

ENVIRONMENTAL PROPERTIES OF POLYURETHANE

Aside from the excellent load bearing capacity and abrasion resistance of molded polyurethane; the material also stands up very well in a large variety of environments. The polyurethane parts made here at Gallagher Corporation are shipped all over the world and withstand the wide variety of environmental conditions they encounter. This part of the engineering guide is provided to you as a snapshot of some of the different operating conditions where molded polyurethanes are typically used. Have an application not listed? Feel free to contact us to discuss your specific needs and find out what we can provide to exceed your expectations.

LOW-TEMPERATURE PERFORMANCE

One particular area where molded polyurethane excels past over elastomers is its resistance to cold temperatures. Molded polyurethane remains flexible at very low temperatures and possesses outstanding resistance to thermal shock. Many of the polyurethanes used here at Gallagher do not become brittle at temperatures below -80°F (-62°C) although stiffening gradually increases as the temperature is reduced below 0°F (-18°C). Special compositions can be made which retain some flexibility at temperatures as low as -125°F (-87°C).

HIGH-TEMPERATURE PERFORMANCE

Molded polyurethane can be formulated for many continuous service applications at temperatures from 185°F to 250°F (85°C to 121°C). As you can see in Table 1, holding a typical compound for one week at 250°F (121°C) causes only a minor decrease in physical properties when tested at 75°F (24°C).

Table 1: Effect of Exposure to Elevated Temperature on Properties of GC1090

(All measurements made at room temperature)

	Original	After 1 Wk. at 212°F (100°C)	After 3 Wks. at 212°F (100°C)	After 1 Wk at 250°F (121°C)
100% Modulus, psi (MPa) (ASTM D142-61T)	1,100 (7.6)	1,070 (7.4)	950 (6.6)	900 (6.2)
Tensile Strength, psi (MPa) (ASTM D142-61T)	4,500 (31.3)	4,500 (31.3)	4,300 (29.5)	2,750 (18.9)
Elongation at Break, % (ASTM D142-61T)	450	520	610	780
Hardness, Durometer A (ASTM D142-61T)	90	90	89	88

Table 2: Properties of GC1090 at Normal and Elevated Temperatures

	Measured at 75°F (24°C)	Measured at 212°F (100°C)	Measured at 250°F (121°C)
100% Modulus, psi (MPa) (ASTM D142-61T)	975 (6.7)	775 (5.3)	775 (5.3)
Tensile Strength, psi (MPa) (ASTM D142-61T)	4,000 (27.6)	2,800 (19.3)	1,500 (10.3)
Elongation at Break, % (ASTM D142-61T)	440	480	350

The one true Achilles Heel of molded polyurethane is heat. Because of this, it's not recommended to use molded polyurethane for applications above 250°F (121°C). Recent advancements in PPDI urethane technology have pushed the upper limits to 300°F (150°C) for certain urethane parts. For applications in environments between 212°F and 300°F (100°C and 150°C) it's best to individually evaluate the part and conduct some application testing beforehand.

RESISTANCE TO AGING

Gallagher Corp processes several different types of polyurethane elastomers. Some of these elastomers are mildly susceptible to breaking down with age and others are extremely resistant to aging. Gallagher Corp polyurethane can be blended such that the passage of time under static, room temperature conditions has little effect. It's always a good idea to let the team at Gallagher know whether a part will be stored prior to use and what the desired service life should be. The polyurethane compounds that do deteriorate with time make up for this in other areas. This is a relationship that should be taken into account when making material selections.

The introduction of other factors can accelerate deterioration. It's well known that increasing temperature will promote chemical changes in organic materials, in polyurethane; this influence is reflected in a progressive loss in physical properties. Heat aging effects representative of Gallagher Corp polyurethane are shown in Table 1.

Dynamic forces or chemical agents acting upon a product over a period of time can also intensify the aging process. However, in such multiple attacks, the effects strictly due to aging may be so masked as to become unrecognizable.

WATER RESISTANCE

Gallagher Corp polyurethane is resistant to swelling and deteriorating effects of immersion in water and has excellent long-term stability in water at temperatures as high as 122°F (50°C). We have some formulations that can withstand higher temperatures. The chart below shows that after immersion in water for as long as one year at 122°F (50°C), a typical compound retained 76 percent of its original strength. The same degree of water resistance is exhibited in exposures where water is present in a mixture or an emulsion with oil.

WEATHERABILITY AND COLOR STABILITY

Polyurethane elastomers will darken and their physical properties will be reduced by prolonged exposure to ultraviolet light. They can be protected against the effects of weathering by pigmentation or by using ultraviolet screening agents. Always be sure to alert the team at Gallagher if your part will be used in direct sunlight so that we can adjust the compound accordingly with UV inhibitors.

MOLD, MILDEW, FUNGUS RESISTANCE

Most high-performance polyurethane elastomers do not support fungus growth and are generally resistant to fungus attack and mildew growth. Certain compounds that could possibly be susceptible to fungus attack can be protected by the addition of commercial fungicides.

RADIATION RESISTANCE

Polyurethanes typically perform quite well when subjected to radiation. Following an independent test, it was concluded molded polyether polyurethane products appear capable of giving satisfactory service even when exposed to relatively large gamma ray exposure of 1×10^9 Roentgens. Polyurethane is more resistant than other elastomers to stress cracking and retains a greater amount of flexibility and physical toughness while exposed to gamma radiation.

OUTGASSING

Products made from polyurethane are very stable under high-vacuum conditions. They exhibit extremely low weight losses in standard outgassing tests. If you have an application where outgassing carries the potential for problems, we can easily provide compounds without additives of any type.

FLAME RESISTANCE

Parts made by molding polyurethane have limited resistance to burning. A modest improvement in this characteristic can be achieved by special compounding. However, in an actual fire situation, even those products will ignite. Whether or not to use polyurethane where fire safety considerations influence design is a matter of practical evaluation of the potential hazards involved in each specific case.

OXYGEN AND OZONE RESISTANCE

Oxygen and Ozone in atmospheric concentrations have no observable effect on molded polyurethane parts. Samples exposed to 300 pphm ozone under static strain conditions for 500 hours, for example, show no signs of surface cracking

or crazing. Stress-strain properties of polyurethane are little changed after oxygen bomb exposure for four weeks at 158°C (70°C) under 300 psi (2.1 MPa) oxygen pressure.

OIL, CHEMICAL AND SOLVENT RESISTANCE

Polyurethane has excellent oil which makes its products particularly suited for service in lubricating oils. Aromatic hydrocarbons and polar solvents have a moderate to severe effect on polyurethanes. Typical chemical resistance information is shown below.

OIL AND CHEMICAL RESISTANCE OF POLYURETHANES

Need to know which Urethane has the best oil or chemical resistance for your application? Here is a partial list of oil and chemical media to which Gallagher Corporation polyurethanes have been subjected. This data was obtained on small billets totally immersed. Always test specific compounds under your particular field conditions.

Note: Unless otherwise stated, all immersion test data was generated at room temperature. Elevated temperatures usually increase the fluid's effect on the urethane. If you have a specification not listed, contact us. We have more test results on file.

KEY:

A = No or Little Effect B = Moderate Effect C = Probably Unsatisfactory D = Unsatisfactory

FLUID	RATING	FLUID	RATING
ACETIC ACID, 30%	C	ACETONE	D
AMMONIUM HYDROXIDE	B	AMMONIUM NITRATE	D
ANIMAL FATS	A	ASPHALT	B
ASTM REF. FUEL NO. 1 (BELOW 158°F)	A	ASTM OIL NO. 3 (BELOW 158°F)	B
ASTM REF. FUEL A	A	ASTM REF. FUEL B	B
ASTM REF. FUEL C	C	BARIUM CHLORIDE	A
BARIUM SULFATE	A	BARIUM SULFIDE	A
BORIC ACID	A	BUTANE	A
BUTTER	A	BUNKER OIL	B
CALCIUM CHLORIDE	A	CALCIUM HYDROXIDE	A
CALCIUM NITRATE	A	CARBON DIOXIDE	A
CARBON MONOXIDE	A	CHLORINE WET, DRY, OR GAS	D
CITRIC ACID	B	COCONUT OIL	A
COD LIVER OIL	A	COPPER CHLORIDE	A
COPPER CYANIDE	A	COPPER SULFATE	A
CORN OIL	A	COTTON SEED OIL	A
CYCLO HEXANE	B	DIESEL OIL	B
DIETHYL ETHER	A	DOWTHERM OIL	B
ETHYL ALCOHOL	C	ETHYL CELLULOSE	B
ETHYL CHLORIDE	C	ETHYL ETHER	B

FLUID	RATING	FLUID	RATING
ETHYLENE GLYCOL	C	GASOLINE (WITH ALCOHOL)	B
GLUCOSE	A	GLYCERINE	A
GLYCOLS	C	HYDRAULIC OIL (PETROLEUM BASED)	A
HYDRAULIC FLUIDS (SYNTHETIC)	D	HYDROGEN GAS	A
ISOOCTANE	B	KEROSENE	B
LARD	A	LINSEED OIL	B
LIQUIFIED PETROLEUM GAS	B	LYE	A,B
MAGNESIUM CHLORIDE	A	METHANE	B
METHYL ALCOHOL	D	METHYLENE CHLORIDE	D
MINERAL OIL	A	NATURAL GAS	B
NITRIC ACID – CONC.	D	NITRIC ACID – DILUTED	C
NITROGEN	A	OLEUM SPIRITS	B
OLIVE OIL	A	OXYGEN – 200°F	A
PEANUT OIL	A	PETROLEUM BELOW 160°F	A
PETROLEUM BELOW 250°F	B	PETROLEUM ABOVE 250°F	D
PHOSPHORIC ACID 20%	B	PHOSPHORIC ACID 45%	C
POTASSIUM CHLORIDE	A	POTASSIUM HYDROXIDE	A
POTASSIUM NITRATE	A	POTASSIUM SULFATE	A
PROPANE	B	RADIATION	A
SEWAGE	A	SILICATE ESTERS	A
SILICONE GREASES	A	SILICONE OILS	A
SOAP SOLUTIONS	B	SODIUM CHLORIDE	B
SODIUM HYDROXIDE	B	SODIUM PEROXIDE	A
SODIUM PHOSPHATE	A	SODIUM SULFATE	B
SOYBEAN OIL	B	STEARIC ACID	A
SULFURIC ACID – DILUTED	C	SULFURIC ACID – CONC.	D
TANNIC ACID	A	TOLUENE	D
TRANSMISSION FLUID TYPE A	A	TUNG OIL	B
WATER, FRESH	A	WATER, SALT	A
WHISKEY, WINES	A		
FLUID ASTM D-471 (158°F/70°C)	RATING	FLUID ASTM D-471 (158°F/70°C)	RATING
NUMBER 1 OIL	A	NUMBER 2 OIL	B
NUMBER 3 OIL	B		
SPECIFICATION FLUID	RATING	SPECIFICATION FLUID	RATING
MIL-H-13862	B	MIL-H-13866A	B
MIL-H-13910B	C	MIL-H-13919A	B
MIL-H-15017	A	MIL-H-15018B	A
MIL-H-15719A	D	MIL-H-15019C	A
MIL-H-16958A	B	MIL-H-17331D	A
MIL-H-17353A	B	MIL-H-18486A	A
MIL-H-19701	C	MIL-H-21260	A
MIL-H-22396	A	MIL-H-23699A	C



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Great Products, On-Time

SPECIFICATION FLUID	RATING	SPECIFICATION FLUID	RATING
MIL-H-25336B	C	MIL-H-26087A	A
MIL-H-27694A	A	MIL-H-3150A	A