Enclosure Materials

Chemical Resistance Specifications

The choice of material is dependent on the concentration of various corrosives present in the application environment and other physical properties necessary to meet the design specifications.

To begin the selection process, one must consider the general atmosphere as well as the corrosive agents which can be present in an application. Defining the corroding agents and determining the concentration can be a complex process. Usually several corrosive elements are present and interactions are not always well documented.

Water (and water states such as ice, snow, mist, fog, vapor) is the most common corrosive and is usually present to some extent in every enclosure application. Each environment is unique and all possible corrosive agents should be identified for the intended enclosure application.

To select the best enclosure material for an application; chemical resistance, physical strength and economic data are presented in several tables beginning on the next page. In Table 1 enclosure materials are rated on a continuum from “Recommended” to “Limited or Unacceptable” in three broad categories of chemicals. Since the chemical resistance categories in the table are extremely broad, some materials may perform well in specific corrosive environments within a general category and it is best to consult the detailed Chemical Resistance Information provided in Table 3.

Besides the enclosure material, the corrosion resistance of windows, gaskets, latches, etc. must also be considered. Table 4 provides corrosion resistance information that can be used to select the commonly used materials for these features.

Much of the chemical resistance information in Table 3 is based on total immersion testing in the chemical for a minimum of 30 days at 72° F. Some fiberglass test specimens were evaluated using procedures outlined in ASTM D 543, Test Method for Resistance of Plastics to Chemical Reagents.

The information in these tables is intended as a guide only. Total immersion testing is considered quite severe and **the results may not necessarily reflect the performance under actual field conditions.** The user assumes responsibility for selection of the material based on the characteristics of the application environment.

Stahlin Enclosure Back Panel Construction Materials

Fiberglass (FG)

Fiber reinforced polymer made of a plastic matrix reinforced by fine fibers made of glass. The plastic matrix is a thermosetting plastic made of polyester.

Carbon Steel (CS)

A low carbon, rolled steel produced by passing bar stock through a set of rolls. Stahlin CS back panels are powder coated for appearance and protection.

Stainless Steel (SS)

Stainless steel is defined as a steel alloy with a minimum of 11% chromium content by mass. Stainless steel is used where both the properties of steel and resistance to corrosion are required. Stahlin hardware and SS back panels are fabricated utilizing 3000 series stainless steel.

Aluminum (AL)

A lightweight metal that quickly forms a natural oxide layer to resist corrosion. Stahlin fabricates back panels from Type 3003 H14 Aluminum, the highest strength non-heat treatable aluminum alloy recommended for marine applications.

TABLE 1. Broad Categories of Enclosure Material Chemical Resistance

CONTINUUM OF USE	GENERAL CATEGORY OF CHEMICALS		
	ACIDS	ALKALINES	SOLVENTS
↓			Fiberglass
↓	Stainless Steel	Fiberglass	Stainless Steel
Recommended		Stainless Steel	Aluminum
↓	Fiberglass		Powder Coated Steel
↓			
Acceptable	PC	PC	Galvanized Steel
↓	PVC	Galvanized Steel	
↓	Powder Coated Steel	Powder Coated Steel	
Limited or Unacceptable			
↓	Aluminum	PVC	PC
↓	Galvanized Steel	Aluminum	PVC

Appendix

TABLE 2. Relative Material Strength and Cost Comparison of Commonly Used Enclosure Materials

MATERIAL	RELATIVE PHYSICAL STRENGTH	RELATIVE COST	APPLICATION CONDITIONS	TEMPERATURE LIMITATIONS
Aluminum	Average	Average	Indoor and Outdoor, Marine, Solvents, Petrochemical Sulfates, Nitrates and Specific Acids.	None for enclosure applications
Fiberglass	Average	Low-Average	Indoor and Outdoor for continuously damp and highly corrosive environments. PetroChem, Water Treatment, Food Processing, Coating, Salts and Chemicals, Solar.	-40°F(C) to 250°F(121°C) -76°F to 274°F (-60°C to 134°C)
Mild Steel: Galvanized Painted	High	Average Low	Indoor and Outdoor where the respective coating provides acceptable protection in a mildly corrosive environment.	None for enclosure applications
Stainless Steel	High	Average-High	Indoor and Outdoor in highly corrosive applications. Food and Dairy Processing or Marine.	None for enclosure applications
Acrylic	Average	Low	Enclosure Windows. Weatherable, Scratch Resistant. Good resistance to Solvents	-31°F (-35°C) to 180°F (82°C)
Polycarbonate	Average	Low-Average	Enclosure Windows. Not recommended for direct sunlight, exposure to organic solvents and concentrated alkalis.	-31°F (-35°C) to 248°F (120°C)
Nylon	Average	Low	Cord Grip, Hinges, Latches	-22°F (-30°C) to 212°F (100°C)
Gaskets: Neoprene Silicone Urethane	Low Low Low	Low Average Average	Oil Resistance. Seams may be a problem Oil Resistance Temperature & Chemical Resistance. Water and Oil Resistance, Chemical Resistance.	-40°F (C) to 225°F (107°C) -40°F (-40°C) to 350°F (175°C) -40°F (C) to 200°F (93°C)

Detailed material strength information is beyond the scope of this catalog and should be obtained from a materials reference; however, Table 2 provides some relative data to help with this selection.

TABLE 3 & 4. KEY:

S = Superior Resistance/Completely Unaffected under all Conditions
L = Limited Resistance, Some Chemical Attack May Occur Over Time
M = Moderate Resistance, Superficial Effects only, Testing Recommended
U = Unsatisfactory, Severe/Chemical Attack in a relatively short time
– = No Data Available

TABLE 3. Chemical Resistance of Fiberglass Materials and Enclosure Accessories

			STEEL			STAINLESS STEEL			
CHEMICAL	ALUMINUM	FIBER GLASS POLYESTER	POLYESTER POWDER	URETHANE ENAMEL	GALVANIZED	TYPE 304	TYPE 316	PC	PVC
Acetyldehyde	S	U	—	—	—	S	S	U	U
Acetic Acid (10%)	L	S	U	U	U	S	U	S	U
Acetone	S	L	L	U	L	S	S	U	U
Aluminum Chloride (10%)	U	S	U	U	U	U	M	S	S
Aluminum Sulfate (10%)	L	S	U	U	U	U	S	S	S
Ammonia Gas	L	S	—	—	—	S	S	—	—
Ammonium Chloride	U	S	U	U	U	S	S	S	S
Ammonium Hydroxide (10%)	S	L	U	U	U	S	S	U	S

TABLE 3. Chemical Resistance of Fiberglass Materials and Enclosure Accessories

CHEMICAL	ALUMINUM	FIBER GLASS POLYESTER	STEEL			STAINLESS STEEL		PC	PVC
			POLYESTER POWDER	URETHANE ENAMEL	GALVANIZED	TYPE 304	TYPE 316		
Ammonium Nitrate (10%)	M	S	U	U	U	S	S	U	S
Ammonium Phosphate (10%)	L	M	S	L	U	S	M	S	—
Ammonium Sulfate	S	S	—	—	—	S	S	S	S
Aniline	L	U	—	—	—	S	S	U	L
ASTM #1 Oil	S	S	S	S	S	S	S	L	—
ASTM #3 Oil	S	S	S	S	S	S	S	L	—
Axle Grease	S	S	S	S	S	S	S	L	—
Benzene	S	S	—	—	S	S	S	U	L
Boric Acid (10%)	M	S	U	U	U	S	S	S	L
Bromine	U	L	U	U	U	U	U	U	U
Butyl Acetate	M	L	—	—	—	S	S	U	U
Butyric Acid	U	S	—	—	—	S	S	U	U
Calcium Chloride (10%)	L	S	U	U	U	L	S	S	L
Calcium Hydroxide (10%)	U	S	U	U	U	S	S	S	L
Calcium Hypochlorite (10%)	L	M	U	U	U	U	M	L	L
Calcium Sulfate	M	S	U	U	U	S	S	S	L
Carbolic Acid (25%)	M	L	U	U	U	S	S	U	
Carbon Disulfide	S	L	—	—	—	S	S	U	U
Carbon Tetrachloride	S	M	U	S	S	U	S	U	
Chlorine (dry)	S	S	—	—	—	S	S	U	U
Chlorine (water) 5-10 ppm	M	L	S	U	U	U	—	S	S
Chlorobenzene	S	S	—	—	S	S	S	U	
Chloroform	L	U	—	—	—	S	S	U	U
Chrome Plating Solution	U	L	U	U	U	L	L	S	—
Chromic Acid	S	S	—	—	—	U	U	U	U
Citric Acid (10%)	U	M	U	U	U	S	S	S	L
Copper Sulfate	U	S	—	—	—	S	S	S	S
Creosote	L	L	—	—	—	S	S	U	—
Cutting Fluid (5 Star) 10%	S	S	U	U	U	S	S	L	—
Cutting Fluid (Castrol 980 H)	S	S	S	U	U	S	S	L	—
Cutting Fluid (Norton 205)	U	S	U	U	U	S	S	S	—
Cutting Fluid (Rustlick) 10%	M	S	U	U	U	S	S	S	—
Cutting Oil (Dark)	S	S	S	S	S	S	S	S	—
Diethyl Ether	S	S	—	—	—	S	S	U	U
Ethyl Alcohol	S	S	M	U	S	S	S	M	S
Ethylene Dichloride	S	L	—	—	—	—	—	U	U
Ethylene Glycol	S	S	S	S	U	S	S	S	S

TABLE 3. Chemical Resistance of Fiberglass Materials and Enclosure Accessories

CHEMICAL	ALUMINUM	FIBER GLASS POLYESTER	STEEL			STAINLESS STEEL		PC	PVC
			POLYESTER POWDER	URETHANE ENAMEL	GALVANIZED	TYPE 304	TYPE 316		
Ferric Chloride	U	S	U	U	U	S	U	S	S
Ferric Nitrate	—	S	—	—	—	S	S	S	S
Ferric Sulfate	M	S	—	—	—	S	S	S	S
Fluorine	S	U	—	—	—	M	—	L	U
Formaldehyde	S	S	—	—	—	L	S	S	L
Formic Acid	U	S	U	U	U	M	S	S	—
Fuel Oil (#2)	S	S	M	S	S	S	M	L	S
Gasoline	S	M	—	—	—	S	S	U	S
Glycerine	S	S	—	—	S	S	S	S	S
Hydraulic Brake Fluid	S	S	U	U	S	S	S	U	—
Hydraulic Oil	S	S	S	S	S	S	S	L	S
Hydrochloric Acid (10%)	U	M	U	U	U	U	U	S	S
Hydrocyanic Acid	S	U	—	—	—	S	S	L	L
Hydrofluoric Acid (20%)	U	U	U	U	U	U	U	L	L
Hydrogen Peroxide	S	M	—	—	—	L	S	S	S
Hydrogen Sulfide	M	S	—	—	—	L	S	L	L
Hypochlorus Acid	U	S	—	—	—	—	—	—	—
Isopropyl Alcohol	S	S	M	U	S	S	S	S	—
Kerosene	S	S	S	S	S	S	S	L	S
Lacquer Thinner	S	S	L	U	S	S	S	U	U
Lactic Acid	M	S	—	—	—	L	S	L	L
Lime	M	M	—	—	—	—	—	—	L
Liquid Dish Soap (10%)	M	S	U	U	U	S	M	S	S
Lubricating Oils	S	S	—	—	—	S	S	S	—
Magnesium Chloride (10%)	L	S	U	U	U	S	S	S	L
Magnesium Hydroxide (10%)	L	S	U	U	U	S	S	S	S
Mercuric Chloride (10%)	U	M	U	U	U	S	U	S	L
Methyl Ethyl Ketone	S	L	—	—	—	S	S	U	U
Methylene Chloride	S	S	U	U	M	S	S	U	U
Milk	S	S	—	—	—	S	S	S	S
Mineral Oil	S	S	—	—	—	S	S	S	S
Mineral Spirits	S	S	S	S	S	S	S	L	S
Motor Oil (10 weight)	S	S	S	S	S	S	S	S	L
Nickel Salts	L	S	—	—	—	L	S	S	S
Nitric Acid (10%)	U	M	U	U	U	S	S	L	S
Nitrobenzene	S	L	—	—	—	S	S	U	U
Oleic Acid	S	S	—	—	—	L	S	S	L

TABLE 3. Chemical Resistance of Fiberglass Materials and Enclosure Accessories

CHEMICAL	ALUMINUM	FIBER GLASS POLYESTER	STEEL			STAINLESS STEEL		PC	PVC
			POLYESTER POWDER	URETHANE ENAMEL	GALVANIZED	TYPE 304	TYPE 316		
Perchlorethylene	S	S	S	U	S	S	S	U	L
Phosphoric Acid (25%)	U	L	U	U	U	S	S	S	S
Phosphoric Acid (50%)	U	U	U	U	U	S	S	S	S
Pickling Solution	U	M	U	U	U	S	M	S	—
Potassium Carbonate (10%)	U	S	S	S	L	S	S	S	L
Potassium Chloride (25%)	L	S	U	U	U	S	S	S	S
Potassium Hydroxide (25%)	U	U	U	U	U	M	M	U	S
Potassium Nitrate (10%)	U	S	U	U	U	S	S	S	S
Potassium Sulfate (10%)	L	S	U	U	U	S	S	S	L
Soap (Igepal) 10%	L	S	S	U	U	S	S	S	S
Sodium Bicarbonate (10%)	L	S	S	S	U	S	S	S	S
Sodium Bisulfate (10%)	U	L	U	U	U	S	S	S	S
Sodium Chloride (25%)	L	S	U	U	U	S	S	S	S
Sodium Hydroxide	U	U	U	U	U	M	M	U	S
Sodium Hypochlorite	U	M	U	U	U	S	M	L	S
Sodium Nitrate (10%)	M	S	U	U	U	S	S	S	S
Sodium Phosphate (10%)	L	S	U	U	U	S	S	S	S
Sulfuric Acid (25%)	U	S	U	U	U	S	S	S	S
Sulfurus Acid (10%)	U	U	U	U	U	S	S	S	S
Tannic Acid ((10%)	L	S	U	U	U	M	M	S	S
Tetrahydrofuran	M	L	U	U	U	S	S	U	U
Toluene	S	S	L	U	S	S	S	U	U
Trichloroethylene	S	U	—	—	—	L	S	U	U
Trisodium Phosphate	L	M	—	—	—	—	—	S	S
Turpentine	S	M	M	U	L	S	S	S	U
Vegetable Oils	S	S	—	—	—	S	S	S	S
Vinegar	M	S	—	—	—	S	S	S	L
Water, Industrial	L	S	L	L	L	S	S	S	S
Water, Rain	L	S	S	L	L	S	S	S	—
Water, Sea	L	S	U	U	U	S	S	S	S
Water, Tap	L	S	S	L	L	S	S	S	S
Xylene	S	S	L	U	S	S	S	U	U
Zinc Acetate	S	S	—	—	—	S	S	—	—
Zinc Chloride	L	S	S	U	U	M	S	M	L
Zinc Sulfate	S	S	—	—	—	M	S	S	S

Sources: Robroy Industries Reagent Testing Lab, Corrosion Resistant Materials Handbook, 4th Edition, Noyes Data Corp., Raw Material Vendors.

TABLE 4. Specific Chemical Resistance Information Other Materials Used for Enclosure Features

			GASKETS			WINDOWS	
CHEMICAL	RIGID PVC	GLASS NYLON	NEOPRENE RUBBER	SILICONE RUBBER	URETHANE	ACRYLIC	POLYCARBONATE
Acetyldehyde	U	—	S	S	—	—	—
Acetic Acid (10%)	L	U	U	M	L	S	S
Acetone	U	S	U	S	U	U	U
Aluminum Chloride (10%)	S	U	S	S	S	S	S
Aluminum Sulfate (10%)	S	L	U	S	S	S	S
Ammonia Gas	—	S	S	S	—	S	—
Ammonium Chloride	S	U	S	S	S	S	S
Ammonium Hydroxide (10%)	S	—	L	L	S	S	U
Ammonium Nitrate (10%)	S	U	U	S	S	S	U
Ammonium Phosphate (10%)	—	L	U	S	S	S	S
Ammonium Sulfate	S	U	S	S	—	—	—
Aniline	S	L	U	U	—	S	—
ASTM #1 Oil	—	—	M	S	S	S	M
ASTM #3 Oil	—	—	U	L	S	S	M
Axle Grease	—	—	L	S	S	S	M
Benzene	U	S	U	U	—	U	—
Boric Acid (10%)	L	S	S	S	S	S	S
Bromine	U	U	U	U	U	L	U
Butyl Acetate	U	S	U	U	—	U	—
Butyric Acid	U	U	U	—	—	—	—
Calcium Chloride (10%)	S	U	S	S	S	S	S
Calcium Hydroxide (10%)	S	—	U	S	L	S	S
Calcium Hypochlorite (10%)	S	U	U	S	U	M	S
Calcium Sulfate	S	U	S	S	S	S	S
Carbolic Acid (25%)	—	—	U	U	U	U	U
Carbon Disulfide	U	—	U	—	—	S	—
Carbon Tetrachloride	L	S	U	U	U	S	U
Chlorine (dry)	L	—	—	—	—	—	—
Chlorine (water) 5-10 ppm	L	—	L	S	S	S	S
Chlorobenzene	U	S	U	U	—	L	—
Chloroform	U	U	U	U	—	U	—
Chrome Plating Solution	—	—	U	U	U	S	S
Chromic Acid	L	U	U	M	—	U	—
Citric Acid (10%)	S	L	U	S	U	S	S
Copper Sulfate	S	L	S	S	—	U	—
Creosote	—	U	U	U	—	—	—
Cutting Fluid (5 Star) 10%	—	—	U	S	S	S	M
Cutting Fluid (Castrol 980 H)	—	—	L	S	S	S	L
Cutting Fluid (Norton 205)	—	—	S	S	S	S	S

TABLE 4. Specific Chemical Resistance Information Other Materials Used for Enclosure Features

			GASKETS			WINDOWS	
CHEMICAL	RIGID PVC	GLASS NYLON	NEOPRENE RUBBER	SILICONE RUBBER	URETHANE	ACRYLIC	POLYCARBONATE
Cutting Fluid (Rustlick) 10%	—	—	S	S	S	S	S
Cutting Oil (Dark)	—	—	U	S	S	S	S
Diethyl Ether	U	—	—	U	—	U	—
Ethyl Alcohol	S	—	L	S	S	U	M
Ethylene Dichloride	U	—	U	U	—	U	—
Ethylene Glycol	S	—	S	S	S	S	S
Ferric Chloride	S	U	L	S	L	S	S
Ferric Nitrate	S	U	S	M	—	—	—
Ferric Sulfate	S	U	S	M	—	—	—
Fluorine	L	—	—	U	—	—	—
Formaldehyde	L	U	U	M	—	S	—
Formic Acid	L	S	U	L	L	U	S
Fuel Oil (#2)	S	—	U	U	U	S	S
Gasoline	S	S	U	L	—	S	—
Glycerine	S	S	S	S	—	S	—
Hydraulic Brake Fluid	—	—	U	S	U	U	U
Hydraulic Oil	—	—	U	S	S	S	M
Hydrochloric Acid (10%)	S	U	L	L	U	S	S
Hydrocyanic Acid	S	—	S	M	M	—	—
Hydrofluoric Acid (20%)	L	U	U	U	—	S	M
Hydrogen Peroxide	S	U	U	M	—	S	—
Hydrogen Sulfide	S	—	U	M	—	—	—
Hypochlorus Acid	—	—	—	—	—	—	—
Isopropyl Alcohol	—	—	S	S	S	S	S
Kerosene	S	—	U	U	S	S	M
Lacquer Thinner	—	S	U	S	L	U	U
Lactic Acid	S	L	L	—	—	L	—
Lime	—	—	S	M	—	—	—
Liquid Dish Soap (10%)	S	—	L	S	S	S	S
Lubricating Oils	—	—	U	U	—	S	—
Magnesium Chloride (10%)	S	S	S	S	S	S	S
Magnesium Hydroxide (10%)	S	—	S	S	S	S	S
Mercuric Chloride (10%)	L	—	U	L	U	S	S
Methyl Ethyl Ketone	U	S	S	U	—	L	—
Methylene Chloride	—	U	U	S	U	U	U
Milk	S	—	S	S	—	S	—
Mineral Oil	S	—	L	M	—	S	—
Mineral Spirits	—	—	U	U	S	S	M
Motor Oil (10 weight)	—	—	U	U	S	S	S

TABLE 4. Specific Chemical Resistance Information Other Materials Used for Enclosure Features

			GASKETS			WINDOWS	
CHEMICAL	RIGID PVC	GLASS NYLON	NEOPRENE RUBBER	SILICONE RUBBER	URETHANE	ACRYLIC	POLYCARBONATE
Nickel Salts	S	—	U	S	—	—	—
Nitric Acid (10%)	S	U	U	U	U	S	L
Nitrobenzene	U	S	U	—	—	—	—
Oleic Acid	S	U	—	U	—	—	—
Perchlorethylene	—	—	U	S	U	U	U
Phosphoric Acid (25%)	S	U	S	S	U	S	S
Phosphoric Acid (50%)	S	U	S	S	U	S	S
Pickling Solution	—	—	L	M	M	S	S
Potassium Carbonate (10%)	L	S	S	S	S	S	S
Potassium Chloride (25%)	S	L	S	S	S	S	S
Potassium Hydroxide (25%)	S	S	U	L	M	U	U
Potassium Nitrate (10%)	S	L	S	S	S	S	S
Potassium Sulfate (10%)	SL	S	S	S	S	S	S
Soap (Igepal) 10%	S	—	U	S	S	S	S
Sodium Bicarbonate (10%)	S	S	S	S	S	S	S
Sodium Bisulfate (10%)	S	L	S	S	L	S	S
Sodium Chloride (25%)	S	S	S	S	S	S	S
Sodium Hydroxide	S	S	U	U	M	S	U
Sodium Hypochlorite	S	U	U	S	U	S	S
Sodium Nitrate (10%)	S	S	S	S	S	S	S
Sodium Phosphate (10%)	S	—	U	S	S	S	S
Sulfuric Acid (25%)	S	U	S	S	U	S	S
Sulfurus Acid (10%)	S	—	U	U	L	S	S
Tannic Acid ((10%)	S	U	U	L	U	S	S
Tetrahydrofuran	—	S	U	U	U	U	U
Toluene	U	S	U	U	U	U	U
Trichloroethylene	U	U	U	U	—	U	—
Trisodium Phosphate	S	—	—	—	—	—	—
Turpentine	—	S	U	L	U	S	S
Vegetable Oils	S	—	L	S	—	S	—
Vinegar	—	S	L	S	—	S	—
Water, Industrial	S	—	S	S	S	S	S
Water, Rain	S	—	S	S	S	S	S
Water, Sea	S	—	S	S	S	S	S
Water, Tap	S	—	S	S	S	S	S
Xylene	—	S	U	M	U	S	U
Zinc Acetate	—	—	—	U	—	—	—
Zinc Chloride	S	U	M	S	U	S	M
Zinc Sulfate	S	L	S	S	—	—	—

Sources: Robroy Industries Reagent Testing Lab, Corrosion Resistant Materials Handbook, 4th Edition, Noyes Data Corp., Raw Material Vendors.