

Book 1: Chapter 5 - Environmental Effects

Resistance to Corrosion

Polyethylene is non-conductive and immune to galvanic and electrochemical effects. Thus polyethylene will not corrode in the manner of metal and concrete piping. Both inside and out, Performance Pipe polyethylene pipe does not rust, rot, corrode or tuberculate.

Resistance to Stress Cracking

Some polyethylene materials may fail from environmental stress cracking that results from the combined actions of stress and the environment. Stress cracking is the slow growth and propagation of cracks through the material by the action of sensitizing agents on minute surface flaws in stressed or strained materials.

Polymer structure, molecular weight, and molecular weight distribution will affect the stress crack resistance of polyethylene. Performance Pipe polyethylenes show excellent resistance to environmental stress cracking. Please see the discussion below on "*Resistance to Slow Crack Growth.*"

Biological Effects

Performance Pipe polyethylene pipe will not degrade due to biological effects. Polyethylene piping materials are not digestible and do not contain ingredients that would attract burrowing insects, animals, or worms. The exceptionally smooth surface of polyethylene pipe is not conducive to the growth of algae or other marine life on the pipe walls, especially under moderate and higher flow conditions.

Sunlight (Ultraviolet) Effects

Without chemical or physical protection, polyethylene is degraded by ultraviolet (UV) light. Because ultraviolet light is present in sunlight, protective chemical systems are compounded into polyethylene pipe to prevent or delay the onset of UV degradation and allow use or storage in direct sunlight. UV protection systems are either blocking systems that are used in black products, or sacrificial absorber systems that are used for color products.

Long term UV protection is provided by compounding 2% to 3% carbon black in the material. Very fine carbon black particles prevent UV degradation by blocking UV energy penetration. Black products are suitable for applications where there is long-term, direct exposure to ultraviolet light. This includes all surface, suspended, and above grade applications.

Sacrificial UV absorbers temporarily protect colored products by absorbing UV energy, but are used up in the process. Sacrificial absorber systems provide protection for uncovered outdoor storage of several months to several years depending upon protection level and exposure level. If left exposed, material degradation will eventually occur as the absorbers in the pipe are used and the protection level drops. Covering the pipe will stop any further UV degradation effects, but will not reverse any prior exposure effects.

The sacrificial UV absorber systems in colored products are designed only to allow a reasonable period of unprotected outdoor storage prior to installation. Color products are intended for underground service — not for surface or above grade service where there will be long-term exposure to UV light in sunlight.

Recommendations for unprotected outdoor storage of colored products vary by product. Consult your Performance Pipe Distributor, Performance Pipe Territory Manager, or Performance Pipe for information.

Thermal Effects

DriscoPlex™ PE 2406 and PE 3408 polyethylene pipe can be applied over a wide temperature range. These materials perform well from –50° F (-45° C) and below, to 140° F (60° C) for pressure service, or to up to 180° F (82° C) for gravity flow (non-pressure) service. Pressurized fluids must be in a flowable liquid or gaseous state.

Gravity flow service above 180° F (82° C) is not recommended. Pressure service above 140° F (60° C) is not recommended. For higher temperature applications, pressure ratings are lower.

Black polyethylene pipe that is on the surface or above grade is usually subject to sunlight heating that will raise the pipe service temperature. Temperature rise and fall will cause pipe length changes as it expands and contracts. See the *Performance Pipe Engineering Manual Book 2: System Design* for additional information.

Temperatures near or below freezing will affect polyethylene pipe by increasing stiffness and vulnerability to damage from suddenly applied stress or impact. *Significant impact or shock loads against a polyethylene pipe that is at freezing or lower temperatures can fracture the pipe.* Polyethylene pipe will be more difficult to uncoil or field bend in cold weather.

Chemical Effects

Performance Pipe polyethylene pipes have outstanding resistance to a wide range of chemicals and environmental conditions, making them ideal candidates for use with corrosive fluids and chemicals, and under harsh environmental conditions. If a chemical has an effect on polyethylene, the effect may or may not be detrimental depending upon application or service requirements.

In some cases, a chemical may have little or no detrimental effect on polyethylene's long term or mechanical properties, but its presence may affect a piping application.

For example, a surfactant may have little if any chemical effect, but it may coat the pipe bore, and change the pipe's resistance to flow. Where water would normally bead up on the surface and flow with little resistance, it may "stick" to the surfactant, resulting in higher flow resistance in the pipe.

Some chemicals may affect polyethylene pipe joining. See "*Solvents and Surface Cleaning*" and "*Chemical Solvation (Permeation)*", below.

Resistance to Chemical Attack

Where there is chemical effect or attack on polyethylene, environmental conditions and combinations of conditions such as higher temperature, higher chemical concentration, higher applied stress, fatigue or combinations of chemicals may accelerate the effect. Chemicals that affect the physical properties or long term performance of polyethylene typically act on the

material by either chemical solvation, which causes the plastic to weaken, soften, or swell or by direct chemical attack, which breaks down or alters the molecular structure. Chemical solvation effects may be reversible, but direct chemical attack is usually is not.

Solvents and Surface Cleaning

There are no commercially available solvents that will dissolve solid polyethylene.

Polyethylene cannot be solvent cemented.

When joining polyethylene pipe, pipe surfaces must be clean and dry. Wiping with a clean dry cloth is usually sufficient. Cleaning with a mild soap and water solution followed by a rinse with clean water is also acceptable. Chemical cleaning solvents are usually not required.

Cleaning solvents may have a chemical effect on the pipe, may leave a residue on the pipe surface, or may be chemically hazardous substances that require personal protective equipment and special handling. The Material Safety Data Sheet (MSDS) for the chemical solvent should be consulted for safety information.

Caution — *Before using chemical solvents, the potential risks and hazards should be known, and appropriate safety precautions taken.*

Chemical Solvation (Permeation)

Chemicals that solvate polyethylene typically do so by diffusing (permeating) into the material. Permeation does not usually degrade or dissolve the material, but it may weaken the material, cause swelling, or have other effects on the piping or the application. Higher temperatures usually increase permeation effects. In some circumstances such as where a liquefied hydrocarbon gas (liquid condensate) has permeated the material, removing the solvating chemicals may allow the polyethylene to dry out and revert back to its original state.

Continuous exposure to some common chemicals and solvents such as liquid hydrocarbons (crude and fuel oils, gasoline, diesel fuel, kerosene, etc.) can allow these chemicals to diffuse or permeate into the piping. Permeation can cause swelling, especially at elevated temperatures.

Permeation reduces strength — long-term pressure service ratings are significantly reduced.

Permeating chemicals such as liquid hydrocarbons typically cause little if any injury to the material; however hydrocarbons can contaminate and weaken heat fusion or electrofusion joints. When the pipe surface is melted, liquid hydrocarbons in the pipe will bubble out of the surface causing porosity and contamination.

Caution — *Where hydrocarbon contamination is indicated, heat fusion and electrofusion joining are not reliable. Use mechanical joining methods such as compression couplings with internal stiffeners, mechanical saddle fittings, etc., to join hydrocarbon permeated piping.*

When the heating iron is removed from the pipe surface during heat fusion, contamination from liquid hydrocarbon permeation is indicated by a rough, or sandpaper-like, or bubbly, or pock-marked surface appearance.

At low temperatures and higher pressures in fuel gas applications, heavier hydrocarbon gasses such as propane or butane may condense and liquefy in the pipe. Such liquefied fuel gasses are known to permeate polyethylene pipe, and result in unreliable heat fusion or electrofusion joints.

In potable water applications, permeating chemicals could affect the pipe or water in the pipe. ANSI/AWWA standards provide the following guidance for potable water applications:

“The selection of materials is critical for water service and distribution piping where there is likelihood the pipe will be exposed to significant concentrations of pollutants comprised of low molecular weight petroleum products or organic solvents or their vapors. Research has documented that pipe materials such as polyethylene, polybutylene, polyvinyl chloride, and asbestos cement, and elastomers, such as used in jointing gaskets and packing glands, may be subject to permeation by lower molecular weight organic solvents or petroleum products. If water pipe must pass through such a contaminated area or an area subject to contamination, consult with the manufacturer regarding permeation of pipe walls, jointing materials, and so forth, before selecting materials for use in that area.”¹

Chemical Attack

A direct chemical attack on the polymer will result in permanent, irreversible polymer damage or chemical change by chain scission, cross-linking, oxidation, or substitution reactions. Removing the chemical cannot reverse direct chemical attack damage or change.

Chemical Resistance Information

The data in Table 5-1 is representative of short-term chemical immersion tests of unstressed specimens. Typical chemical immersion testing involves submerging a material test specimen in the chemical for several days; then testing some physical properties of the specimen after removal. Unless stated otherwise, tests were conducted in the relatively pure or concentrated chemical.

DISCLAIMER

Because the particular conditions of an application may vary, Table 5-1 information should be used only as a preliminary guide for Performance Pipe polyethylene pipe materials. This information is offered in good faith, and is believed to be accurate at the time of publication, but it is offered without any warranty, express or implied, and specifically excluding implied warranties of merchantability and fitness for a particular purpose. Additional information may be required, particularly with regard to unusual or special applications. Determinations of suitability for use in particular chemical or environmental conditions may require specialized laboratory testing.

In general, chemical solutions that are more dilute than shown here, or at lower temperatures, and in the absence of stress have reduced potential to affect the material. Higher concentrations, higher temperatures, applied stress and combinations of chemicals may reduce resistance or may affect the material beyond these published values. ***The apparent absence of effect in a short-term immersion test does not imply that there will be no effect where there is long-term exposure or applied stress or combinations chemicals or elevated temperature either individually or in any combination.***

Where information about the suitability of polyethylene piping for use with chemicals or chemical combinations for a particular application or environment is not available, tests should be conducted to determine suitability. *Performance Pipe cannot provide chemical testing services.*

Additional information on chemical compatibility may be found in *PPI TR-19, Thermoplastic Piping for the Transport of Chemicals*.

¹ Quoted text from ANSI/AWWA C901 and ANSI/AWWA C906.

Chemical Resistance Key for Table 5-1

Key†	<i>Meaning</i>
R	Resistant (swelling <3%; weight loss <0.5%; elongation at break not substantially changed.)
L	Limited resistance (swelling 3-8%; weight loss 0.5-5%; elongation at break reduced by <50%.)
N	Not resistant (swelling >8%; weight loss >5%; elongation at break reduced by >50%.)
D	Discoloration
*	Aqueous solutions in all concentrations.
**	Only under low mechanical stress.

† Where a key is not printed in the table, data is not available.

Caution: See Chemical Resistance Information above.

Table 5-1 Chemical Resistance

<i>Medium</i>	<i>73°F</i>	<i>140°F</i>
Acetaldehyde, gaseous	R	L
Acetic acid (10%)	R	R
Acetic acid (100%) (Glacial acetic acid)	R	LD
Acetic anhydride	R	LD
Acetone	R	R
Acetylene tetrabromide	**L to N	N
Acids, aromatic	R	R
Acrylonitrile	R	R
Adipic acid	R	R
Allyl alcohol	R	R
Aluminum chloride, anhydrous	R	R
Aluminum sulphate	*R	R
Alums	R	R
Ammonia, liquid (100%)	R	R
Ammonium chloride	*R	R
Ammonium fluoride, aqueous (up to 20%)	*R	R
Ammonium nitrate	*R	R
Ammonium sulphate	*R	R
Ammonium sulfide	*R	R
Amyl acetate	R	R
Aniline, pure	R	R
Anisole	L	N
Antimony trichloride	R	R
Aqua regia	N	N
Barium chloride	*R	R
Barium hydroxide	*R	R
Beeswax	R	**L to N
Benzene	L	L
Benzenesulphonic acid	R	R

<i>Medium</i>	<i>73°F</i>	<i>140°F</i>
Benzoic acid	*R	R
Benzyl alcohol	R	R to L
Borax, all concentrations	R	R
Boric acid	*R	R
Brine, saturated	R	R
Bromine	N	N
Bromine vapor	N	
Butanetriol	R	R
Butanol	R	R
Butoxyl	*R	L
Butyl acetate	R	L
Butyl glycol	R	R
Butyric acid	R	L
Calcium chloride	*R	R
Calcium hypochlorite	*R	R
Camphor	R	L
Carbon dioxide	R	R
Carbon disulphide	L	
Carbon tetrachloride	**L to N	N
Caustic potash	R	R
Caustic soda	R	R
Chlorine, liquid	N	N
Chlorine bleaching or disinfecting solution (12% active chlorineCl)	L	N
Chlorine gas, dry	L	N
Chlorine gas, moist	L	N
Chlorine water, 5ppm 'R' under 73F and 'N' under 140F	R	
Chloroacetic acid (mono)	R	R
Chlorobenzene	L	N
Chloroethanol	R	RD
Chloroform	**L to N	N
Chlorosulphonic acid	N	N
Chromic acid (80%)	R	ND
Citric acid	R	R
Coconut oil	R	L
Copper salts	*R	R
Corn oil	R	L
Creosote	R	RD
Creosol	R	RD
Cyclohexane	R	R
Cyclohexanol	R	R
Cyclohexanone	R	R
Decahydronapthalene	R	L
Dessicator grease	R	L

<i>Medium</i>	<i>73°F</i>	<i>140°F</i>
Detergents, synthetic	R	R
Dextrin, aqueous (18% saturated)	R	R
Dibutyl ether	R to L	N
Dibutyl phthalate	R	L
Dichloroacetic acid (100%)	R	LD
Dichloroacetic acid (50%)	R	R
Dichloroacetic acid methyl ester	R	R
Dichlorobenzene	L	N
Dichloroethane	L	L
Dichloroethylene	N	N
Diesel oil	R	N
Diethyl ether	R to L	L
Diisobutyl ketone	R	L to N
Dimethyl formamide (100%)	R	R to L
Dioxane	R	R
Emulsifiers	R	R
Esters, aliphatic	R	R to L
Ether	R to L	L
Ethyl acetate	L	N
Ethyl alcohol	R	R
Ethyl glycol	R	R
Ethyl hexanol	R	R
Ethylene chloride (dichloroethene)	L	L
Ethylene diamine	R	R
Fatty acids (>C ⁶)	R	L
Ferric chloride*	R	R
Fluorine	N	N
Fluorocarbons	L	N
Fluorosilic acid, aqueous (up to 32%)	R	R
Formaldehyde (40%)	R	R
Formamide	R	R
Formic acid	R	
Fruit juices	R	R
Fruit pulp	R	R
Furfuryl alcohol	R	RD
Gelatine	R	R
Glucose	*R	R
Glycerol	R	R
Glycerol chlorohydrin	R	R
Glycol (conc.)	R	R
Glycolic acid (50%)	R	R
Glycolic acid (70%)	R	R
Halothane	L	L

<i>Medium</i>	73°F	140°F
Hydrazine hydrate	R	R
Hydrobromic acid	R	R
Hydrochloric acid (all concentrations)	R	R
Hydrocyanic acid	R	R
Hydrofluoric acid (40%)	R	L
Hydrofluoric acid (70%)	R	L
Hydrogen	R	R
Hydrogen chloride gas, moist and dry	R	R
Hydrogen peroxide (30%)	R	R
Hydrogen peroxide (100%)	R	
Hydrogen sulfide	R	R
Iodine, tincture of, DAB 7 (German Pharmacopeia)	R	LD
Isooctane	R	L
Isopropanol	R	R
Isopropyl ether	R to L	N
Jam	R	R
Ketones	R	R to L
Lactic acid	R	R
Lead acetate	*R	R
Linseed oil	R	R
Magnesium chloride	*R	R
Magnesium sulphate	*R	R
Maleic acid	R	R
Malic acid	R	R
Menthol	R	L
Mercuric chloride (sublimate)	R	R
Mercury	R	R
Methanol	R	R
Methyl butanol	R	R
Methyl ethyl ketone	R	L to N
Methyl glycol	R	R
Methylene chloride	L	L
Mineral oils	R	R to L
Molasses	R	R
Monochloroacetic acid	R	R
Monochloroacetic ethyl ester	R	R
Monochloroacetic methyl ester	R	R
Morpholine	R	R
Naptha	R	L
Napthalene	R	L
Nickel salts	*R	R
Nitric acid (25%)	R	R
Nitric acid (50%)	L	N

<i>Medium</i>	<i>73°F</i>	<i>140°F</i>
Nitrobenzene	R	L
o-Nitrotolulene	R	L
Octyl creosol	L	N
Oils, ethereal	L	L
Oils, vegetable and animal	R	R to L
Oleic acid (conc.)	R	L
Oxalic acid (50%)	R	R
Ozone	L	N
Ozone, aqueous solution (Drinking water purification)	R	
Paraffin oil	R	R
Perchloric acid (20%)	R	R
Perchloric acid (50%)	R	L
Perchloric acid (70%)	R	ND
Petrol	R	R to L
Petroleum	R	L
Petroleum ether	R	L
Petroleum jelly	**R to L	L
Phenol	R	RD
Phosphates	*R	R
Phosphoric acid (25%)	R	R
Phosphoric acid (50%)	R	R
Phosphoric acid (95%)	R	LD
Phosphorus oxychloride	R	LD
Phosphorus pentoxide	R	R
Phosphorus trichloride	R	L
Photographic developers, commercial	R	R
Phthalic acid (50%)	R	R
Polyglycols	R	R
Potassium bichromate (40%)	R	R
Potassium borate, aqueous (1%)	R	R
Potassium bromate, aqueous (up to 10%)	R	R
Potassium bromide	*R	R
Potassium chloride	*R	R
Potassium chromate, aqueous (40%)	R	
Potassium cyanide	*R	R
Potassium hydroxide (30% solution)	R	R
Potassium nitrate	*R	R
Potassium permanganate	R	RD
Propanol	R	R
Propionic acid (50%)	R	R
Propionic acid (100%)	R	L
Propylene glycol	R	R
Pseudocumene	L	L

<i>Medium</i>	<i>73°F</i>	<i>140°F</i>
Pyridine	R	L
Seawater	R	R
Silicic acid	R	R
Silicone oil	R	R
Silver nitrate	R	R
Sodium benzoate	R	R
Sodium bisulphate, weak aqueous solutions	R	R
Sodium Carbonate	*R	R
Sodium Chloride	*R	R
Sodium chlorite (50%)	R	L
Sodium hydroxide (30% solution)	R	R
Sodium hypochlorite (12% solution)	L	N
Sodium nitrate	*R	R
Sodium silicate	*R	R
Sodium sulfide	*R	R
Sodium thiosulphate	R	R
Spermaceti	R	L
Spindle oil	R to L	L
Starch	R	R
Steric acid	R	L
Succinic acid (50%)	R	R
Sugar syrup	R	R
Sulfates	*R	R
Sulfur	R	R
Sulfur dioxide, dry	R	R
Sulfur dioxide, moist	R	R
Sulfur trioxide	N	N
Sulfuric acid (10%)	R	R
Sulfuric acid (50%)	R	R
Sulfuric acid (98%)	L	N
Sulfuric acid, fuming	N	N
Sulfurous acid	R	R
Sulfuryl chloride	N	
Tallow	R	R
Tannic acid (10%)	R	R
Tartaric acid	R	R
Tetrachloroethane	**R to L	N
Tetrahydrofuran	**R to L	
Tetrahydronaphthalene	R	L
Thionyl chloride	N	N
Thiophene	L	L
Toluene	L	N
Transformer oil	R	L

<i>Medium</i>	<i>73°F</i>	<i>140°F</i>
Tributyl phosphate	R	R
Trichloroacetic acid (50%)	R	R
Trichloroacetic acid (100%)	R	L to N
Trichloroethylene	**R to L	N
Triethanolamine	R	R
Turpentine, oil of	R to L	L
Tween® 20 and 90 (Atlas Chemical)	R	R
Urea	*R	R
Vinegar (commercial conc.)	R	R
Viscose spinning solutions	R	R
Waste gases containing carbon dioxide	R	R
Waste gases containing carbon monoxide	R	R
Waste gases containing hydrochloric acid (all conc.)	R	R
Waste gases containing hydrogen fluoride (traces)	R	R
Waste gases containing nitrous vitriol (traces)	R	R
Waste gases containing sulfur dioxide (low conc.)	R	R
Waste gases containing sulphuric acid, moist (all conc.)	R	R
Water gas	R	R
Xylene	N	N
Yeast, aqueous preparations	R	R
Zinc chloride	*R	R