PLASKOLITE

CHEMICAL / ENVIRONMENTAL RESISTANCE

GENERAL CHEMICAL BEHAVIOR:

The chemical and environmental resistance of TUFFAK® depends on the unique combination of factors and variables it encounters in its application. Outlined below is an overview of its primary outside influencers, and common types of potential damage. A summary of laboratory tests designed to meet its practical requirements, as well as its resistance to a wide range of chemicals and substances, is also provided. Influencing parameters

TUFFAK properties are influenced chiefly by:

- The composition of chemical ingredients
- Temperature
- Duration of exposure
- The level of internal or applied stress and strain
- Types of damage

TUFFAK can sustain several distinct types of damage, including swelling, dissolution, stress cracking and molecular degradation. Circumstances under which these potential types of damage can occur are detailed below. Different chemicals may act simultaneously on TUFFAK sheet causing one or more types of damage.

DISSOLVING/SWELLING
Low-molecular, aromatic, halogenated, and polar components migrate into the polycarbonate. The damage can range from a tacky surface to complete dissolution.

STRESS CRACKING
Even in small quantities, a small number of chemicals can penetrate the surface of TUFFAK. This may result in stress cracks that affect the formed or fabricated part's appearance or mechanical properties. With transparent grades of TUFFAK, stress cracks are generally easy to detect. In opaque grades, it may be difficult to detect them. Stress cracks can act like a notch, leading to significant deterioration in several mechanical properties, particularly impact. flexural and tensile.

MOLECULAR DEGRADATION
Many of TUFFAK properties are determined by the size of its molecules. If an incompatible chemical causes a reduction in molecular weight. mechanical property degradation can occur. The molecular weight has virtually no influence on electrical properties and only a slight influence on thermal properties.

Solutions with a high pH (bases) can act to lower the molecular weight of polycarbonate. Low pH (acids) solutions typically do not degrade the molecular weight. Ammonia and amines are aggressive towards polycarbonate.

Plaskolite laboratories have tested a series of chemicals and commercial products to determine their compatibility with polycarbonate. The results of TUFFAK resistance to substances are included below.

Laboratory tests supply information on the formulation tested. The composition of many commercial products can change over time.

OXIDATIVE DAMAGE
TUFFAK is relatively stable toward oxidizing agents such as oxygen, nitric acid, and hydrogen peroxide.

TUFFAK's resistance to chemicals, common industrial cleaners, pharmaceuticals, household and cosmetic substances, is dependent on the ingredients in the product as well as the temperature and duration of exposure. The following section provides a general overview of resistance to these commonly used materials. If you require additional information, please contact your Plaskolite representative.

RESISTANCE TO SEALING COMPOUNDS, ADHESIVES AND PLASTICS

TUFFAK's resistance to sealants, adhesives and plastics is largely dependent on the presence of aggressive components, such as plasticizers (e.g., phthalates) or solvents, which can migrate into polycarbonate.

RESISTANCE TO PAINTS

Solvents in paints may cause stress cracking or swelling depending upon the solvent, the flash-off and drying conditions. It is possible to formulate paints with solvents that do not cause damage. In some applications, painting can increase the chemical resistance of the finished part. Two component paints are resistant if the individual components do not cause damage to TUFFAK in the short period between the application and curing. The SDS can be used to identify the chemical composition of the paint.

RESISTANCE TO CLEANING AND WASHING AGENTS

TUFFAK is resistant to most household soaps but not those containing amines, ammonia and sodium hydroxide.

RESISTANTCE TO DISINFECTANTS, DRUGS AND COSMETICS

TUFFAK may be damaged by disinfectants, drugs and cosmetics, which contain solvents or active ingredients that are incompatible with polycarbonate. For example, nail polish and nail polish remover will cause damage to the material. If the product ingredients are known, it is possible to estimate the compatibility with TUFFAK. However, it is recommended to put the finished part through a practical test if no data is available. Refer to the compatibility table (see below) for resistance levels.

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Testing to meet practical requirements. The compatibility information presented in this section should be used as a starting point for determining the integrity and durability of your application. Testing is essential if finished TUFFAK components are likely to encounter aggressive chemicals during sue. The internal and applied stress in a formed or fabricated part as well as duration of chemical exposure can lead to very different results.

COMPATIBILITY ASSESSMENT METHODS

The data shown in the compatibility table was generated using DIN 53499-3. This method uses test pieces of 80 x 10 x 4 mm TUFFAK sheet clamped to a curved fixture. The fixture applies a graduated strain ranging from O to 2%

ASSESSMENT CRITERIA

The information in the compatibility table is based on exposure to chemicals at 23°C and a range from 0-2% strain. Components that lead to damage with a strain of ε <1.0% are classified as incompatible. The results shown in the following tables are based on a one-time test. Change in the composition by the producers of these substances can change the results. Please contact your Plaskolite representative or the Technical Service Group at 800-628-5084 with any questions, or if you require additional information.

EXAMPLES

Solvents not resistant to – Methylene chloride/Toluene/Chloroform/Xylene
Swelling agents – Benzene/Chlorine Benzene/Acetone
Not influenced by or resistant to - diluted mineral acids, many organic acids, oxidizing or reducing agents, neutral and acid salt solutions, and waxes.

In the following table you can find the resistance of TUFFAK to chemicals and several other substances.

The test results have been obtained at samples with low internal tensions, which have been stored during 6 months in the substance at a temperature of 20 degrees C (68°F), without any mechanical load.

Apart from the nature of the substances, the chemical resistance is also depending on the concentration of the substance, the temperature during the contact, the contact time and the internal tension of the tested specimen.

This means that our products can be resistant to a number of chemical for short contracts, but are not resistant in case of long exposure, such as performed in these tests.

Therefore, it is always recommendable to execute a test under application conditions, if these differ from the test environment described above.

The tested substances have been chosen as a function of their importance in several areas. In a lot of cases it is possible to deduct results to other, chemically comparable, substances, even if these have not been tested.

Scratch resistance materials (TUFFAK® AR) show improved chemical resistance, if the sheet surface remains intact.

LEGEND

Explanation of the symbols:
+ Resistant
O Partially resistant
- Not Resistant

The results shown in the sections 2 up to 10, and especially the commercial products marked with ®, are based on a one-time test. Change in the composition by the producers of these substances can influence the product properties.

1. CHEMICALS

Chemicals	
Acetaldehyde	-
Acetic acid, up to 10% solution	+
Acetone	-
Acetylene	+
Acrylonitrile	-
Allylalcohol	O
Alum	+
Aluminum chloride, saturated aqueous solution	+
Aluminum oxalate	+
Aluminum sulphate, saturated aqueous solution	+
Ammonia	-
Ammoniacal liquor	-
Ammonium chloride, saturated aqueous solution	+
Ammonium nitrate, saturated aqueous solution	+
Ammonium sulphate, saturated aqueous solution	+
Ammonium sulphide, saturated aqueous solution	-
Amylo acetate	-
Aniline	-
Antimony chloride, saturated aqueous solution	+
Arsenic acid, 20% solution	+
Benzaldehyde	-
Benzene	-
Benzoic acid	-
Benzyl alcohol	-
Borax, saturated aqueous solution	+
Boric acid	+
Bromic benzene	-
Bromine	-
Butane (liquid or gaseous)	+
Butanol	+
Butyl acetate	-
Butylene glycol	+
Butyric acid	-
Calcium chloride, saturated aqueous solution	+
Calcium hypochloride	+
Calcium nitrate, saturated aqueous solution	+
Calcium-soap, fat/pure	+
Carbon acid, wet	+
Carbon disulphide	-
Carbon monoxide	+
Chlorine benzene	-

Chlorine gas, dry	O
Chlorine gas, wet	-
Chlorine lime slurry	+
Chlorine lime, 2% in water	+
Chloroform	-
Chrom alum, saturated aqueous solution	+
Chromic acid, 20% in water	+
Citric acid	+
Copper sulphate, saturated aqueous solution	+
Cresol	-
Cupric chloride, saturated aqueous solution	+
Cuprous chloride, saturated aqueous solution	+
Cyclo hexane	-
Cyclo hexanol	O
Cyclo hexanone	-
Dekaline	+
Diamyl phthalate	-
Dibutyl phthalate (plasticizer)	-
Diethylene glykol	+
Diethylether	-
Diglycolic acid, saturated aqueous solution	+
Dimethyl formamide	-
Dinonyl phthalate (plasticizer)	O
Dioctyl phthalate (plasticizer)	O
Dioxane	-
Diphyl 5, 3	O
Ether	-
Ethyl alcohol, 96% pure	+
Ethyl amine	-
Ethyl bromide	-
Ethylene chloride	-
Ethylene chlorohydrine	-
Ethylene glykol	+
Ferritrichloride, saturated aqueous solution	+
Ferro bisulphate	+
Formaline, 10%ig	+
Formic acid, 30%	O
Gasoline	+
Glycerine	O
Glycol	+
Heptane	+
Hexane	+
Hydrochloric acid, 20%	+
Hydrochloric acid, conc.	-
Hydrofluoric acid, 5%	+
Hydrofluoric acid, conc.	-
Hydrofluorosilicic acid, 30%	+
Hydrogen peroxide, 30%	+
Hydrogen sulphide	+
Iodine	-
Isoamyl alcohol	O
Isopropyl alcohol	+
Lactic acid, 10% in water	+
Lead tetraethylene, 10% in gasoline	O
Lighting gas	+
Ligroin (hydrocarbon compound)	+
Lime milk, 30% in water	O
Magnesium chloride, saturated aqueous solution	+
Magnesium sulphate, saturated aqueous solution	+
Manganous sulphate, saturated aqueous solution	+
Mercuro chloride, saturated aqueous solution	+
Mercury	+
Methacrylic acid	-
Methane	+
Methanol	-
methyester (MMA)	-

Methyl amine	-
Methyl ethyl ketone (MEK)	-
Methylene chloride	-
Nitric acid, 10%	+
Nitric acid, 10-20%	O
Nitric acid, 20%	-
Nitric Gas, dry	-
Nitrobenzene	-
Oxalic acid, 10% in water	+
Oxygen	+
Ozone	+
Pentane	+
Perchloric acid, 10% in water	+
Perchloric acid, concentrated	O
Perchloro ethylene	-
Perhydrol, 30%	+
Petroleum	O
Petroleum ether	O
Petroleum spirit	+
Phenol	-
Phenyl ethyl alcohol	-
Phosphor trichloride	-
Phosphoric acid, conc.	+
Phosphoric oxichloride	-
Potassium aluminum sulpate, saturated aqueous solution	+
Potassium bichromate, saturated aqueous solution	+
Potassium bromide, saturated aqueous solution	+
Potassium carbonate, saturated aqueous solution	+
Potassium chloride, saturated aqueous solution	+
Potassium cyanide	-
Potassium hydroxide	-
Potassium metabisulphide, 4% in water	+
Potassium nitrate, saturated aqueous solution	+
Potassium perchlorate, 10% in water	+
Potassium permanganate, 10% in water	+
Potassium persulphate, 10% in water	+
Potassium rhodanide, saturated aqueous solution	+
Potassium sulphate, saturated aqueous solution	+
Propane gas	+
Propargyl alcohol	+
Propionic acid, 20%	+
Propionic acid, conc.	-
Propyl alcohol	+
Pyridine	-
Resorcin oil solution, 1%	+
Soda	+
Sodium bicarbonate, saturated aqueous solution	+
Sodium bisulphate, saturated aqueous solution	+
Sodium bisulphide, saturated aqueous solution	+
Sodium carbonate, saturated aqueous solution	+
Sodium chlorate, saturated aqueous solution	+
Sodium chloride, saturated aqueous solution	+
Sodium hydroxide	-
Sodium hypochloride, 5% in water	+
Sodium sulphate, saturated aqueous solution	+
Sodium sulphide, saturated aqueous solution	O
Styrene	-
Sublimate, saturated aqueous solution	+
Sulphur	+
Sulphur dioxide	O
Sulphuric acid, 50%	+
Sulphuric acid, 70%	O
Sulphuric acid, conc.	-
Sulphurous acid, 10%	-
Sulphuryl chloride	-

Tartaric acid, 10%	+
Tetrachlorocarbon	-
Tetrachloroethane	-
Tetrahydrofurane	-
Tetraline	-
Thiophene	-
Toluene	-
Trichloro acetic acid, 10%	O
Trichloroethyl amine	-
Trichloroethyl phosphate (plasticizer)	O
Trichloroethylene	-
Tricresyl phosphate (plasticizer)	-
Urea, saturated aqueous solution	+
Water	+
Xylene	-
Zinc chloride, saturated aqueous solution	+
Zinc oxide	+
Zinc sulphate, saturated aqueous solution	+

2. DISINFECTANTS

Disinfectants	
Baktol®, 5%	+
Carbolic acid	-
Chloroamine	+
DDT	-
Delegol ®, 5%	+
Dimamin T, 5%	O
Hydrogen peroxide	+
Iodine tincture	O
Lysoform, 2%	+
Maktol ®	+
Merfen ®, 2%	+
Oktozon ®, 1%	+
Perhydrol	+
Resorcinol solutions, 1%	+
Sagrotan ®, 5%	O
Spirit, pure	+
Sublimate	+
TB-Lysoform	-
Trosilin G extra ®, 1, 5%	+
Zephirol ®	O

3. PHARMACEUTICS, COSMETICS

Pharmaceutics, Cosmetics	
Blood plasma	+
Delial-Sunmilk ®	+
Hydroplex	+
Iodine tincture	O
Klosterbalsam	+
Lanoline	+
Menthol, 90% in Alcohol	O
Nail polish	-
Nail polish remover	-
Odol-mouthwater ®	+
Periston blood substitute ®	+
Vaseline	+
Vick-Vaporub ®	+

4. NUTRITION

Nutrition	
All-spice	-
Apple juice	+
Beef sebum	+
Beer	+
Beets syrup	+

Brandy, 38%	+
Butter	+
Chocolate	+
Cinnamon	+
Clove	-
Cod-liver oil	+
Coffee	+
Common salt	+
Fish	+
Fruit juice	+
Fruit syrup (Raspberry)	+
Gherkins	+
Grape sugar	+
Grapefruit juice	+
Juniper berry	+
Lard	O
Linseed oil	+
Liquor	+
Margarine	+
Meat	+
Milk	+
Mineral water	+
Mustard	+
Nutmeg	-
Onion	+
Orange juice	+
Paprika	+
Pepper	+
Rum	+
Salad oil	+
Syrup	+
Sugar solution, saturated aqueous solution	+
Tea	+
Tobacco	+
Tomato juice	+
Tomato puree	+
Vanilla	+
Vegetable juice	+
Vegetable oils	+
Vinegar	+
Vodka	+
Water	+
Wine	+
Worcester-Sauce	+

5. WASHING and CLEANING AGENTS

Washing and cleaning agents	
Household soap	+
Top Job, Joy®	+
Palmolive Liquid®	+

6. TECHNICAL OILS AND FATS

Technical oils and fats	
Camphor oil	-
Castor oil	+
Cod-liver oil	+
Drilling oil	-
Fish oil	+
Fuel oil	O
Lubricant based on paraffin	+
Paraffin oil	+
Sodium soap fat	+

7. MISCELLANEOUS

Miscellaneous	
Battery acid	+
Blood	+
Castor oil	+
Cement	+
Freon ® 113	+
Gasoline	O
Natural rubber	+
Oleic acid, conc.	+
Polishing wax	+
Polyethylene	+
Polyvinylchloride, (containing plasticizer)	O
Sea water	+
Starch	+
Weak acid >4.7 pH	+
Weak base <9.5 pH	O
Tannic acid	-

DISCLAIMER:

These suggestions and data are based on information we believe to be reliable. They are offered in good faith, but without guarantee, as conditions and methods of use are beyond our control. We recommend that the prospective user determine the suitability of our materials and suggestions before adopting them on a commercial scale.