

TECHNICAL INFORMATION: CHEMICAL RESISTANCE

DuPont™ Surlyn® resins have outstanding resistance to both physical and chemical attack. They are also highly resistant to permeation by liquids. However, some aromatic, cyclic, and high eraliphatic hydrocarbon solvents cause swelling and permeate through the resin; therefore, they should be used with caution. The permeation rate of any liquid will vary depending upon the particular grade of resin and wall thickness, as well as the molecular weight and polarity of the liquid.

Note: This report applies to industrial applications for Surlyn® resins and not for flexible packaging applications. Generally, industrial applications involve material thicknesses greater than 20 mil. Flexible packaging applications, by comparison, typically involve thin films and/or thin coatings or laminations to other substrates. The chemical resistance performance of Surlyn® for these thin, flexible packaging applications may be different than indicated in this report.

Chemical environmental effects on Surlyn® resins may be divided into three categories: oxidation, stress cracking, and plasticization. Only oxidation is a chemical degradation; the other two involve the physical properties of the polymer.

Oxidizers

Oxidizers are capable of chemically degrading Surlyn®. The chemical effects of even a strong oxidizer may be gradual and may not be measurable over the short term. However, they may be significant over the long term and should be evaluated if continuous exposure is expected. The following materials are examples of strong oxidizers that are unsuitable for long-term exposure to Surlyn® resin:

- Nitric acid, fuming
- Sulfuric acid, fuming (oleum)
- Aqua regia Chlorine (wet gas)
- Bromine (liquid)

Stress Crack Agents

Certain surface-active materials, although they have no chemical effect, can accelerate the cracking of Surlyn® resins when under stress. This accelerated form of stress failure is called environmental stress cracking (ESC). Although all resins are subject to stress cracking, some are more susceptible to it than others. Certain Surlyn® grades are specially designed to be more resistant to this type of failure.

ESC failure depends on the amount of stress in the resin and, therefore, thermal history and design factors are very important. When designing for known or possible stress crack agents, Surlyn® grade selection and optimum fabrication techniques (i.e., for minimum internal stress) must be considered. The following materials are examples of stress crack agents that are unsuitable for long-term exposure to Surlyn® resin:

- Methyl alcohol
- Ethyl alcohol
- n-Propyl alcohol
- Isopropyl alcohol
- Ethylene glycol

Plasticizers

Certain types of nonaqueous chemicals are absorbed to varying degrees by Surlyn® resins causing swelling, weight gain, softening, and some loss of yield strength. These plasticizing materials cause no actual chemical degradation of the resin. Some organic solvents such as aliphatic hydrocarbons, chlorinated hydrocarbons, aromatics, and heterocyclic compounds have a strong plasticizing action (10–20% solubility in the polymer). However, most of these solvents are sufficiently volatile, so that if they are removed from contact with the resin, the part will "dry out" and return to its original condition with no impairment of properties. Sodium-type resins absorb less of these solvents than zinc types. Conversely, aqueous solutions will plasticize sodium-type resins more than zinc types. If the end product is unsupported, absorption of either aqueous or nonaqueous product will reduce the product stiffness and may change color and increase internal haze.

Testing Is Important

It cannot be expected that one chemical resistance data chart will include the effects of all chemicals. Furthermore, the suitability of Surlyn® depends not only on the nature of the chemical environment, but also on the expected service temperature and stress, the duration of exposure, and whether it is intermittent or continuous.

Because so many variables are involved, it must be recognized that standard laboratory tests can give only a general guide as to whether a resin may resist exposure to a specific environment. Therefore, the feasibility of any chemical environment must be determined by extensive laboratory tests carried out under conditions that approximate as closely as possible those expected in service.

The following procedure is recommended to determine the suitability of Surlyn® to resist a specific chemical exposure:

1. Immerse a sample of the Surlyn® resin in the chemical under study. The sample should be preweighed and immersed at the expected service temperature for a reasonable time.

Note: Many of the chemicals under study may be toxic, corrosive, flammable, and/or irritants. In addition, many of the chemicals under study should not be inhaled, ingested, or come in contact with human skin. Therefore, accepted industrial standards should be used when involved with these chemicals.

2. At the end of the test period, the sample should be reweighed to determine if there is a weight gain or loss. In addition, any change in surface hardness should be noted.
3. Check for chemical degradation of the resin by observing any surface crazing, cracking, or discoloration.
4. Tensile properties should be checked by measuring ultimate tensile strength and elongation. Tensile properties will change with percent plasticization. If chemical attack has occurred, a remarkable decrease in ultimate tensile strength should be evident.
5. Environmental stress cracking characteristics of the chemical under study can be determined using ASTM test procedure D1693 by substituting the chemical of interest for the test liquid specified in this procedure.

Guide to Chemical Resistance

The chemical resistance data presented in the following table originated in part from tests conducted at DuPont laboratories and, in part, from reliable published sources. *This table is intended only as a preliminary, general guide to the resistance of Surlyn® to various chemicals. It should not be used by the industry as the basis for final decisions because the specific end-use application, design, and/or conditions of use may have added effects on performance in a particular chemical environment. It is recommended that laboratory testing of the specific end-use application be conducted under expected service conditions.*

Resistance Code	Caution Code
R Resistant; no indication that serviceability would be impaired.	O Oxidizer P Plasticizer
V Variable resistance, depending on conditions of use.*	A Known stress crack agent ^b
U Not resistant. Not recommended for service applications under any conditions	B Possible stress crack agent ^b

*The classification "variable resistance" is very broad. Depending on the nature of the chemical, its concentration, the service temperature and pressure, and the time of exposure, Surlyn® resin can be either very resistant or very susceptible to attack. Therefore, where Surlyn® is said to have variable resistance to a chemical, it is critical that extensive pretesting be conducted.

^b A system using Surlyn® in exposure to a chemical to which it is designated resistant, but which carries a stress crack identifier (A or B), may be serviceable over a useful lifetime providing the following precautions are observed:

- A stress crack resistant grade of Surlyn® resin should be used.
- Stresses in the fabricated Surlyn® must be minimized by design and processing.
- Conditions and limitations of the application should be carefully observed (avoidance of high temperature, etc.)

Chemical Resistance Data – Surlyn® Resin

Caution Code	Chemical	Chemical Resistance Code		Caution Code	Chemical	Chemical Resistance Code	
		21°C (70°F)	60°C (140°F)			21°C (70°F)	60°C (140°F)
B	Acetaldehyde (100%)	V	U		Beer	R	R
	Acetic Acid (10%)	R	R	B	Beet Sugar Liquors	R	R
B	Acetic Acid (60%)	R	V	B	Benzaldehyde	V	U
	Acetic Anhydride	R	R	P	Benzene	R	V
	Acetone	R	*	P	Benzene Sulfonic Acid (10%)	R	R
	Acrylic Emulsions	R	R		Benzoic Acid	R	R
	Adipic Acid	R	R		Bismuth Carbonate	R	R
	Air	R	R		Black Liquor	R	R
B,P	Allyl Chloride	U	U		Bleach Lye (10%)	R	R
	Aluminum Chloride	R	R		Borax	R	R
	Aluminum Fluoride	R	R		Boric Acid	R	R
	Aluminum Hydroxide	R	R		Brine	R	R
	Aluminum Nitrate	R	R		Bromic Acid	R	V
	Aluminum Oxychloride	R	R	O	Bromine, Liquid	U	U
	Aluminum Sulfate	R	R	O	Bromine, Vapor (25%)	U	U
	Alums (all types)	R	R	O	Bromine, Water	U	U
	Ammonia (100% dry gas)	R	R	P	Butadiene	V	*
	Ammonia, Liquid	R	R	P	Butane	R	*
	Ammonium Acetate	R	R	A	Butanediol	R	V
	Ammonium Carbonate	R	R		Butter	R	R
	Ammonium Chloride	R	R	P	n-Butyl Acetate (100%)	R	V
	Ammonium Fluoride	R	R	A	n-Butyl Alcohol (100%)	V	U
	Ammonium Hydroxide (10-28%)	R	R		Butyric Acid	U	U
	Ammonium Metaphosphate	R	R		Cadmium Cyanide	R	R
	Ammonium Nitrate	R	R		Calcium Bisulfite	R	R
	Ammonium Persulfate	R	R		Calcium Bisulfide	R	R
	Ammonium Phosphate, Ammoniacal and Neutral	R	R		Calcium Carbonate	R	R
	Ammonium Sulfide	R	R		Calcium Chlorate	R	R
	Ammonium Sulfate	R	R		Calcium Chloride	R	R
	Ammonium Thiocyanate	R	R		Calcium Hydroxide	R	R
B,P	Amyl Acetate (100%)	U	U	B	Calcium Hydroxide (bleach solution)	V	V
A,P	Amyl Alcohol (100%)	V	V		Calcium Nitrate (50%)	R	R
P	Amyl Chloride (100%)	U	U		Calcium Oxide	R	R
P	Aniline (100%)	R	U		Calcium Sulfate	R	R
P	Aniline Hydrochloride	U	U	B,P	Camphor Oil	U	U
	Anthraquinone	R	R		Carbon (slurry)	R	R
	Anthraquinone Sulfonic Acid	R	R		Carbon Dioxide	R	R
	Antimony Trichloride	R	R		Carbon Disulfide	U	U
O	Aqua Regia	U	U		Carbon Monoxide	R	R
P	Aromatic Hydrocarbons	R	V	P	Carbon Tetrachloride	U	U
	Arsenic Acid	R	R		Carbonic Acid	R	R
	Ascorbic Acid (10%)	R	R		Castor Oil	R	R
	Barium Carbonate	R	R		Caustic Potash	R	R
	Barium Chloride	R	R		Caustic Soda	R	R
	Barium Hydroxide	R	R	P	Cellosolve	R	U
	Barium Sulfate	R	R	P	Chloralhydrate	U	U
	Barium Sulfide	R	R	O	Chlorine (100% dry gas)	U	U
				O	Chlorine (wet gas)	U	U
				O	Chlorine Liquid	U	U

V – Variable resistance U – Not resistant * – Insufficient data

Refer to text for explanation of Resistance and Caution Codes.

Chemical Resistance Data – Surlyn® Resin

Caution Code	Chemical	Chemical Resistance Code		Caution Code	Chemical	Chemical Resistance Code	
		21°C (70°F)	60°C (140°F)			21°C (70°F)	60°C (140°F)
B	Chlorine Water (2%)	R	V		Ferric Chloride	R	R
P	Chlorobenzene	U	U		Ferric Hydroxide	R	R
P	Chloroform	U	U		Ferric Nitrate	R	R
	Chlorosulfonic Acid (100%)	U	U		Ferric Sulfate	R	R
	Chromic Acid (10%)	R	*		Ferrous Chloride	R	R
O	Chromic Acid (30—50%)	R	*		Ferrous Sulfate	R	R
	Cider	R	R		Fish Solubles	R	R
	Citric Acid	R	R		Fluoboric Acid	R	R
A	Coconut Oil Alcohols	R	V	O	Fluorine, Gas, Wet	U	U
	Coffee	R	R		Fluosilicic Acid (conc.)	R	V
	Cola Concentrates	R	R		Fluosilicic Acid (32%)	R	R
	Copper Carbonate	R	R	B	Formaldehyde	R	V
	Copper Chloride	R	R		Formic Acid	R	R
	Copper Cyanide	R	R		Fructose	R	R
	Copper Fluoride (2%)	R	R	B	Fruit Pulp	R	R
	Copper Nitrate	R	R	P	Furfural (100%)	U	U
	Copper Sulfate	R	R	B,P	Furfuryl Alcohol	U	U
	Corn Oil	R	R	B	Gallic Acid	R	R
	Corn Syrup	R	R	P	Gas, Natural, Dry and Wet	R	*
P	Cottonseed Oil	R	R	P	Gasoline	R	V
P	Cresol	U	U	P	Gasoline, High Octane	R	V
	Crude Oil	R	R	P	Genetron, 11, 12 & 22	R	*
	Cupric Fluoride	R	R		Glucose R	R	R
	Cupric Sulfate	R	R	B	Glycerine	R	R
	Cuprous Chloride	R	R	A	Glycol	V	U
B	Cyclohexanol	R	V	A	Glycolic Acid (30%)	R	R
P	Cyclohexanone	R	U		Grape Sugar (sat. aq.)	R	R
B	Detergents, Synthetic	R	R	P	n-Heptane	R	V
	Developers, Photographic	R	R		Hexachlorobenzene	R	R
	Dextrin	R	R	P	Hexane	R	V
	Dextrose	R	R	B	Hexanol, Tertiary	R	R
	Diazo Salts	R	R	*	Hydrobromic Acid (50%)	R	R
	Dibutylphthalate	R	V		Hydrochloric Acid	R	R
B,P	Dichlorobenzene (o & p)	U	U		Hydrocyanic Acid	R	R
B	Diethyl Ketone	V	U	*	Hydrofluoric Acid (40–60%)	R	R
A	Diethylene Glycol	R	V		Hydrogen (100%)	R	R
A	Diglycolic Acid	R	R		Hydrogen Chloride (dry gas)	R	R
	Dimethylamine	U	U		Hydrogen Peroxide (3%)	R	V
P	Diethylphthalate	R	U		Hydrogen Sulfide	R	R
	Disodium Phosphate	R	R		Hydroquinone	R	R
	Distilled Water	R	R		Hydroxylamine Sulfate	R	R
P	Esters	R	V		Hypochlorous Acid	R	R
P	Ethers	R	V	B	Inks	R	R
P	Ethyl Acetate (100%)	R	U	O	Iodine (in KI solution)	U	U
P	Ethyl Acrylate	R	V	A	Isopropyl Alcohol	V	U
A	Ethyl Alcohol	V	U	P	Jet Fuels, JP4 and JP5	V	U
B,P	Ethyl Benzene	U	U	P	Kerosene	V	U
P	Ethyl Chloride	U	U		Kraft Liquors	R	R
P	Ethyl Ether	U	U		Lactic Acid (25%)	R	R
B,P	Ethylene Bromide	U	U		Lard Oil	R	R
B,P	Ethylene Chloride	U	U		Latex	R	R
B,P	Ethylene Chlorohydrin	U	U		Lauric Acid	R	V
B,P	Ethylene Dichloride	U	U	P	Lauryl Chloride	V	*
A	Ethylene Glycol	V	U				
	Ethylene Oxide	R	V				

V -- Variable resistance U – Not resistant * -- Insufficient data Refer to text for explanation of Resistance and Caution Codes.

Chemical Resistance Data – Surlyn® Resin

Caution Code	Chemical	Chemical Resistance Code		Caution Code	Chemical	Chemical Resistance Code	
		21°C (70°F)	60°C (140°F)			21°C (70°F)	60°C (140°F)
	Lead Acetate	R	R		Phosphoric Acid	R	R
	Lead Chloride	R	R		Photographic Solutions	R	R
	Lead Nitrate	R	R	O	Picric Acid	U	U
	Lead Sulfate	R	R		Plating Solutions		
P	Linseed Oil	V	U		Brass	R	R
	Lithium Bromide	R	R		Cadmium	R	R
P	Lubricating Oil, ASTM #1, #2, #3	R	V		Copper	R	R
					Gold	R	R
P	Machine Oil	R	V		Lead	R	R
	Magnesium Carbonate	R	R		Nickel	R	R
	Magnesium Chloride	R	R		Silver	R	R
	Magnesium Citrate	R	R		Tin	R	R
	Magnesium Hydroxide	R	R		Zinc	R	R
	Magnesium Nitrate	R	R		Potassium Bicarbonate	R	R
	Magnesium Sulfate	R	R		Potassium Bichromate	R	R
	Maleic Acid	R	R		Potassium Borate	R	R
	Mercuric Chloride	R	R		Potassium Bromate	R	R
	Mercuric Cyanide	R	R		Potassium Bromide	R	R
	Mercurous Nitrate	R	R		Potassium Carbonate	R	R
	Mercury				Potassium Chlorate	R	R
P	Methane	R	*		Potassium Chloride	R	R
A	Methyl Alcohol	V	U		Potassium Chromate (40%)	R	R
P	Methyl Chloride	U	U		Potassium Cyanide	R	R
					Potassium Dichromate (40%)	R	R
P	Methyl Ethyl Ketone	R	V		Potassium Ferri/ Ferro Cyanide	R	R
P	Methyl Isobutyl Ketone	R	V		Potassium Fluoride	R	R
					Potassium Hydroxide	R	R
	Methyl Sulfate	R	R		Potassium Nitrate	R	R
B,P	Methyl Sulfuric Acid	R	R				
	Methylene Chloride (100%)	U	U		Potassium Perborate	R	R
					Potassium Perchlorate (10%)	R	R
	Milk	R	R		Potassium Permanganate (20%)	R	R
	Mineral Oils	R	V		Potassium Persulfate	R	R
	Molasses	R	R		Potassium Sulfate	R	R
					Potassium Sulfide	R	R
P	Naptha	V	U		Potassium Sulfite	R	R
P	Napthalene	U	U	P	Propane	U	U
	Nickel Chloride	R	R	A	Propargyl Alcohol	R	V
	Nickel Nitrate	R	R	A	n-Propyl Alcohol	V	U
	Nickel Sulfate	R	R	P	Propylene Dichloride (100%)	U	U
B	Nicotine (dilute)	R	R				
	Nitric Acid (0–10%)	R	V	A	Propylene Glycol	R	V
O	Nitric Acid (10–98%)	U	U		Pyridine	R	U
O	Nitric Acid, fuming	U	U		Resorcinol	R	R
P	Nitrobenzene (100%)	U	U		Salicylic Acid	R	R
					Sea Water	R	R
P	Nitrous Oxide	R	*		Selenic Acid	R	R
					Sewage	R	R
P	n-Octane	R	R		Shortening	R	R
P	Oleic Acid	U	U		Silicic Acid	R	R
	Oxalic Acid	R	R		Silver Cyanide	R	R
O	Oxygen	R	V		Silver Nitrate Solution	R	R
O	Ozone	R	*		Silver Sulfate	R	R
					Soap Solution	R	R
O	Perchloric Acid (10–70%)	U	U				
P	Perchloroethylene	R	U				
P	Phenol	U	U				
P	Phenylhydrazine	U	U				
P	Phenylhydrazine Hydrochloride	U	U				

V -- Variable resistance U – Not resistant * -- Insufficient data Refer to text for explanation of Resistance and Caution Codes.

Chemical Resistance Data – Surlyn® Resin

Caution Code	Chemical	Chemical Resistance Code		Caution Code	Chemical	Chemical Resistance Code	
		21°C (70°F)	60°C (140°F)			21°C (70°F)	60°C (140°F)
	Sodium Acetate	R	R	P	Thionyl Chloride	U	U
	Sodium Benzoate (35%)	R	R		Titanium Tetrachloride	U	U
	Sodium Bicarbonate	R	R	P	Toluene	U	U
	Sodium Bisulfate	R	R	P	Tributylphosphate	V	V
	Sodium Bisulfite	R	R	P	Trichloroethylene	U	U
	Sodium Borate	R	R	B	Triethylene Glycol	R	V
	Sodium Bromide (dilute)	R	R		Trisodium Phosphate	R	R
	Sodium Carbonate	R	R	P	Turpentine	V	U
	Sodium Chlorate	R	R		Urea (0–30%)	R	R
	Sodium Chloride	R	R		Urine	R	R
	Sodium Cyanide	R	R	A	Vanilla Extract	R	V
	Sodium Dichromate	R	R		Vinegar	R	R
	Sodium Ferri/Ferro Cyanide	R	R	P	Vinyl Acetate	V	*
	Sodium Fluoride	R	R		Water	R	R
	Sodium Hydroxide	R	R		Water, Acid Mine	R	R
B	Sodium Hypochlorite	R	V		Water, Salt and Sea	R	R
	Sodium Nitrate	R	R		Wetting Agents	R	R
	Sodium Nitrite	R	R	A	Whiskey	R	V
O	Sodium Peroxide	R	*	B	Wines	R	V
	Sodium Sulfate	R	R	P	Xylene	R	V
	Sodium Sulfide	R	R		Yeast	R	R
	Sodium Sulfite	R	R		Zinc Bromide	R	R
P	Sour Crude Oil	R	V		Zinc Carbonate	R	R
	Stannic Chloride	R	R		Zinc Chloride	R	R
	Stannous Chloride	R	R		Zinc Nitrate	R	R
	Starch Solution	R	R		Zinc Oxide	R	R
	Stearic Acid (100%)	R	R		Zinc Stearate	R	R
P	Stoddards Solvent	R	V		Zinc Sulfate	R	R
	Sulfur	R	R				
	Sulfur Dioxide, Dry or Wet	R	V				
	Sulfuric Acid (0–30%)	R	R				
O	Sulfuric Acid (30–98%)	U	U				
O	Sulfuric Acid, fuming (oleum)	U	U				
	Sulfurous Acid	R	R				
P	Tallow	R	V				
	Tannic Acid	R	R				
	Tanning Liquors	R	R				
	Tartaric Acid	R	R				
P	Tetrahydrofuran	U	U				

V -- Variable resistance U – Not resistant * -- Insufficient data Refer to text for explanation of Resistance and Caution Codes.

DuPont Worldwide:

Americas

DuPont Packaging & Industrial
Polymers
Chesnut Run Plaza 730
974 Centre Road Wilmington,
DE 19805
Tel: +1 302 774 1000
Tel: +1 800 628 6208 ext. 6
Fax: +1 302 355 4056

DuPont do Brasil, S.A.
Alameda Itapecuru, 506
06454-080 Barueri, SP Brasil
Tel: +55 11 4166 8000
Fax: +55 11 4166 8736

Asia Pacific

DuPont China Holding Co., Ltd.
Shanghai Branch
399 Keyuan Road, Bldg. 11
Zhangjiang Hi-Tech Park
Pudong New District, Shanghai
P.R. china (Postcode: 201203)
Tel: +86 21 3862 2888
Fax: +86 21 3862 2889

Europe/Middle East/Africa

DuPont de Nemours Int'l S.A.
2, Chemin du Pavillon
P.O. Box 50
CH-1218 Le Grand Saconnex
Geneva, Switzerland
Tel: +41 22 717 51 11
Fax: +41 22 717 55 00

www.surlyn.dupont.com

The technical data contained herein are guides to the use of DuPont resins. The advice contained herein is based upon tests and information believed to be reliable, but users should not rely upon it absolutely for specific applications because performance properties will vary with processing conditions. It is given and accepted at user's risk and confirmation of its validity and suitability in particular cases should be obtained independently. The DuPont Company makes no guarantees of results and assumes no obligations or liability in connection with its advice. This publication is not to be taken as a license to operate under, or recommendation to infringe any patents.

CAUTION: Do not use in medical applications involving permanent implantation in the human body. For other medical applications, see DuPont Medical Caution Statement, H-50102.

The DuPont Oval Logo, DuPont™, The miracles of science and Surlyn® are trademarks or registered trademarks of E.I. du Pont de Nemours and Company.

