

Technical Note : Chemical Resistance for Geomembranes

Aquatan's geomembranes are made of high quality, virgin polyethylene which demonstrates excellent chemical resistance. Aquatan's polyethylene geomembranes are resistant to a great number and combinations of chemicals. It is this property of (HDPE) high density polyethylene geomembranes that makes it the lining material of choice.

In order to gauge the durability of a material in contact with a chemical mixture, testing is required in which the material is exposed to the chemical environment in question. Chemical resistance testing is a very large and complex topic because of two factors. First, the number of specific media is virtually endless and second, there are many criteria such as tensile strength, hardness, etc. that may be used to assess a material's resistance to degradation.

The chemical resistance of polyethylene has been investigated by many people over the past few decades. We are able to draw from that work when making statements about the chemical resistance of today's polyethylene geomembranes. In addition to that, many tests have been performed that specifically use geomembranes and certain chemical mixtures. Naturally, however, every mixture of chemicals cannot be tested for. As a result of these factors, Aquatan published a chemical resistance chart, demonstrating general guidelines.

Polyethylene is, for practical purposes, considered impermeable. Be aware, however, that all materials are permeable to some extent. Permeability varies with concentration, temperature, pressure and type of permeant. The rates of permeation are usually so low, however, that they are insignificant. As a point of reference, polyethylene is commonly used for packaging of several types of materials. These include gasoline, motor oil, household cleaners (i.e. bleach), muratic acid, pesticides, insecticides, fungi-

cides, and other highly concentrated chemicals. Also, you should be aware that there are some chemicals which may be absorbed by the material but only when present at very high concentrations. These include halogenated and/or aromatic hydrocarbons at greater than 50%; their absorption results in swelling and slight changes in physical properties such as increased tensile elongations. This includes many types of fuels and oils. Recognize that this action, however, does not affect the liner's ability to act as a barrier for the material it is containing.

Since polyethylene is a petroleum product, it can absorb other petroleum products. Like a sponge, the material becomes slightly thicker and more flexible but does not produce a hole or void. However, unlike a sponge, this absorption is not immediate. It takes a much longer time for a polyethylene liner to swell than it does for a sponge. The exact time it takes for swelling to occur depends on the particular constituents and concentrations of the contained media. However, a hole would not be produced. Also, this absorption is reversible and the material will essentially return to it's original state when the chemical is no longer in contact with the liner.

With regard to typical municipal landfills in the United States, legally allowable levels of chemicals have been demonstrated to have no adverse affect on polyethylene geomembrane performance. The very low levels of salts, metals and organic compounds do not damage polyethylene. A double-lined containment with a leachate (leak detection) removal system effectively prevents any significant, continuous exposure of the secondary membrane to these materials and for practical purposes makes the total liner system even more impermeable.

This information is provided for reference purposes only and is not intended as a warranty or guarantee. Aquatan assumes no liability in connection with the use of this information. Please check with us for current, standard minimum quality assurance procedures and specifications.

Technical Note: Chemical Resistance Chart

Produced by a world-leading supplier of high quality polyethylene geomembranes, Aquatan's polyethylene geomembranes are resistant to a great number and combinations of chemicals. Note that the effect of chemicals on any material is influenced by a number of variable factors such as temperature, concentration, exposed area and duration. Many tests have been performed that use geomembranes and certain specific chemical mixtures. Naturally, however, every mixture of chemicals cannot be tested for, and various criteria may be used to judge performance. Reported performance ratings may not apply to all applications of a given material in the same chemical. Therefore, these ratings are offered as a guide only. This information is provided for reference purposes only and is not intended as a warranty or guarantee. Aquatan assumes no liability in connection with the use of this information.

| Medium | Concentration | Resistance at: | |
|-----------------------------|----------------------|-----------------|-------------------|
| | | 20°C (68 °F) | 60 °C (140 °F) |
| A | | | |
| Acetic acid | 100% | S | L |
| Acetic acid | 10% | S | S |
| Acetic acid anhydride | 100% | S | L |
| Acetone | 100% | L | L |
| Adipic acid | sat. sol. | S | S |
| Allyl alcohol | 96% | S | S |
| Aluminum chloride | sat. sol. | S | S |
| Aluminum fluoride | sat. sol. | S | S |
| Aluminum sulfate | sat. sol. | S | S |
| Alum | sol. | S | S |
| Ammonia, aqueous | dil. sol. | S | S |
| Ammonia, gaseous dry | 100% | S | S |
| Ammonia, liquid | 100% | S | S |
| Ammonium chloride | sat. sol. | S | S |
| Ammonium fluoride | sol. | S | S |
| Ammonium nitrate | sat. sol. | S | S |
| Ammonium sulfate | sat. sol. | S | S |
| Ammonium sulfide | sol. | S | S |
| Amyl acetate | 100% | S | L |
| Amyl alcohol | 100% | S | L |
| Aniline | 100% | S | L |
| Antimony trichloride | 90% | S | S |
| Arsenic acid | sat. sol. | S | S |
| Aqua regia | HCl-HNO ₃ | U | U |
| B | | | |
| Barium carbonate | sat. sol. | S | S |
| Barium chloride | sat. sol. | S | S |
| Barium hydroxide | sat. sol. | S | S |
| Barium sulfate | sat. sol. | S | S |
| Barium sulfide | sol. | S | S |
| Benzaldehyde | 100% | S | L |
| Benzene | - | L | L |
| Benzoic acid | sat. sol. | S | S |
| Beer | - | S | S |
| Borax (sodium tetraborate) | sat. sol. | S | S |
| Boric acid | sat. sol. | S | S |
| Bromine, gaseous dry | 100% | U | U |
| Bromine, liquid | 100% | U | U |
| Butane, gaseous | 100% | S | S |
| 1-Butanol | 100% | S | S |
| Butyric acid | 100% | S | L |
| C | | | |
| Calcium carbonate | sat. sol. | S | S |
| Calcium chlorate | sat. sol. | S | S |
| Calcium chloride | sat. sol. | S | S |
| Calcium nitrate | sat. sol. | S | S |
| Calcium sulfate | sat. sol. | S | S |
| Calcium sulfide | dil. sol. | L | L |
| Carbon dioxide, gaseous dry | 100% | S | S |
| Carbon disulfide | 100% | L | U |
| Carbon monoxide | 100% | S | S |
| Chloroacetic acid | sol. | S | S |

| Medium | Concentration | Resistance at: | |
|----------------------------|---------------|-----------------|-------------------|
| | | 20°C (68 °F) | 60 °C (140 °F) |
| Carbon tetrachloride | 100% | L | U |
| Chlorine, aqueous solution | Sat.sol. | L | U |
| Chlorine, gaseous dry | 100% | L | U |
| Chloroform | 100% | U | U |
| Chromic acid | 20% | S | L |
| Chromic acid | 50% | S | L |
| Citric acid | Sat.sol. | S | S |
| Copper chloride | sat. sol. | S | S |
| Copper nitrate | sat. sol. | S | S |
| Copper sulfate | sat. sol. | S | S |
| Cresylic acid | sat. sol. | L | |
| Cyclohexanol | 100% | S | S |
| Cyclohexanone | 100% | S | L |
| D | | | |
| Decahydronaphthalene | 100% | S | L |
| Dextrine | sol. | S | S |
| Diethyl ether | 100% | L | |
| Diocylphthalate | 100% | S | L |
| Dioxane | 100% | S | S |
| E | | | |
| Ethenediol | 100% | S | S |
| Ethanol | 40% | S | L |
| Ethyl acetate | 100% | S | U |
| Ethylene trichloride | 100% | U | U |
| F | | | |
| Ferric chloride | sat. sol. | S | S |
| Ferric nitrate | sol. | S | S |
| Ferric sulfate | sat. sol. | S | S |
| Ferrous chloride | sat. sol. | S | S |
| Ferrous sulfate | sat. sol. | S | S |
| Fluorine, gaseous | 100% | U | U |
| Fluorosilicic acid | 40% | S | S |
| Formaldehyde | 40% | S | S |
| Formic acid | 50% | S | S |
| Formic acid | 98-100% | S | S |
| Furfuryl alcohol | 100% | S | L |
| G | | | |
| Gasoline | - | S | L |
| Glacial acetic acid | 96% | S | L |
| Glucose | sat. sol. | S | S |
| Glycerine | 100% | S | S |
| Glycol | sol. | S | S |
| H | | | |
| Heptane | 100% | S | U |
| Hydrobromic acid | 50% | S | S |
| Hydrobromic acid | 100% | S | S |
| Hydrochloric acid | 10% | S | S |
| Hydrochloric acid | 35% | S | S |
| Hydrocyanic acid | 10% | S | S |
| Hydrofluoric acid | 4% | S | S |
| Hydrofluoric acid | 60% | S | L |
| Hydrogen | 100% | S | S |
| Hydrogen peroxide | 30% | S | L |
| Hydrogen peroxide | 90% | S | U |
| Hydrogen sulfide, gaseous | 100% | S | S |
| L | | | |
| Lactic acid | 100% | S | S |
| Lead acetate | sat. sol. | S | |
| M | | | |
| Magnesium carbonate | sat. sol. | S | S |
| Magnesium chloride | sat. sol. | S | S |
| Magnesium hydroxide | sat. sol. | S | S |
| Magnesium nitrate | sat. sol. | S | S |
| Maleic acid | sat. sol. | S | S |
| Mercuric chloride | sat. sol. | S | S |

| Medium | Concentration | Resistance at: | |
|--------------------------|---------------|-----------------|-------------------|
| | | 20°C (68 °F) | 60 °C (140 °F) |
| Mercuric cyanide | sat. sol. | S | S |
| Mercuric nitrate | sol. | S | S |
| Mercury | 100% | S | S |
| Methanol | 100% | S | S |
| Methylene chloride | 100% | L | - |
| Milk | - | S | S |
| Molasses | - | S | S |
| N | | | |
| Nickel chloride | sat. sol. | S | S |
| Nickel nitrate | sat. sol. | S | S |
| Nickel sulfate | sat. sol. | S | S |
| Nicotinic acid | dil. sol. | S | - |
| Nitric acid | 25% | S | S |
| Nitric acid | 50% | S | U |
| Nitric acid | 75% | U | U |
| Nitric acid | 100% | U | U |
| O | | | |
| Oils and Grease | - | S | L |
| Oleic acid | 100% | S | L |
| Orthophosphoric acid | 50% | S | S |
| Orthophosphoric acid | 95% | S | L |
| Oxalic acid | sat. sol. | S | S |
| Oxygen | 100% | S | L |
| Ozone | 100% | L | U |
| P | | | |
| Petroleum (kerosene) | - | S | L |
| Phenol | sol. | S | S |
| Phosphorus tricWoride | 100% | S | L |
| Photographic developer | cust. conc. | S | S |
| Picric acid | sat. sol. | S | - |
| Potassium bicarbonate | sat. sol. | S | S |
| Potassium bisulfide | sol. | S | S |
| Potassium bromate | sat. sol. | S | S |
| Potassium bromide | sat. sol. | S | S |
| Potassium carbonate | sat. sol. | S | S |
| Potassium cWorate | sat. sol. | S | S |
| Potassium chloride | sat. sol. | S | S |
| Potassium chromate | sat. sol. | S | S |
| Potassium cyanide | sol. | S | S |
| Potassium dichromate | sat. sol. | S | S |
| Potassium ferricyanide | sat. sol. | S | S |
| Potassium ferrocyanide | sat. sol. | S | S |
| Potassium fluoride | sat. sol. | S | S |
| Potassium hydroxide | 10% | S | S |
| Potassium hydroxide | sol. | S | S |
| Potassium hypochlorite | sol. | S | L |
| Potassium nitrate | sat. sol. | S | S |
| Potassium orthophosphate | sat. sol. | S | S |
| Potassium perchlorate | sat. sol. | S | S |
| Potassium permanganate | 20% | S | S |
| Potassium persulfate | sat. sol. | S | S |
| Potassium sulfate | sat. sol. | S | S |
| Potassium sulfite | sol. | S | S |
| Propionic acid | 50% | S | S |
| Propionic acid | 100% | S | L |
| Pyridine | 100% | S | L |
| Q | | | |
| Quinol (Hydroquinone) | sat. sol. | S | S |
| S | | | |
| Salicylic acid | sat. sol. | S | S |

| Medium | Concentration | Resistance at: | |
|-----------------------|---------------------|-----------------|-------------------|
| | | 20°C (68 °F) | 60 °C (140 °F) |
| Silver acetate | sat. sol. | S | S |
| Silver cyanide | sat. sol. | S | S |
| Silver nitrate | sat. sol. | S | S |
| Sodium benzoate | sat. sol. | S | S |
| Sodium bicarbonate | sat. sol. | S | S |
| Sodium biphosphate | sat. sol. | S | S |
| Sodium bisulfite | sol. | S | S |
| Sodium bromide | sat. sol. | S | S |
| Sodium carbonate | sat. sol. | S | S |
| Sodium chlorate | sat. sol. | S | S |
| Sodium chloride | sat. sol. | S | S |
| Sodium cyanide | sat. sol. | S | S |
| Sodium ferricyanide | sat. sol. | S | S |
| Sodium ferrocyanide | sat. sol. | S | S |
| Sodium fluoride | sat. sol. | S | S |
| Sodium hydroxide | 40% | S | S |
| Sodium hydroxide | sat. so l. | S | S |
| Sodium hypochlorite | 15% active chlorine | S | S |
| Sodium nitrate | sat. sol. | S | S |
| Sodium nitrite | sat. sol. | S | S |
| Sodium orthophosphate | sat. sol. | S | S |
| Sodium sul fate | sat. sol. | S | S |
| Sodium sulfide | sat. sol. | S | S |
| Sulfur dioxide, dry | 100% | S | S |
| Sulfur trioxide | 100% | U | U |
| Sulfuric acid | 10% | S | S |
| Sulfuric acid | 50% | S | S |
| Sulfuric acid | 98% | S | U |
| Sulfuric acid | fuming | U | U |
| Sulfurous acid | 30% | S | S |
| T | | | |
| Tannic acid | sol. | S | S |
| Tartaric acid | sol. | S | S |
| Thionyl chloride | 100% | L | U |
| Toluene | 100% | L | U |
| Triethylamine | sol. | S | L |
| U | | | |
| Urea | sol. | S | S |
| Urine | - | S | S |
| W | | | |
| Water | | S | S |
| Wine vinegar | | S | S |
| Wines and liquors | - | S | S |
| X | | | |
| Xylenes | 100% | L | U |
| Y | | | |
| Yeast | sol. | S | S |
| Z | | | |
| Zinc carbonate | sat. sol. | S | S |
| Zinc chloride | sat. sol. | S | S |
| Zinc (II) cWoride | sat. sol. | S | S |
| Zinc (IV) chloride | sat. sol. | S | S |
| Zinc oxide | sat. sol. | S | S |
| Zinc sulfate | sat. sol. | S | S |

Specific immersion testing should be undertaken to ascertain the suitability of chemicals not listed above with reference to special requirements.

NOTES:

(S) Satisfactory: *Liner material is resistant to the given reagent at the given concentration and temperature. No mechanical or chemical degradation is observed.*

(L) Limited Application Possible: *Liner material may reflect some attack. Factors such as concentration, pressure and temperature directly affect liner performance against the given media. Application, however, is possible under less severe conditions. e.g. lower concentration, secondary containment, additional liner protections, etc.*

(U) Unsatisfactory: *Liner material is not resistant to the given reagent at the given concentration and temperature. Mechanical and/or chemical degradation is observed.*

(-) Not tested

sat. sol. = Saturated aqueous solution, prepared at 20°C (68°F)

sol. = aqueous solution with concentration above 10% but below saturation level

dil. sol. = diluted aqueous solution with concentration below 10%

cust. conc. = customary service concentration

PO Box 633, Isando 1600, South Africa
10 Diesel Road, Isando 1600, South Africa

Tel: +27 11 974 5271
Fax: +27 11 974 4111

E-mail: aqua@aquatan.co.za
Website: www.aquatan.co.za