temperature:	
	23 °C	60 °C
Sulphuric acid 50-75%	M	U
Sulphuric acid 75-90%	M	U
Sulphuric acid 95%	U	U
Sulphurous acid	S	S
Sulphyr trioxide	M	U
Tannic acid	S	S
Tanning liquors	S	S
Tartaric acid	S	S
Tetrahydrofurane	M	U
Thionyl chloride	S	S
Toluol or toluene	U	U
Trichloroethylene	U	U
Triethanolamine	S	M
Trisodium phosphate	S	S
Turpentine	U	U
Urea	S	S
Urine	S	S
Vinegar	S	S
Water - acid mine water	S	S
Water - distilled	S	S
Water - fresh	S	S
Water - salt	S	S
Whiskey	S	S
White gasoline	U	U
Wines (still)	S	S
Xylene or xylol	U	U
Zinc chromate	S	S
Zinc cyanide	S	S
Zinc nitrate	S	S
Zinc sulphate	S	S