B

BACTERIAL CORROSION

When certain bacteria produce substances such as sulfuric acid, ammonia, etc. the resulting corrosion is known as bacterial corrosion. See also “Biological Corrosion.”

BARRIER COATINGS

Barrier coatings are used to keep moisture and/or corrosive materials away from a metallic (usually steel) substrate. These protective barriers may vary in thickness from a thin paint film of only a few mils to a mastic coating applied about 1/4 to 1/2 inch thick, to acid-proof brick linings several inches thick. Barrier coatings are effective because they keep moisture, oxygen, and corrosives away from the metallic substrate. The lower the moisture vapor transmission of the polymer, the more effective it is as a vehicle for protective coatings. Protective coatings vary greatly in composition, cost, and performance. Refer to “Liquid Applied Linings” and “Paint Coatings.”

BASE

A compound of a metal or metal-like group, with hydrogen and oxygen in the proportion to form an OH radical, which ionizes in aqueous solution to yield hydroxyl ions. A base is formed when a metallic oxide reacts with water.

BAUMÉ SCALE

For liquids heavier than water, a Baumé hydrometer is used to determine specific gravity and concentration by weight. It is most often used in relation to acids.

This hydrometer was originally based on the density of a 10% sodium chloride solution, which was given the value of 10°, and the density of pure water, which was given the value of 0°. The interval between these two values was divided into ten equal parts. Other reference points have been taken, and as a result there are about thirty-six different scales in use, many of which are incorrect. In general, a Baumé hydrometer should have inscribed on it the temperature at which it was calibrated and the temperature of the water used in relating the density to a specific gravity. The relationship between the specific gravity and the Baumé scale is as follows:

$$\text{specific gravity} = \frac{m}{m - \text{Baumé}}$$

where:

m = 145 at 60°/60°F (15.56°C) for the American scale
m = 144 for the old scale used in Holland
m = 146.3 at 15°C for the Gedach scale
m = 144.3 at 15°C for the Rational scale generally used in Germany.

Tables B.1, B.2, and B.3 show the conversion from degrees Baumé based on specific gravity and weight percent of hydrochloric acid, nitric acid, and sulfuric acid, respectively. Conversion of degrees Baumé based on weight percent of other solutions may be found in similar tables.

BEARING CORROSION

During operation the lubricating oil or grease contained within the bearing may be subject to chemical deterioration and produce a corrosive material. When this corrodent attacks one of the metals in the bearing alloy, the action is referred to as bearing corrosion.

BIOLOGICAL CORROSION

Corrosive conditions can be developed by living organisms as a result of their influence on anodic and cathodic reactions. This metabolic activity can directly or indirectly cause deterioration of a metal by the corrosion process. This activity can

1. Produce a corrosive environment
2. Create electrolytic concentration cells on the metal surface
3. Alter the resistance of surface films
4. Have an influence on the rate of anodic or cathodic reaction
5. Alter the environment composition

Because this form of corrosion gives the appearance of pitting, it is first necessary to diagnose the presence of bacteria. Once established, prevention can be accomplished by the use of biocides or by the selection of a more resistant material of construction. For some species of bacteria a change in pH will provide control. Refer to "Microbial Corrosion."

See Refs. 1 and 2.

Table B.1 Baumé Scale Conversion for Hydrochloric Acid

Based on Baumé hydrometers graduated using the following formula, which must be printed on the scale:

$$\text{Baumé} = 145 - \frac{145}{\text{sp. gr.}}$$

Be°	Sp. gr.	% HCl	Be°	Sp. gr.	% HCl	Be°	Sp. gr.	% HCl
1.00	1.0069	1.40	4.00	1.0284	5.69	5.50	1.0394	7.89
2.00	1.0140	2.82	5.00	1.0357	7.15	5.75	1.0413	8.26
3.00	1.0211	4.25	5.25	1.0375	7.52	6.00	1.0432	8.64

Table B.1 Baumé Scale Conversion for Hydrochloric Acid (Continued)

Be°	Sp. gr.	% HCl	Be°	Sp. gr.	% HCl	Be°	Sp. gr.	% HCl
6.25	1.0450	9.02	16.2	1.1256	24.90	20.4	1.1637	32.19
6.50	1.0488	9.78	16.3	1.1265	24.06	20.5	1.1647	32.38
7.00	1.0507	10.17	16.4	1.1274	25.23	20.6	1.1656	32.56
7.25	1.0526	10.55	16.5	1.1283	25.39	20.7	1.1666	32.76
7.50	1.0545	10.94	16.6	1.1292	25.56	20.8	1.1675	32.93
7.75	1.0564	11.32	16.7	1.1301	25.72	20.9	1.1684	33.12
8.00	1.0584	11.71	16.8	1.1310	25.89	21.0	1.1694	33.31
8.25	1.0603	12.09	16.9	1.1319	26.05	21.1	1.1703	33.50
8.50	1.0623	12.48	17.0	1.1326	26.22	21.2	1.1713	33.69
8.75	1.0624	12.87	17.1	1.1336	26.39	21.3	1.1722	33.88
9.00	1.0662	13.26	17.2	1.1345	26.56	21.4	1.1732	34.07
9.25	1.0681	13.65	17.3	1.1354	26.73	21.5	1.1741	34.26
9.50	1.0701	14.04	17.4	1.1363	26.90	21.6	1.1751	34.45
9.75	1.0721	14.43	17.5	1.1372	27.07	21.7	1.1760	34.64
10.00	1.0741	14.83	17.6	1.1381	27.24	21.8	1.1770	34.83
10.25	1.0761	15.22	17.7	1.1390	27.41	21.9	1.1779	35.02
10.50	1.0781	15.62	17.8	1.1399	27.58	22.0	1.1789	35.21
10.75	1.0801	16.01	17.9	1.1408	27.75	22.1	1.1798	35.40
11.00	1.0821	16.41	18.0	1.1417	27.92	22.2	1.1808	35.69
11.25	1.0841	16.81	18.1	1.1426	28.09	22.3	1.1817	35.78
11.50	1.0861	17.21	18.2	1.1435	28.26	22.4	1.1827	35.97
11.75	1.0881	17.61	18.3	1.1444	28.44	22.5	1.1836	36.16
12.00	1.0902	18.01	18.4	1.1453	28.61	22.6	1.1846	36.35
12.25	1.0922	18.41	18.5	1.1462	28.78	22.7	1.1856	36.54
12.50	1.0943	18.82	18.6	1.1471	28.95	22.8	1.1866	36.73
12.75	1.0964	19.22	18.7	1.1480	29.13	22.9	1.1875	36.93
13.00	1.0985	19.63	18.8	1.1489	29.30	23.0	1.1885	37.14
13.25	1.1006	20.04	18.9	1.1498	29.48	23.1	1.1895	37.36
13.50	1.1027	20.45	19.0	1.1508	29.65	23.2	1.1904	37.58
13.75	1.1048	20.86	19.1	1.1517	29.83	23.3	1.1914	37.80
14.00	1.1069	21.27	19.2	1.1526	30.00	23.4	1.1924	38.03
14.25	1.1090	21.68	19.3	1.1535	30.18	23.5	1.1934	38.26
14.50	1.1111	22.09	19.4	1.1544	30.35	23.6	1.1944	38.49
14.75	1.1132	22.50	19.5	1.1554	30.53	23.7	1.1953	38.72
15.00	1.1154	22.92	19.6	1.1563	30.71	23.8	1.1963	38.93
15.25	1.1176	23.33	19.7	1.1572	30.80	23.9	1.1973	39.18
15.50	1.1197	23.75	19.8	1.1581	31.08	24.0	1.1983	39.41
15.75	1.1219	24.16	19.9	1.1690	31.27	24.1	1.1993	34.64
16.00	1.1240	24.57	20.0	1.1600	31.45	24.2	1.2903	39.96
15.50	1.1197	23.75	20.1	1.1609	31.64	24.3	1.2013	40.09
15.75	1.1219	24.16	20.2	1.1619	31.82	24.4	1.2023	40.32
16.00	1.1240	24.57	20.3	1.1628	32.01	24.5	1.2033	40.55
16.1	1.1248	24.73						

Table B.2 Baumé Scale Conversion for Nitric Acid

Based on Baumé hydrometers graduated using the following formula, which must always be printed on the scale:

$$\text{Baumé} = 145 - \frac{145}{\text{sp. gr.}}$$

Be°	Sp. gr.	% HNO_3	Be°	Sp. gr.	% HNO_3	Be°	Sp. gr.	% HNO_3
10.00	1.0741	12.86	21.25	1.1718	28.02	32.50	1.2889	45.68
10.25	1.0761	13.18	21.50	1.1741	28.36	32.75	1.2918	46.14
10.50	1.0781	13.49	21.75	1.1765	28.72	33.00	1.2946	46.58
10.75	1.0801	13.81	22.00	1.1789	29.07	33.25	1.2975	47.04
11.00	1.0821	14.13	22.25	1.1813	29.43	33.50	1.3004	47.49
11.25	1.0841	14.44	22.50	1.1837	29.78	33.75	1.3034	47.95
11.50	1.0861	14.76	22.75	1.1861	30.14	34.00	1.3063	48.42
11.75	1.0881	15.07	23.00	1.1885	30.49	34.25	1.3093	48.90
12.00	1.0902	15.41	23.25	1.1910	30.86	34.50	1.3122	49.35
12.25	1.0922	15.72	23.50	1.1934	31.21	34.75	1.3152	49.63
12.50	1.0943	16.05	23.75	1.1959	31.58	35.00	1.3182	50.32
12.75	1.0964	16.39	24.00	1.1983	31.94	35.25	1.3212	50.81
13.00	1.0985	16.72	24.25	1.2008	32.31	35.50	1.3242	51.30
13.25	1.1006	17.05	24.50	1.2033	32.68	35.75	1.3273	51.60
13.50	1.1027	17.58	24.75	1.2058	33.05	36.00	1.3303	52.30
13.75	1.1048	17.71	25.00	1.2083	33.42	36.25	1.3334	52.81
14.00	1.1069	18.04	25.25	1.2109	33.60	36.50	1.3364	53.32
14.25	1.1090	18.37	25.50	1.2134	34.17	36.75	1.3395	53.84
14.50	1.1111	18.70	25.75	1.2160	34.56	37.00	1.3426	54.36
14.75	1.1132	19.02	26.00	1.2185	34.94	37.25	1.3457	54.89
15.00	1.1154	19.36	26.25	1.2211	35.53	37.50	1.3468	55.43
15.25	1.1176	19.70	26.50	1.2236	35.70	37.75	1.3520	55.97
15.50	1.1197	20.02	26.75	1.2262	35.09	38.00	1.3551	56.52
15.75	1.1219	20.36	27.00	1.2288	36.48	38.25	1.3583	57.08
16.00	1.1290	20.69	27.25	1.2314	36.87	38.50	1.3615	57.65
16.25	1.1262	21.03	27.50	1.2340	37.26	38.75	1.3647	58.23
16.50	1.1284	21.36	27.75	1.2367	37.67	39.00	1.3679	58.82
16.75	1.1306	21.70	28.00	1.2393	38.06	39.25	1.3712	59.43
17.00	1.1328	22.04	28.25	1.2420	38.46	39.50	1.3744	60.06
17.25	1.1350	22.63	28.50	1.2446	38.85	39.75	1.3777	60.71
17.50	1.1373	22.74	28.75	1.2473	39.25	40.00	1.3810	61.36
17.75	1.1395	23.08	29.00	1.2500	39.66	40.25	1.3843	62.07
18.00	1.1417	23.42	29.25	1.2527	40.06	40.50	1.3876	62.77
18.25	1.1440	23.77	29.50	1.2554	40.47	40.75	1.3909	63.48
18.50	1.1462	24.11	29.75	1.2582	40.89	41.00	1.3942	64.20
18.75	1.1485	24.47	30.00	1.2609	41.30	41.25	1.3976	64.93
19.00	1.1508	24.82	30.25	1.2637	41.72	41.50	1.4010	65.67
19.25	1.1531	25.18	30.50	1.2664	42.14	41.75	1.4044	66.42
19.50	1.1554	25.53	30.75	1.2692	42.58	42.00	1.4078	67.18
19.75	1.1577	25.88	31.00	1.2719	43.00	42.25	1.4112	67.95
20.00	1.1600	26.24	31.25	1.2747	43.44	42.50	1.4146	68.73
20.25	1.1624	26.61	31.50	1.2775	43.89	42.75	1.4181	69.52
20.50	1.1647	26.96	31.75	1.2804	44.34	43.00	1.4212	70.33
20.75	1.1671	27.33	32.00	1.2832	44.78	43.25	1.4251	71.15
21.00	1.1694	27.67	32.25	1.2861	45.24	43.50	1.4286	71.98

Table B.2 Baumé Scale Conversion for Nitric Acid (Continued)

Be°	Sp. gr.	% HNO_3	Be°	Sp. gr.	% HNO_3	Be°	Sp. gr.	% HNO_3
43.75	1.4321	72.82	45.50	1.4573	79.03	47.25	1.4834	86.98
44.00	1.4356	73.67	45.75	1.4610	80.04	47.50	1.4872	88.32
44.25	1.4392	74.53	46.00	1.4646	81.08	47.75	1.4910	89.76
44.50	1.4428	75.40	46.25	1.4684	82.16	48.00	1.4948	91.35
44.75	1.4464	76.28	46.50	1.4721	83.33	48.25	1.4987	93.13
45.00	1.4500	77.17	46.75	1.4758	83.48	48.50	1.5026	95.11
45.25	1.4536	78.07	47.00	1.4796	85.70			

Table B.3 Baumé Scale Conversion for Sulfuric Acid

Based on Baumé hydrometers graduated using the following formula, which must be printed on the scale:

$$\text{Baumé} = 145 - \frac{145}{\text{sp. gr.}}$$

Be°	Sp. gr.	% H_2SO_4	Be°	Sp. gr.	% H_2SO_4	Be°	Sp. gr.	% H_2SO_4
0	1.0000	0.00	24	1.1983	27.03	48	1.4948	59.32
1	1.0069	1.02	25	1.2083	28.28	49	1.5104	60.75
2	1.0140	2.08	26	1.2185	29.53	50	1.5263	62.18
3	1.0211	3.13	27	1.2268	30.79	51	1.5426	63.66
4	1.0284	4.21	28	1.2393	32.05	52	1.5591	65.13
5	1.0357	5.28	29	1.2500	33.33	53	1.5761	66.63
6	1.0432	6.37	30	1.2609	34.63	54	1.5934	68.13
7	1.0507	7.45	31	1.2719	35.93	55	1.6110	69.65
8	1.0584	8.55	32	1.2832	37.26	56	1.6292	71.17
9	1.0602	9.66	33	1.2946	38.58	57	1.6477	72.75
10	1.0741	10.77	34	1.3063	39.92	58	1.6667	74.36
11	1.0821	11.89	35	1.3182	41.27	59	1.6860	75.99
12	1.0902	13.01	36	1.3303	42.63	60	1.7059	77.67
13	1.0985	14.13	37	1.3426	43.99	61	1.7262	79.43
14	1.1069	15.25	38	1.3551	45.35	62	1.7470	81.30
15	1.1154	16.38	39	1.3679	46.72	63	1.7683	83.34
16	1.1240	17.53	40	1.3810	48.10	64	1.7901	85.66
17	1.1328	18.71	41	1.3942	49.47	64.25	1.7957	86.33
18	1.1417	19.89	42	1.4078	50.87	64.50	1.8012	87.04
19	1.1508	21.07	43	1.4216	52.26	64.75	1.8068	87.81
20	1.1600	22.25	44	1.4356	53.66	65	1.8125	88.65
21	1.1694	23.43	45	1.4500	55.07	65.25	1.8182	89.55
22	1.1789	24.61	46	1.4646	55.48	65.50	1.8239	90.60
23	1.1885	25.81	47	1.4796	57.90	65.75	1.8297	91.80
						66	1.8345	93.81

BISPHENOL POLYESTERS

See also "Polymers and Thermoset Polymers."

The bisphenol polyesters are superior in their corrosion-resistant properties to the isophthalic polyesters. They show good performance with moderate alkaline solutions and excellent resistance to the various categories of bleaching agents. The bisphenol polyesters will break down under highly concentrated acids or alkalies. These resins can be used in the handling of the following materials:

Acids (to 200°F/93°C)

acetic
benzoic
boric
butyric
chloroacetic (15%)
chromic (5%)
citric
fatty acids
hydrochloric (10%)
lactic
maleic
oleic
oxalic
phosphoric (80%)
stearic
sulfonic (50%)
tannic
tartaric
trichloroacetic (50%)
rayon spin bath

Salts (solution to 200°F/93°C)

all aluminum salts
most ammonium salts
calcium salts
most plating solutions
copper salts
iron salts
zinc salts

Solvents (all solvents shown are for the isophthalic resins)

sour crude oil
alcohols at ambient temperature
linseed oil
glycerine

Alkalies

ammonium hydroxide 5%
calcium hydroxide 25%
calcium hypochlorite 20%
chlorine dioxide 15%
potassium hydroxide 25%
sodium hydroxide 25%
chlorite
hydrosulfite

Solvents such as benzene, carbon disulfide, ether, methyl ethyl ketone, toluene, xylene, trichloroethylene, and trichloroethane will attack the resin. Sulfuric acid above 70% concentration, 73% sodium hydroxide, and 30% chromic acid will also attack the resin. Refer to Table B.4 for the compatibility of bisphenol A–fumarate polyester with selected corrodents and Table B.5 for hydrogenated bisphenol A–bisphenol A resin with selected corrodents. Refer to Ref. 3 for the compatibility of the bisphenol esters with a wider range of selected corrodents.

See also Refs. 4–6.

BLISTER CRACKING

Blister cracking is a hydrogen-induced failure in steels containing internal flaws by nonmetallic inclusions due to superficial corrosion of the steel by an acid hydrogen sulfide environment liberating atomic hydrogen, which diffuses into the metal and is released at the inclusion metal interface as molecular hydrogen under high pressure.

Table B.4 Compatibility of Bisphenol A–Fumarate Polyester with Selected Corrodents[a]

	Maximum temp.			Maximum temp.	
Chemical	°F	°C	Chemical	°F	°C
Acetaldehyde	x	x	Benzene	x	x
Acetic acid 10%	220	104	Benzene slfuric acid 10%	200	93
Acetic acid 50%	160	171	Benzoic acid	180	82
Acetic acid 80%	160	171	Benzyl alcohol	x	x
Acetic acid, glacial	x	x	Benzyl chloride	x	x
Acetic amhydride	110	43	Borax	220	104
Acetone	x	x	Boric acid	220	104
Acetyl chloride	x	x	Bromine gas, dry	90	32
Acrylic acid	100	38	Bromine gas, moist	100	38
Acrylonitrile	x	x	Bromine liquid	x	x
Adipic acid	220	104	Butyl acetate	80	27
Allyl alcohol	x	x	Butyl alcohol	80	27
Allyl chloride	x	x	*n*-Butylamine	x	x
Alum	220	104	Butyric acid	220	93
Aluminum chloride. aqueous	200	93	Calcium bisulfite	180	82
Aluminum fluoride 10%	90	32	Calcium carbonate	210	99
Aluminum hydroxide	160	71	Calcium chlorate	200	93
Aluminum nitrate	200	93	Calcium chloride	220	104
Aluminum sulfate	200	93	Calcium hydroxide 10%	180	82
Ammonia gas	200	93	Calcium hydroxide sat.	160	71
Ammonium carbonate	90	32	Calcium hypochlorite 10%	80	27
Ammonium chloride 10%	200	93	Calcium nitrate	220	104
Ammonium chloride 50%	220	104	Calcium sulfate	220	104
Ammonium chloride sat.	220	104	Caprylic acid	160	71
Ammonium fluoride 10%	180	82	Carbon bisulfide	x	x
Ammonium fluoride 25%	120	49	Carbon dioxide, dry	350	177
Ammonium hydroxide 25%	100	38	Carbon dioxide, wet	210	99
Ammonium hydroxide 20%	140	60	Carbon disulfide	x	x
Ammonium nitrate	220	104	Carbon monoxide	350	177
Ammonium persulfate	180	82	Carbon tetrachloride	110	43
Ammonium phosphate	80	27	Carbonic acid	90	32
Ammonium sulfate 10–40%	220	104	Cellosolve	140	60
Ammonium sulfide	110	43	Chloracetic acid, 50% water	140	60
Ammonium sulfite	80	27	Chloracetic acid to 25%	80	27
Amyl acetate	80	27	Chlorine gas dry	200	93
Amyl alcohol	200	93	Chlorine gas wet	200	93
Amyl chloride	x	x	Chlorine liquid	x	x
Aniline	x	x	Chlorobenzene	x	x
Antimony trichloride	220	104	Chloroform	x	x
Aqua regia 3:1	x	x	Chlorosulfonic acid	x	x
Barium carbonate	200	93	Chromic acid 10%	x	x
Barium chloride	220	104	Chronic acid 50%	x	x
Barium hydroxide	150	66	Chromyl chloride	150	66
Barium sulfate	220	104	Citric acid 15%	220	104
Barium sulfide	140	60	Citric acid, concentrated	220	104
Benzaldehyde	x	x	Copper acetate	180	82

Table B.4 Compatibility of Bisphenol A–Fumarate Polyester with Selected Corrodents[a] (Continued)

	Maximum temp.			Maximum temp.	
Chemical	°F	°C	Chemical	°F	°C
Copper chloride	220	104	Nitric acid 20%	100	38
Copper cyanide	220	101	Nitric acid 70%	x	x
Copper sulfate	220	104	Nitric acid, anhydrous	x	x
Cresol	x	x	Oleum	x	x
Cyclohexane	x	x	Phenol	x	x
Dichloroacetic acid	100	38	Phosphoric acid 50–80%	220	104
Dichloroethane (ethylene dichloride)	x	x	Picric acid	110	43
Ethylene glycol	220	104	Potassium bromide 30%	200	93
Ferric chloride	220	104	Salicylic acid	150	66
Ferric chloride 50% in water	220	104	Sodium carbonate	160	71
Ferric nitrate 10–50%	220	104	Sodium chloride	220	104
Ferrous chloride	220	104	Sodium hydroxide 10%	130	54
Ferrous nitrate	220	104	Sodium hydroxide 50%	220	104
Fluorine gas, moist			Sodium hydroxide, concentrated	200	93
Hydrobromic acid, dilute	220	104	Sodium hypochlorite 20%	x	x
Hydrobromic acid 20%	220	104	Sodium sulfide to 50%	210	99
Hydrobromic acid 50%	160	71	Stannic chloride	200	93
Hydrochloric acid 20%	190	88	Stannous chloride	220	104
Hydrochloric acid 38%	x	x	Sulfuric acid 10%	220	104
Hydrocyanic acid 10%	200	93	Sulfuric acid 50%	220	104
Hydrofluoric acid 30%	90	32	Sulfuric acid 70%	160	71
Hypochlorous acid 20%	90	32	Sulfuric acid 90%	x	x
Iodine solution 10%	200	93	Sulfuric acid 98%	x	x
Lactic acid 25%	210	99	Sulfuric acid 100%	x	x
Lactic acid, concentrated	220	104	Sulfuric acid fuming	x	x
Magnesium chloride	220	104	Sulfurous acid	110	43
Malic acid	160	71	Thionyl chloride	x	x
Methyl ethyl ketone	x	x	Toluene	x	x
Methyl isobutyl ketone	x	x	Trichloroacetic acid 50%	180	82
Muriatic acid	130	54	White liquor	180	82
Nitric acid 5%	160	71	Zinc chloride	250	121

[a] The chemicals listed are in the pure state or in a saturated solution unless otherwise indicated. Compatibility is shown to the maximum allowable temperature for which data are available. Incompatibility is shown by an x. A blank space indicates that data are unavailable.

Source: PA Schweitzer, *Corrosion Resistance Tables.* 4th ed. Vols. 1–3. New York: Marcel Dekker, 1995.

BLISTERING

Early stages of corrosion can be recognized as blistering. Frequently blistering occurs without external evidence of rusting or corrosion. Blistering is mainly the result of volume expansion due to swelling, gas inclusion, gas formation, soluble impurities at the film/support interface from osmotic processes, or electroosmotic effects. Water and chemical gases pass through the film, dissolve ionic material either from the film or from the substrate material, causing an osmotic pressure greater than that of the external face of the coating. This establishes a solute concentration gradient, with water building up at these sites until the film eventually blisters.

Table B.5 Compatibility of Hydrogenated Bisphenol A—Bisphenol A Polyester with Selected Corrodents[a]

	Maximum temp.	
Chemical	°F	°C
Acetic acid 10%	200	93
Acetic acid 50%	160	71
Acetic anhydride	x	x
Acetone	x	x
Acetyl chloride	x	x
Acrylonitrile	x	x
Aluminum acetate		
Aluminum chloride, aqueous	200	93
Aluminum fluoride	x	x
Aluminum sulfate	200	93
Ammonium chloride, sat.	200	93
Ammonium nitrate	200	93
Ammonium persulfate	200	93
Ammonium sulfide	100	38
Amyl acetate	x	x
Amyl alcohol	200	93
Amyl chloride	90	32
Aniline	x	x
Antimony trichloride	80	27
Aqua regia 3:1	x	x
Barium carbonate	180	82
Barium chloride	200	93
Benzaldehyde	x	x
Benzene	x	x
Benzoic acid	210	99
Benzyl alcohol	x	x
Benzyl chloride	x	x
Boric acid	210	99
Bromine liquid	x	x
Butyl acetate	x	x
n-Butylamine	x	x
Butyric acid	x	x
Calcium bisulfide	120	49
Calcium chlorate	210	99
Calcium chloride	210	99
Calcium hypochlorite 10%	180	82
Carbon bisulfide	x	x
Carbon disulfide	x	x
Carbon tetrachloride	x	x
Chloracetic acid, 50% water	90	32
Chlorine gas, dry	210	99
Chlorine gas, wet	210	99
Chloroform	x	x
Chromic acid 50%	x	x
Citric acid 15%	200	93
Citric acid, concentrated	210	99
Copper acetate	210	99
Copper chloride	210	99
Copper cyanide	210	99
Copper sulfate	210	99
Cresol	x	x
Cyclohexane	210	99
Dichloroethane (ethylene dichloride)	x	x
Ferric chloride	210	99
Ferric chloride 50% in water	200	93
Ferric nitrate 10–50%	200	93
Ferrous chloride	210	99
Ferrous nitrate	210	99
Hydrobromic acid 20%	90	32
Hydrobromic acid 50%	90	32
Hydrochloric acid 20%	180	82
Hydrochloric acid 38%	190	88
Hydrocyanic acid 10%	x	x
Hydrofluoric acid 30%	x	x
Hydrofluoric acid 70%	x	x
Hydrofluoric acid 100%	x	x
Hypochlorous acid 50%	210	99
Lactic acid 25%	210	99
Lactic acid, concentrated	210	99
Magnesium chloride	210	99
Methyl ethyl ketone	x	x
Methyl isobutyl ketone	x	x
Muriatic acid	190	88
Nitric acid 5%	90	32
Oleum	x	x
Perchloric acid 10%	x	x
Perchloric acid 70%	x	x
Phenol	x	x
Phosphoric acid 50–80%	210	99
Sodium carbonate 10%	100	38
Sodium chloride	210	99
Sodium hydroxide 50%	x	x
Sodium hydroxide 50%	x	x
Sodium hydroxide, concentrated	x	x
Sodium hypochlorite 10%	160	71
Sulfuric acid 10%	210	99
Sulfuric acid 50%	210	99
Sulfuric acid 70%	90	32
Sulfuric acid 90%	x	x
Sulfuric acid 98%	x	x
Sulfuric acid 100%	x	x
Sulfuric acid, fuming	x	x

Table B.5 Compatibility of Hydrogenated Bisphenol A—Bisphenol A Polyester with Selected Corrodents[a] (Continued)

	Maximum temp.			Maximum temp.	
Chemical	°F	°C	Chemical	°F	°C
Sulfurous acid 25%	210	99	Trichloroacetic acid	90	32
Toluene	90	32	Zinc chloride	200	93

[a] The chemicals listed are in the pure state or in a saturated solution unless otherwise indicated. Compatibility is shown to the maximum allowable temperature for which data are available. Incompatibility is shown by an x. A blank space indicates that data are unavailable.

Source: PA Schweitzer. *Corrosion Resistance Tables.* 4th ed. Vols. 1–3. New York: Marcel Dekker, 1995.

Blistering is also an effect of hydrogen damage, particularly to low-strength alloys. This occurs when atomic hydrogen diffuses to internal defects and then precipitates as molecular hydrogen. See "Blister Cracking."

BORON CARBIDE

Boron carbide is used as a high-strength reinforcing material for thermosetting resins. See "Thermoset Reinforcing Materials."

BOROSILICATE GLASS

Of the many glass compositions available, the one most commonly used for corrosive applications is borosilicate glass. This particular composition has been selected because of its wide range of corrosion resistance, relatively high operating temperature, good heat resistance due to low thermal expansion, transparency to ultraviolet light, and ability to be prestressed.

The chemical stability of borosilicate glass is one of the most comprehensive of any known construction material. It is highly resistant to water, acids, salt solutions, organic substances, and even halogens like chlorine and bromine.

Only hydrofluoric acid, phosphoric acid with fluorides, or strong alkalies at temperatures above 102°F (49°C) can visibly affect the glass surface. Refer to Table B.6 for the compatibility of borosilicate glass with selected corrodents.

BRASS

See "Copper-Zinc Alloys."

BUTADIENE-STYRENE RUBBER (SBR, BUNA-S, GR-S)

During World War II a shortage of natural rubber was created when Japan occupied the Far Eastern nations from which natural rubber was obtained. Because of the great need for rubber, the U.S. government developed what was originally known as Government Rubber Styrene-Type because it was the most practical to put into rapid production on a wartime scale. It was later designated GR-S.

The rubber is produced by copolymerizing butadiene and styrene. As with natural rubber and the other synthetic elastomers, compounding with other ingredients will improve certain properties. Continued development since World War II has improved its properties considerably over what was initially produced by either Germany or the United States.

Table B.6 Compatibility of Borosilicate Glass with Selected Corrodents[a]

	Maximum temp.			Maximum temp.	
Chemical	°F	°C	Chemical	°F	°C
Acetaldehyde	450	232	Benzyl alcohol	200	93
Acetamide	270	132	Benzyl chloride	200	93
Acetic acid 10%	400	204	Borax	250	121
Acetic acid 50%	400	204	Boric acid	300	149
Acetic acid 80%	400	204	Bromine gas, moist	250	121
Acetic acid, glacial	400	204	Bromine liquid	90	32
Acetic anhydride	250	121	Butadiene	90	32
Acetone	250	121	Butyl acetate	250	121
Adipic acid	210	99	Butyl alcohol	200	93
Allyl alcohol	120	49	Butyric acid	200	93
Allyl chloride	250	121	Calcium bisulfite	250	121
Alum	250	121	Calcium carbonate	250	121
Aluminum chloride, aqueous	250	121	Calcium chlorate	200	93
Aluminum chloride, dry	180	82	Calcium chloride	200	93
Aluminum fluoride	x	x	Calcium hydroxide 10%	250	121
Aluminum hydroxide	250	121	Calcium hydroxide, sat.	x	x
Aluminum nitrate	100	38	Calcium hypochlorite	200	93
Aluminum oxychloride	190	88	Calcium nitrate	100	38
Aluminum sulfate	250	121	Carbon bisulfide	250	121
Ammonium bifluoride	x	x	Carbon dioxide, dry	160	71
Ammonium carbonate	250	121	Carbon dioxide, wet	160	71
Ammonium chloride 10%	250	121	Carbon disulfide	250	121
Ammonium chloride 50%	250	121	Carbon monoxide	450	232
Ammonium chloride, sat.	250	121	Carbon tetrachloride	200	93
Ammonium fluoride 10%	x	x	Carbonic acid	200	93
Ammonium fluoride 25%	x	x	Cellosolve	160	71
Ammonium hydroxide 25%	250	121	Chloracetic acid, 50% water	250	121
Ammonium hydroxide, sat.	250	121	Chloracetic acid	250	121
Ammonium nitrate	200	93	Chlorine gas, dry	450	232
Ammonium persulfate	200	93	Chlorine gas, wet	400	204
Ammonium phosphate	90	32	Chlorine, liquid	140	60
Ammonium sulfate l0–40%	200	93	Chlorobenzene	200	93
Amyl acetate	200	93	Chloroform	200	93
Amyl alcohol	250	121	Chlorosulfonic acid	200	93
Amyl chloride	250	121	Chromic acid 10%	200	93
Aniline	200	93	Chromic acid 50%	200	93
Antimony trichloride	250	121	Citric acid 15%	200	93
Aqua regia 3:1	200	93	Citric acid, concentrated	200	93
Barium carbonate	250	121	Copper chloride	250	121
Barium chloride	250	121	Copper sulfate	200	93
Barium hydroxide	250	121	Cresol	200	93
Barium sulfate	250	121	Cupric chloride 5%	160	71
Barium sulfide	250	121	Cupric chloride 50%	160	71
Benzaldehyde	200	93	Cyclohexane	200	93
Benzene	200	93	Cyclohexanol		
Benzene sulfonic acid 10%	200	93	Dichloroacetic acid	310	154
Benzoic acid	200	93	Dichloroethane (ethylene dichloride)	250	121

Table B.6 Compatibility of Borosilicate Glass with Selected Corrodents[a] (Continued)

Chemical	Maximum temp. °F	Maximum temp. °C	Chemical	Maximum temp. °F	Maximum temp. °C
Ethylene glycol	210	99	Oleum	400	204
Ferric chloride	290	143	Perchloric acid 10%	200	93
Ferric chloride 50% in water	280	138	Perchloric acid 70%	200	93
Ferric nitrate 10–50%	180	82	Phenol	200	93
Ferrous chloride	200	93	Phosphoric acid 50–80%	300	149
Fluorine gas, dry	300	149	Picric acid	200	93
Fluorine gas, moist	x	x	Potassium bromide 30%	250	121
Hydrobromic acid, dilute	200	93	Silver bromide 10%		
Hydrobromic acid 20%	200	93	Sodium carbonate	250	121
Hydrobromic acid 50%	200	93	Sodium chloride	250	121
Hydrochloric acid 20%	200	93	Sodium hydroxide 10%	x	x
Hydrochloric acid 38%	200	93	Sodium hydroxide 50%	x	x
Hydrocyanic acid 10%	200	93	Sodium hydroxide, concentrated	x	x
Hydrofluoric acid 30%	x	x	Sodium hypochlorite 20%	150	66
Hydrofluoric acid 70%	x	x	Sodium hypochlorite, concentrated	150	66
Hydrofluoric acid 100%	x	x	Sodium sulfide to 50%	x	x
Hypochlorous acid	190	88	Stannic chloride	210	99
Iodine solution 10%	200	93	Stannous chloride	210	99
Ketones, general	200	93	Sulfuric acid 10%	400	204
Lactic acid 25%	200	93	Sulfuric acid 50%	400	204
Lactic acid, concentrated	200	93	Sulfuric acid 70%	400	204
Magnesium chloride	250	121	Sulfuric acid 90%	400	204
Malic acid	160	72	Sulfuric acid 98%	400	204
Methyl chloride	200	93	Sulfuric acid 100%	400	204
Methyl ethyl ketone	200	93	Sulfurous acid	210	99
Methyl isobutyl ketone	200	93	Thionyl chloride	210	99
Nitric acid 5%	400	204	Toluene	250	121
Nitric acid 20%	400	204	Trichloroacetic acid	210	99
Nitric acid 70%	400	204	White liquor	210	99
Nitric acid, anhydrous	250	121	Zinc chloride	210	99

[a] The chemicals listed are in the pure state or in a saturated solution unless otherwise indicated. Compatibility is shown to the maximum allowable temperature for which data are available. Incompatibility is shown by an x. A blank space indicates that data are unavailable.

Source: PA Schweitzer. *Corrosion Resistance Tables*. 4th ed. Vols. 1–3. New York: Marcel Dekker, 1995.

Physical and Mechanical Properties

In general, Buna-S is very similar to natural rubber, although some of its physical and mechanical properties are inferior. It is lacking in tensile strength, elongation, resilience, hot tear, and hysteresis. These disadvantages are offset somewhat by its low cost, cleanliness, slightly better heat-aging properties, slightly better wear than natural rubber for passenger tires, and availability at a stable price. The electrical properties of SBR are generally good but are not outstanding in any one area.

Buna-S has a maximum operating temperature of 170°F (80°C), which is not exceptional. At reduced temperatures, below 0°F, Buna-S products are more flexible than those produced from natural rubber.

Butadiene-styrene rubber has poor flame resistance and will support combustion. Table B.7 lists the physical and mechanical properties of Buna-S.

Table B.7 Physical and Mechanical Properties of Butadiene-Styrene Rubber (SBR, Buna-S, GR-S)[a]

Specific gravity	0.94
Refractive index	1.53
Specific heat, cal/g	0.454
Brittle point	–76°F (–60°C)
Insulation resistance, ohms/cm	10^{15}
Dielectric constant at 50 Hz	2.9
Swelling, % by volume	
in kerosene at 77°F (25°C)	100
in benzene at 77°F (25°C)	200
in acetone at 77°F (25°C)	30
in mineral oil at 100°F (38°C)	150
Tear resistance, psi	550
Creep at 70°C	14.6
Tensile strength, psi	1600–3700
Elongation, % at break	650
Hardness, Shore A	35–90
Abrasion resistance	Excellent
Maximum temperature, continuous use	175°F (80°C)
Resistance to compression set	Poor
Machining qualities	Can be ground
Resistance to sunlight	Deteriorates
Effect of aging	Little effect
Resistance to heat	Stiffens

[a] These are representative values since they may be altered by compounding.

Resistance to Sun, Weather, and Ozone

Butadiene-styrene rubber has poor weathering and aging properties. Sunlight will cause it to deteriorate. However, it does have better water resistance than natural rubber.

Chemical Resistance

The chemical resistance of Buna-S is similar to that of natural rubber. It is resistant to water and exhibits fair to good resistance to dilute acids, alkalies, and alcohols. It is not resistant to oils, gasoline, hydrocarbons, or oxidizing agents.

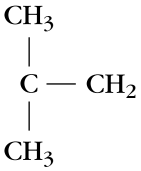
Applications

The major use of Buna-S is in the manufacture of automobile tires, although Buna-S materials are also used to manufacture conveyor belts, hose, gaskets, and seals against air, moisture, sound, and dirt.

See Ref. 7.

BUTYL RUBBER (IIR) AND CHLOROBUTYL RUBBER (CIIR)

Butyl rubber contains isobutylene,



$$\begin{array}{l} \mathrm{CH_3} \\ \;\;| \\ \;\mathrm{C} - \mathrm{CH_2} \\ \;\;| \\ \mathrm{CH_3} \end{array}$$

as its parent material, with small proportions of butadiene or isoprene added. Commercial butyl rubber may contain 5% butadiene as a copolymer. It is a general-purpose synthetic rubber whose outstanding physical properties are low permeability to air (approximately one-fifth that of natural rubber) and high energy absorption.

Chlorobutyl rubber is chlorinated isobutylene-isoprene. It has the same general properties as butyl rubber but with slightly higher allowable operating temperatures.

Physical and Mechanical Properties

The single outstanding physical property of butyl rubber is its impermeability. It does not permit gases like hydrogen or air to diffuse through it nearly as rapidly as ordinary rubber does, and it has excellent resistance to the aging action of air. These properties make butyl rubber valuable in the production of life jackets (inflatable type), life rafts, and inner tubes for tires.

At room temperature the resiliency of butyl rubber is poor, but as the temperature increases the resiliency increases. At elevated temperatures butyl rubber exhibits good resiliency. Its abrasion resistance, tear resistance, tensile strength, and adhesion to fabrics and metals is good. Butyl rubber has a maximum continuous service temperature of 250–350°F (120–177°C), with good resistance to heat aging. Its electrical properties are generally good but not outstanding in any one category. The flame resistance of butyl rubber is poor.

Table B.8 lists the physical and mechanical properties of butyl rubber.

Chlorobutyl (CIIR) rubbers have a maximum operating temperature of 300°F (177°C) and can be operated as low as –30°F (–34°C). The other physical and mechanical properties are similar to those of butyl rubber.

Resistance to Sun, Weather, and Ozone

Butyl rubber has excellent resistance to sun, weather, and ozone. Its weathering qualities are outstanding, as is its resistance to water absorption.

Chemical Resistance

Butyl rubber is very nonpolar. It has exceptional resistance to dilute mineral acids, alkalies, phosphate ester oils, acetone, ethylene, ethylene glycol, and water. Resistance to concentrated acids, except nitric and sulfuric, is good. Unlike natural rubber, it is very

Table B.8 Physical and Mechanical Properties of Butyl Rubber (IIR)[a]

Specific gravity	0.91
Dielectric strength, V/mm	25,000
Tensile strength, psi	500–3000
Hardness, Shore A	15–90
Abrasion resistance	Excellent
Maximum temperature, continuous use	250–35°F (120–177°C)
Machining qualities	Can be ground
Resistance to sunlight	Excellent
Effect of aging	Highly resistant
Resistance to heat	Stiffens slightly

[a] These are representative values since they may he altered by compounding.

resistant to swelling by vegetable and animal oils. It has poor resistance to petroleum oils, gasoline, and most solvents (except oxygenated solvents).

CIIR has the same general resistance as natural rubber but can be used at higher temperatures. Unlike butyl rubber, CIIR cannot be used with hydrochloric acid. Refer to Table B.9 for the compatibility of butyl rubber with selected corrodents and Table B.10 for the compatibility of chlorobutyl rubber with selected corrodents.

Table B.9 Compatibility of Butyl Rubber with Selected Corrodents[a]

	Maximum temp.			Maximum temp.	
Chemical	°F	°C	Chemical	°F	°C
Acetaldehyde	80	27	Benzaldehyde	90	32
Acetic acid 10%	150	66	Benzene	x	x
Acetic acid 50%	110	43	Benzene sulfonic acid 10%	90	32
Acetic acid 80%	110	43	Benzoic acid	150	66
Acetic acid, glacial	x	x	Benzyl alcohol	190	88
Acetic anhydride	x	x	Benzyl chloride	x	x
Acetone	100	38	Borax	190	88
Acrylonitrile	x	x	Boric acid	150	66
Adipic acid	x	x	Butyl acetate	x	x
Allyl alcohol	190	88	Butyl alcohol	140	60
Allyl chloride	x	x	Butyric acid	x	x
Alum	200	93	Calcium bisulfite	120	49
Aluminum acetate	200	93	Calcium carbonate	150	66
Aluminum chloride, aqueous	200	93	Calcium chlorate	190	88
Aluminum chloride, dry	200	93	Calcium chloride	190	88
Aluminum fluoride	180	82	Calcium hydroxide 10%	190	88
Aluminum hydroxide	100	38	Calcium hydroxide, sat.	190	88
Aluminum nitrate	100	38	Calcium hypochlorite	x	x
Aluminum sulfate	200	93	Calcium nitrate	190	88
Ammonium bifluoride	x	x	Calcium sulfate	100	38
Ammonium carbonate	190	88	Carbon dioxide, dry	190	88
Ammonium chloride 10%	200	93	Carbon dioxide, wet	190	88
Ammonium chloride 50%	200	93	Carbon disulfide	190	88
Ammonium chloride, sat.	200	93	Carbon monoxide	x	x
Ammonium fluoride 10%	150	66	Carbon tetrachloride	90	32
Ammonium fluoride 25%	150	66	Carbonic acid	150	66
Ammonium hydroxide 25%	190	88	Cellosolve	150	66
Ammonium hydroxide, sat.	190	88	Chloracetic acid, 50% water	150	66
Ammonium nitrate	200	93	Chloracetic acid	100	38
Ammonium persulfate	190	88	Chlorine gas, dry	x	x
Ammonium phosphate	150	66	Chlorine, liquid	x	x
Ammonium sulfate 10–40%	150	66	Chlorobenzene	x	x
Amyl acetate	x	x	Chloroform	x	x
Amyl alcohol	150	66	Chlorosulfonic acid	x	x
Aniline	150	66	Chromic acid 10%	x	x
Antimony trichloride	150	66	Chromic acid 50%	x	x
Barium chloride	150	66	Citric acid 15%	190	88
Barium hydroxide	190	88	Citric acid, concentrated	190	88
Barium sulfide	190	88	Copper chloride	150	66

Table B.9 Compatibility of Butyl Rubber with Selected Corrodents[a] (Continued)

	Maximum temp.			Maximum temp.	
Chemical	°F	°C	Chemical	°F	°C
Copper sulfate	190	88	Nitric acid 5%	200	93
Cresol	x	x	Nitric acid 20%	150	66
Cupric chloride 5%	150	66	Nitric acid 70%	x	x
Cupric chloride 50%	150	66	Nitric acid, anhydrous	x	x
Cyclohexane	x	x	Nitrous acid, concentrated	125	52
Dichloroethane (ethylene dichloride)	x	x	Oleum	x	x
Ethylene glycol	200	93	Perchloric acid 10%	150	66
Ferric chloride	175	79	Phenol	150	66
Ferric chloride 50% in water	160	71	Phosphoric acid 50–80%	150	66
Ferric nitrate 10–50%	190	88	Salicylic acid	80	27
Ferrous chloride	175	79	Sodium chloride	200	93
Ferrous nitrate	190	88	Sodium hydroxide 10%	150	66
Fluorine gas, dry	x	x	Sodium hydroxide 50%	150	66
Hydrobromic acid, dilute	125	52	Sodium hydroxide, concentrated	150	66
Hydrobromic acid 20%	125	52	Sodium hypochlorite 20%	x	x
Hydrobromic acid 50%	125	52	Sodium hypochlorite, concentrated	x	x
Hydrochloric acid 20%	125	52	Sodium sulfide to 50%	150	66
Hydrochloric acid 38%	125	52	Stannic chloride	150	66
Hydrocyanic acid 10%	140	60	Stannous chloride	150	66
Hydrofluoric acid 30%	150	66	Sulfuric acid 10%	200	93
Hydrofluoric acid 70%	150	66	Sulfuric acid 50%	150	66
Hydrofluoric acid 100%	150	66	Sulfuric acid 70%	x	x
Hypochlorous acid	x	x	Sulfuric acid 90%	x	x
Lactic acid 25%	125	52	Sulfuric acid 98%	x	x
Lactic acid, concentrated	125	52	Sulfuric acid 100%	x	x
Magnesium chloride	200	93	Sulfuric acid, fuming	x	x
Malic acid	x	x	Sulfurous acid	200	93
Methyl chloride	90	32	Thionyl chloride	x	x
Methyl ethyl ketone	100	38	Toluene	x	x
Methyl isobutyl ketone	80	27	Trichloroacetic acid	x	x
Muriatic acid	x	x	Zinc chloride	200	93

[a] The chemicals listed are in the pure state or in a saturated solution unless otherwise indicated. Compatibility is shown to the maximum allowable temperature for which data are available. Incompatibility is shown by an x.

Source: PA Schweitzer. *Corrosion Resistance Tables.* 4th ed. Vols. 1–3. New York: Marcel Dekker, 1995.

Table B.10 Compatibility of Chlorobutyl Rubber with Selected Corrodents[a]

	Maximum temp.			Maximum temp.	
Chemical	°F	°C	Chemical	°F	°C
Acetic acid 10%	150	60	Alum	200	93
Acetic acid 50%	150	60	Aluminum chloride, aqueous	200	93
Acetic acid 80%	150	60	Aluminum nitrate	190	88
Acetic acid, glacial	x	x	Aluminum sulfate	200	93
Acetic anhydride	x	x	Ammonium carbonate	200	93
Acetone	100	38	Ammonium chloride 10%	200	93

Table B.10 Compatibility of Chlorobutyl Rubber with Selected Corrodents[a] (Continued)

	Maximum temp.			Maximum temp.	
Chemical	°F	°C	Chemical	°F	°C
Ammonium chloride 50%	200	93	Ferrous chloride	175	79
Ammonium chloride, sat.	200	93	Hydrobromic acid, dilute	125	52
Ammonium nitrate	200	93	Hydrobromic acid 20%	125	52
Ammonium phosphate	150	66	Hydrobromic acid 50%	125	52
Ammonium sulfate 10–40%	150	66	Hydrochloric acid 20%	x	x
Amyl alcohol	150	66	Hydrochloric acid 38%	x	x
Aniline	150	66	Hydrofluoric acid 70%	x	x
Antimony trichloride	150	66	Hydrofluoric acid 100%	x	x
Barium chloride	150	66	Lactic acid 25%	125	52
Benzoic acid	150	66	Lactic acid, concentrated	125	52
Boric acid	150	66	Magnesium chloride	200	93
Calcium chloride	160	71	Nitric acid 5%	200	93
Calcium nitrate	160	71	Nitric acid 20%	150	66
Calcium sulfate	160	71	Nitric acid 70%	x	x
Carbon monoxide	100	38	Nitric acid, anhydrous	x	x
Carbonic acid	150	66	Nitrous acid, concentrated	125	52
Chloracetic acid	100	38	Phenol	150	66
Chromic acid 10%	x	x	Phosphoric acid 50–80%	150	66
Chromic acid 50%	x	x	Sodium chloride	200	93
Citric acid 15%	90	32	Sodium hyroxide 10%	150	66
Copper chloride	150	66	Sodium sulfide to 50%	150	66
Copper cyanide	160	71	Sulfuric acid 10%	200	93
Copper sulfate	160	71	Sulfuric acid 70%	x	x
Cupric chloride 5%	150	66	Sulfuric acid 90%	x	x
Cupric chloride 50%	150	66	Sulfuric acid 98%	x	x
Ethylene glycol	200	93	Sulfuric acid 100%	x	x
Ferric chloride	175	79	Sulfuric acid, fuming	x	x
Ferric chloride 50% in water	100	38	Sulfurous acid	200	93
Ferric nitrate 10–50%	160	71	Zinc chloride	200	93

[a] The chemicals listed are in the pure state or in a saturated solution unless otherwise indicated. Compatibility is shown to the maximum allowable temperature for which data are available. Incompatibility is shown by an x.
Source: PA Schweitzer. *Corrosion Resistance Tables.* 4th ed. Vols. 1–3. New York: Marcel Dekker, 1995.

Applications

Because of its impermeability, butyl rubber finds many uses in the manufacture of inflatable items such as life jackets, lifeboats, balloons, and inner tubes. The excellent resistance it exhibits in the presence of water and steam makes it suitable for hoses and diaphragms. Applications are also found as flexible electrical insulation, shock and vibration absorbers, curing bags for tire vulcanization, and molding.

See Refs. 3 and 7.

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