

HALAR[®] ECTFE
FLUOROPOLYMER

Chemical Resistance Data



Introduction

What is HALAR® Fluoropolymer ?

HALAR ECTFE is essentially a 1:1 alternating copolymer of ethylene and chlorotrifluoro-ethylene. It contains about 80% by weight of chlorotrifluoro-ethylene, one of the most chemically resistant building blocks that can be used to make a polymer. CTFE homopolymers are difficult to fabricate into complex shapes. By copolymerization with ethylene, HALAR ECTFE was developed with the chemical resistance of CTFE based materials with easy processability.

Why is HALAR Fluoropolymer Used for Chemical Applications?

HALAR ECTFE, as the following data indicate, is one of the most chemically resistant polymers available today. This chemical resistance is due to the chemically resistant monomers used, the highly ordered 1:1 structure, and the high crystallinity of the resulting product.

In addition to its high degree of chemical resistance, HALAR possesses the following factors that make it suitable for demanding applications.

- Mechanically tough with excellent cut through and abrasion resistance
- Low cold flow
- High tensiles and elongation
- Excellent impact at room temperature and down into the cryogenic
- Dimensionally stable
- Continuous use to 300°F in many applications
- Excellent release properties
- Resistant to Cobalt-60 radiation
- High purity and does not contaminate high purity fluids
- Easily fabricated into complex shapes by normal melt processable techniques
- Extremely smooth surface

Known Factors Affecting Chemical Resistance

Chemical attack and chemical resistance are very complex phenomena. The known factors affecting chemical suitability of HALAR or any other plastic for a chemical application, not listed in order of priority, are as follows:

- Specific chemical or mixture composition
- Temperature and temperature variation
- Concentration of the attacking chemical which may be a complex completely different than the individual components
- Exotherm or heat of reaction or mixing
- Pressure, due primarily to the effect of pressure on concentration of a reactive gas
- Time of exposure
- Stress levels
- Velocity
- Suspended solids
- Thickness
- EMF potential of the supporting metal compared to the ground potential

Other factors probably exist but the above are the existing known factors.

Recommended Procedure to Determine Suitability

The recommended procedure to determine suitability of HALAR is as follows:

- Determine as accurately as possible the chemicals in the stream in question.
- Determine the maximum temperature and the normal operating temperature
- Review the maximum recommended temperature from the list provided.

The effect of synergism or reaction or complex formation with mixtures cannot be predicted by the table. In any case, appropriate chemical resistance tests using a representative sample of the stream should be performed.

HALAR® 300 Chemical Compatibility Data Based on Actual Laboratory Tests
 All specimens tested for 30 days chemical immersion at specified temperatures

| Chemical Name | Test Temp. °C | Retained Properties | | | |
|------------------------|------------------|---------------------|------------|----------------|--------------|
| | | Tensile Strength | Elongation | Weight Gain, % | Color Change |
| Acetic Acid | 140 | I | I | 3.4 | 1 |
| Acetone | 100 | A | I | 3.5 | 1 |
| Acetone cyanohydrin | 50 | I | I | 0.0 | 1 |
| Acetonitrile | 140 | A | I | 2.2 | 1 |
| Acetophenone | 75 | I | I | 3.9 | 1 |
| Acrylic Acid | 100 | I | I | 0.4 | 1 |
| Aluminum Chloride 50% | 100 | I | I | 0.0 | 2 |
| Anisole * | 50 | I | I | 3.9 | 1 |
| Ammonium Hydroxide 30% | 140 | I | I | 1.2 | 2 |
| Amyl Acetate, 99% * | 50 | I | I | 4.7 | 1 |
| Aniline | 100 | I | I | 2.5 | 3 |
| Benzaldehyde | 100 | A | I | 5.4 | 2 |
| Benzene | 66 | A | I | 4.2 | 1 |
| Benzyl Chloride, 97% * | 50 | I | I | 2.3 | 1 |
| Benzyl Alcohol | 121 | I | I | 1.6 | 1 |
| Butanol n, | 121 | I | I | 1.9 | 1 |
| Butyl Acrylate * | 50 | I | I | 4.4 | 1 |

LEGEND

RETAINED PROPERTIES: I - Insignificant A- Reduced 25-50% B- Reduced 50-75% C- Reduced >75%
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* - tested for 28 days; all others tested at 30 days. Values are comparable.

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|------------------------|------------------|---------------------|------------|----------------|--------------|
| | | Tensile Strength | Elongation | Weight Gain, % | Color Change |
| Butyl Acetate | 50 | A | I | 3.8 | 1 |
| Butylaldehyde* | 50 | I | I | 2.8 | 1 |
| Butyl Amine * | 50 | A | I | 8.7 | 4 |
| Butyl Lactate * | 50 | I | I | 0.5 | 1 |
| Butyl Phthalate | 100 | I | I | 2.4 | 1 |
| Calcium Chloride 20% | 160 | I | A | 0.0 | 1 |
| Calcium Hydroxide 0.5% | 140 | I | I | 0.3 | 2 |
| Cellosolv Acetate | 100 | I | I | 4.6 | 1 |
| Chlorine water, sat. | 121 | I | I | 3.5 | 2 |
| Chloroacetic acid, 50% | 100 | I | I | 0.3 | 3 |
| Chlorobenzene | 50 | I | I | 4.8 | 1 |
| Chlorosulfonic acid | 50 | I | I | 4.3 | 3 |
| Chlorotoluene a, | 50 | I | I | 2.9 | 2 |
| Chromic Acid, 30% | 100 | I | I | 0.0 | 2 |
| Chromic Acid, 30% | 140 | A | I | 0.0 | 3 |
| Cresol o, | 100 | I | I | 3.3 | 1 |
| Cyclohexane | 100 | A | I | 5.0 | 1 |

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| Cyclohexanone | 75 | I | I | 5.7 | 1 |
| Cyclohexylamine * | 50 | I | I | 2.3 | 3 |
| Dexron II (Auto Trans Fluid) | 150 | I | I | 1.1 | 1 |
| Dibutyl Sebacate | 100 | I | I | 2.4 | 1 |
| Dibutyl Phthalate * | 50 | I | I | 0.1 | 1 |
| Diethyl Phthalate * | 50 | I | I | 0.08 | 1 |
| Dichlorobenzene o, | 50 | I | I | 5.6 | 1 |
| Dichloroethane | 20 | I | I | 4.7 | 1 |
| Dichloroethylene | 50 | A | I | 4.9 | 1 |
| Dichloroethylene 1,2 | 20 | I | I | 1.8 | 1 |
| Dichloropropane | 100 | I | I | 6.4 | 1 |
| Dichlorotoluene a,a | 121 | I | I | 10.5 | 1 |
| Diethylamine * | 50 | I | I | 4.3 | 3 |
| N, N Diethylethanolamine * | 50 | I | I | 0.2 | 1 |
| Diethyl Hydroxy Amine, 85% | 30 | I | I | 0.0 | 1 |
| Diethylene glycol butyl ether acetate * | 50 | I | I | 0.5 | 1 |
| Diethylene glycol mono butyl ether * | 50 | I | I | 0.2 | 1 |

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| | | Tensile Strength | Elongation | Weight Gain, % | Color Change |
| Diethylene Triamine | 50 | I | I | 0.2 | 2 |
| Diisobutyl Ketone * | 50 | I | I | 1.1 | 1 |
| Diisopropyl Acetate * | 20 | I | I | 0.2 | 1 |
| Diisopropyl Ketone | 100 | I | I | 6.5 | 1 |
| Dimethyl Acetamide N,N | 100 | I | I | 5.9 | 2 |
| Dimethyl Formamide N,N | 100 | I | I | 4.8 | 2 |
| Dimethyl Phthalate | 100 | I | I | 2.5 | 2 |
| Dimethyl Sulfoxide | 100 | I | I | 1.9 | 1 |
| Dimethylamine | 20 | I | I | 1.9 | 1 |
| Dioctyl Phthalate | 50 | I | I | 0.2 | 1 |
| Dioxane 1,4- | 50 | I | I | 4.7 | 1 |
| Dioxane 2,4 | 100 | A | I | 5.7 | 1 |
| Dipropylene glycol methyl ether * | 50 | I | I | 0.2 | 1 |
| Ethanol | 140 | I | I | 1.6 | 1 |
| Ether * | 50 | I | I | 3.5 | 1 |
| 2 Ethoxy-ethanol, 99% * | 50 | I | I | 0.4 | 1 |
| Ethyl Acetate | 50 | I | I | 3.4 | 1 |

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| | | Tensile Strength | Elongation | Weight Gain, % | Color Change |
| Ethyl Acrylate | 100 | I | I | 6.4 | 1 |
| Ethyl Formate | 100 | I | I | 3.8 | 1 |
| Ethylacetate | 75 | A | I | 3.4 | 1 |
| Ethylacrylate | 75 | A | I | 3.6 | 1 |
| Ethylene Glycol | 100 | I | I | 0.4 | 1 |
| Ethylenediamine | 20 | I | I | 0.3 | 2 |
| Ferric Chloride 55% | 100 | I | I | -0.1 | 1 |
| Fluoroboric Acid, 10% | 100 | I | I | 0.1 | 1 |
| Formaldehyde, 37% | 80 | I | I | 0.6 | 1 |
| Fuming Sulfuric Acid | 50 | I | I | 1.4 | 3 |
| Furfural | 100 | I | I | 4.0 | 3 |
| Hexane | 149 | A | I | 2.7 | 2 |
| Hydrochloric acid, 37% | 100 | I | I | 0.7 | 3 |
| Hydrofluoric acid, 37% | 121 | I | I | 0.9 | 2 |
| Hydrofluoric acid, 49% | 100 | I | I | 0.2 | 2 |
| Hydrofluoric acid, 70% HF | 50 | I | A | 0.1 | 2 |
| Hydrogen Peroxide (60%) | 30 | I | I | 0.3 | 1 |

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| | | Tensile Strength | Elongation | Weight Gain, % | Color Change |
| 4-Hydroxybenzene sulfonic acid * | 70 | I | I | 0.1 | 2 |
| Isopentyl Alcohol | 100 | A | I | 1.5 | 2 |
| Isophorone * | 50 | I | I | 0.5 | 1 |
| Lithium Hydroxide | 100 | I | I | 0.0 | 1 |
| Methane Sulfuric Acid, 50% | 66 | I | I | 0.0 | 1 |
| Methanol | 50 | I | I | 0.4 | 1 |
| Methanol | 140 | B | B | 1.6 | 2 |
| 5-Methyl-2-hexanone * | 50 | I | I | 4.1 | 1 |
| Methyl Acetate * | 50 | I | I | 5.8 | 1 |
| Methyl Acrylate * | 50 | I | I | 5.5 | 1 |
| Methyl Cellosolv | 140 | I | I | 2.4 | 1 |
| Methyl Ethyl Ketone | 100 | I | I | 6.1 | 1 |
| Methyl Formate | 100 | A | I | 5.5 | 1 |
| Methyl Isobutyl Ketone | 100 | I | I | 5.7 | 1 |
| Methyl Methacrylate | 50 | I | I | 3.7 | 1 |
| N-Methylpyrrolidinone | 20 | I | I | 1.5 | 1 |
| 1-methyl-2-pyrrolidinone | 20 | I | I | 0.3 | 1 |
| Methylene Chloride | 50 | I | I | 4.1 | 1 |

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| | | Tensile Strength | Elongation | Weight Gain, % | Color Change |
| Mesityloxiide * | 50 | I | I | 4.5 | 2 |
| N,N-Dimethyldodecylamine | 75 | I | I | 0.5 | 1 |
| Napthalene | 121 | I | I | 8.8 | 1 |
| Nitric Acid, 10% | 121 | I | I | 0.4 | 1 |
| Nitric Acid, 50% | 50 | I | I | 0.1 | 1 |
| Nitric Acid, 90% | 71 | I | I | 2.3 | 2 |
| Nonyl Phenol * | 50 | I | I | 0.1 | 1 |
| 2-Octanol | 50 | I | I | 0.2 | 1 |
| Oleum 30% in Sulfuric Acid | 20 | I | I | 0.4 | 1 |
| Oleum 30% in Sulfuric Acid | 50 | A | B | 3.4 | 3 |
| Pentanedione 2,4 | 100 | I | I | 6.3 | 1 |
| Pentyl Acetate | 50 | I | I | 3.9 | 1 |
| Phenol | 50 | I | I | 0.1 | 1 |
| Phosphoric Acid, 30% | 100 | I | I | 0.1 | 1 |
| Phosphoric Acid, 85% | 140 | I | I | -0.1 | 2 |
| Phosphorous Oxychloride | 50 | I | I | 12.8 | 1 |
| Potassium Carbonate, 53.2% | 140 | I | I | -0.1 | 2 |
| Potassium Carbonate, 53.2% sat. | 100 | I | I | -0.1 | 1 |

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| Potassium Hydroxide, 50% | 121 | I | I | -0.1 | 2 |
| Potassium Hydroxide, 50% | 140 | C | C | -0.2 | 3 |
| Propanol * | 50 | I | I | 0.16 | 1 |
| Propyl Acetate | 50 | I | I | 3.6 | 1 |
| Sodium Carbonate, 33.7% sat. | 100 | I | I | 0.0 | 1 |
| Sodium Chlorite, 45.9% sat. | 100 | I | I | 0.1 | 1 |
| Sodium Hydrosulfide, 50% | 140 | I | I | 0.0 | 2 |
| Sodium Hydroxide, 50% | 132 | I | I | -0.2 | 2 |
| Sodium Hypochlorite, 12.5-15.5% | 45 | I | I | 0.1 | 1 |
| Sodium Hypochlorite, 5% | 121 | I | I | 0.1 | 1 |
| Stearoyl Chloride | 125 | A | A | 2.0 | 3 |
| Sulfuric Acid, 98% | 121 | I | I | 0.7 | 3 |
| Sulfuric Acid, 98% | 150 | A | B | 1.7 | 3 |
| Tetrachloroethylene | 50 | I | I | 7.9 | 1 |
| Tetrahydrofuran | 50 | A | I | 4.3 | 1 |
| Tetramethyl Ammonium Hydroxide | 100 | I | I | 0.6 | 2 |
| Thionyl Chloride * | 50 | A | I | 12.9 | 2 |

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| | | Tensile Strength | Elongation | Weight Change | Color Change |
| p-Toluenesulfonic acid (sol. sat.) * | 70 | I | I | 0.0 | 1 |
| Toluene | 20 | I | I | 0.7 | 1 |
| Toluene | 50 | A | I | 3.8 | 1 |
| Tributyl Phosphate * | 50 | I | I | 0.12 | 1 |
| Trichlorobenzene | 50 | I | I | 4.0 | 1 |
| Trichloroethylene 1,1,1 | 20 | I | I | 0.3 | 1 |
| Trichloroethylene and nitric acid * | 50 | I | I | 4.6 | 2 |
| Trichloroethylene in methanol * | 50 | I | I | 0.5 | 1 |
| Triethylamine * | 50 | I | I | 0.93 | 2 |
| Tricresyl Phosphate | 100 | I | I | 0.3 | 1 |
| Triethyl Phosphate | 100 | I | I | 4.5 | 1 |
| Triethylene Tetramine | 50 | I | I | 0.0 | 2 |
| Vinyl Acetate | 50 | I | I | 3.1 | 1 |
| Water | 140 | I | I | 0.6 | 2 |
| Xylene | 50 | I | I | 3.4 | 1 |

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