Table 13-2: Pump materials of construction (Source: ITT/Goulds, Seneca Falls, NY 13148)

Table 13-2A: Typical pump material selections (pg. 1 of 4)

This chart is intended as a guide in the selection of economical materials. It must be kept in mind that corrosion rates may vary widely with temperature, concentration, and the presence of trace elements or abrasive solids. Blank spaces in the chart indicate a lack of accurate corrosion data for those specific conditions. In general, the chart is limited to metals and non-metals regularly furnished by Goulds.

Code:
A = Recommended
B = Useful Resistance
X = Unsuitable

Note: Maximum temperature limits are shown where data is available. Contact a Goulds representative for temperature limits of all materials before final material selection.

A-20 — Carpenter Stainless
CD4MCu — Stainless Steel
Alloy 2205 — Stainless Steel
H-B — Hastelloy Alloy - B
H-C — Hastelloy Alloy - C
Ti — Titanium Unalloyed
316SS — Stainless Steel
'Tefzel — Ethyltetrafluoroethylene

C.I. — Cast Iron
D.I. — Ductile Iron
Steel — Carbon Steel
Brz. — Bronze
Zi — Zirconium
FRP — Fibre Reinforced Vinylester
PFA — Virgin Teflon

Corrosive	Steel C.I. D.I.	Brz	316	A-20	CD4MCu	ALLOY 2205	HAST B	HAST C	Ti	Zi	TEFZEL (ETFE)	PFA	FRP
Acetaldehyde, 70°F.	B	A	A	A	A	A		A	A	A	A	A	X
Acetic Acid, 70° F.	X	A	A	A	A	A	A	A	A	A	A	A	X
Acetic Acid, <50%, To Boiling	X	B	A	A	B	A	X	A	A	A			
Acetic Acid, >50%, To Boiling	X	X	B	A	X	A	X	A	A	A	104°C	149°C	X
Acetone, To Boiling	A	A	A	A	A	A	A	A	A	A	104°C	149°C	X
Aluminum Chloride, <10%, 70° F.	X	B	X	B	X	B	A		B	A	A	A	A
Aluminum Chloride, >10%, 70° F.	X	X	X	B	X	B	A		B	A	A	A	A
Aluminum Chloride, <10%, To Boiling	X	X	X	X	X	X	A		X	A	104°C	149°C	X
Aluminum Chloride, >10%, To Boiling	X	X	X	X	X	X	A	X	X	A	104°C	149°C	X
Aluminum Sulphate, 70° F.	X	B	A	A	A	A	B	B	A	A	A	A	A
Aluminum Sulphate, <10%, To Boiling	X	B	B	A	B	A	A	A	A	A	104°C	149°C	
Aluminum Sulphate, >10%, To Boiling	X	X	X	B	X	B	B	B	X	B	104°C	149°C	
Ammonium Chloride, 70° F.	X	X	B	B	B	B		A	A	A	A	A	A
Ammonium Chloride, <10%, To Boiling	X	X	B	B	X	B	B	A	A	A	104°C	149°C	
Ammonium Chloride, >10%, To Boiling	X	X	X	X	X	X		X	X	X	104°C	149°C	
Ammonium Fluosilicate, 70° F.	X	X	X	B	X	B		X	X	X			A
Ammonium Sulphate, <40%, To Boiling	X	X	B	B	X	B	X	B	A	A	104°C	149°C	
Arsenic Acid, to 225° F.	X	X	X	B	X	B					A	A	
Barium Chloride, 70° F. <30%	X	B	X	B	X	B	B	B	B	B	A	A	A
Barium Chloride, <5%, To Boiling	X	B	X	B	X	B	B	B	A	A	104°C	149°C	
Barium Chloride >5%, To Boiling	X	X	X	X	X	X	X	X	X	X	104°C	149°C	
Barium Hydroxide, 70° F.	B	X	A	A	A	A	B	B	A	A	A	A	A
Barium Nitrate, To Boiling	X	X	B	B	B	B	B		B	B	104°C	149°	
Barium Sulphide, 70° F.	X	X	B	B	B	B			A	A	A	A	A
Benzoic Acid	X	X	B	B	B	B	A	A	A	A	A	A	
Boric Acid, To Boiling	X	X	B	B	B	B	A	A	B	B	104°C	149°C	
Boron Trichloride, 70° F. Dry	B	B	B	B	B	B	B	B					
Boron Trifluoride, 70° F. 10%, Dry	B	B	B	A	B	A		A					
Brine (acid), 70° F.	X	X	X	X	X	X		B	B		A	A	A
Bromine (dry), 70° F.	X	X	X	X	X	X	B	B	X	X	A	A	X
Bromine (wet), 70° F.	X	X	X	X	X	X		B	X	X	A	A	X
Calcium Bisulphite, 70°F.	X	X	B	B	B	B		B	A	A	A	A	
Calcium Bisulphite,	X	X	X	B	X	B		X	A	A	A	A	
Calcium Chloride, 70° F.	B	X	B	B	B	B	A	A	A	A	A	A	A
Calcium Chloride <5%, To Boiling	X	X	B	B	B	B	A	A	A	A	104°C	149°C	
Calcium Chloride >5%, To Boiling	X	X	X	B	X	B	A	A	B	B	104°C	149°C	
Calcium Hydroxide, 70° F.	B	B	B	B	B	B		A	A		A	A	A
Calcium Hydroxide, <30%, To Boiling	X	B	B	B	B	B		A	A		104°C	149°C	
Calcium Hydroxide, >30%, To Boiling	X	X	X	X	X	X		B	A		104°C	149°C	

Table 13-2B: Typical pump material selections (pg. 2 of 4)

Corrosive	Steel C.I. D.I.	Brz	316	A-20	CD4MCu	ALLOY 2205	HAST B	HAST C	Ti	Zi	TEFZEL (ETFE)	PFA	FRP
Calcium Hypochlorite, <2%, 70° F.	X	X	X	X	X	X		A	A	A	A	A	X
Calcium Hypochlorite, >2%, 70° F.	X	X	X	X	X	X		B	A	B	A	A	X
Carbolic Acid, 70° F. (phenol)	X	B	A	A	A	A	A	A	A	A	A	A	
Carbon Bisulphide, 70° F.	B	B	A	A	A	A			A		A	A	
Carbonic Acid, 70° F.	B	X	A	A	A	A	A	A	A	A	A	A	
Carbon Tetrachloride, Dry to Boiling	B	B	A	A	A	A	B	B	A	A	104°C	149°C	
Chloric Acid, 70° F.	X	X	X	B	X	B	X	X			A	A	
Chlorinated Water, 70° F.	X	X	B	B	B	B		A	A	A	A	A	
Chloroacetic Acid, 70° F.	X		X	X		X			A	B	A	A	A
Chlorosulphonic Acid, 70° F.	X	X	X	X	X	X	A	A	B	X	A	A	A
Chromic Acid, <30%	X	X	X	B	X	B		B	A	A	65°C	A	X
Citric Acid	X	X	A	A	A	A	A	A	A	A	A	A	A
Copper Nitrate, to 175° F.	X	X	B	B	B	B	X	X	B		A	A	A
Copper Sulphate, To Boiling	X	X	X	B	X	B		A	A	A	104°C	149°C	
Cresylic Acid	X	X	B	B	B	B	B	B			A	A	
Cupric Chloride	X	X	X	X	X	X		X	B	X	A	A	
Cyanohydrin, 70° F.	X		B	B	B	B					A	A	A
Dichloroethane	X	B	B	B	B	B	B	B	A	B	65°C	149°C	
Diethylene Glycol, 70° F.	A	B	A	A	A	A	B	B	A	A	A	A	
Dinitrochlorobenzene, 70° F. (dry)	X	B	A	A	A	A	A	A	A	A	A	A	
Ethanolamine, 70° F.	B	X	B	B	B	B			A	A	A	A	
Ethers, 70° F.	B	B	B	A	A	A	B	B	A	A	A	A	
Ethyl Alcohol, To Boiling	A	A	A	A	A	A	A	A	A	A	104°C	149°C	
Ethyl Cellulose, 70° F.	A	B	B	B	B	B	B	B	A	A	A	A	
Ethyl Chloride, 70° F.	X	B	B	A	B	A	B	B	A	A	A	A	X
Ethyl Mercaptan, 70° F.	X	X	B	A	B	A	B	B			A	A	X
Ethyl Sulphate, 70° F.	X	B	B	A	B	A					A	A	X
Ethylene Chlorohydrin, 70° F.	X	B	B	B	B	B	B	B	A	A	A	A	X
Ethylene Dichloride, 70° F.	X	B	B	B	B	B	B	X	A	A	A	A	X
Ethylene Glycol, 70° F.	B	B	B	B	B	B	A	A	A	A	A	A	A
Ethylene Oxide, 70° F.	X	X	B	B	B	B	A	A	A	A	A	A	
Ferric Chloride, <5%, 70° F.	X	X	X	X	X	X	X	A	A	B	A	A	A
Ferric Chloride, >5%, 70° F.	X	X	X	X	X	X	X	B	B	X	A	A	X
Ferric Nitrate, 70° F.	X	X	B	A	B	A		B			A	A	A
Ferric Sulphate, 70° F.	X	X	X	B	X	B		B	B	B	A	A	A
Ferrous Sulphate, 70° F.	X	X	X	B	X	B	B	B	A	A	A	A	A
Formaldehyde, To Boiling	B	B	A	A	A	A	B	B	A	A	104°C	149°C	
Formic Acid, to 212° F.	X	X	X	A	B	A	A	A	X	A	A	A	
Freon, 70° F.	A	A	A	A	A	A	A	A	A	A	A	A	
Hydrochloride Acid, <1%, 70° F.	X	X	X	B	X	B	B	A	B	A	A	A	A
Hydrochloric Acid, 1-20%, 70° F.	X	X	X	X	X	X	B	X	X	A	A	A	A
Hydrochloric Acid, >20%, 70° F.	X	X	X	X		X	B	X	X	B	A	A	X
Hydrochloric Acid, <½ %, 175° F.	X	X	X	X	X	X	A	X	X	A	A	A	X
Hydrochloric Acid, ½-2%, 175° F.	X	X	X		X		B	X	X	A	A	A	X
Hydrocyanic Acid, 70° F.	X	X	X	B	X	B	X	X			A	A	A
Hydrogen Peroxide, <30% <150° F.	X	X	B	B	B	B	B	B	A	A	A	A	
Hydrofluoric Acid, <20%, 70° F.	X	B	X	B	X	B	X	B	X	X	A	A	
Hydrofluoric Acid, >20%, 50° F.	X	X	X	X	X	X	X	B	X	X	A	A	
Hydrofluoric Acid, To Boiling	X	X	X	X	X	X		X	X	X			
Hydrofluorsilicic Acid, 70° F.	X		X	B	X	B		B			A	A	
Lactic Acid, <50%, 70° F.	X	B	A	A	A	A	B	B	A	A	A	A	
Lactic Acid, >50%, 70° F.	X	B	B	B	B	B	B	B	A	A	A	A	
Lactic Acid, <5%, To Boiling	X	X	X	B	X	B	B	B	A	A	104°C	149°C	
Lime Slurries, 70° F.	B	B	B	B	A	B	B	B	B	B			

Table 13-2C: Typical pump material selections (pg. 3 of 4)

Corrosive	Steel C.I. D.I.	Brz	316	A-20	CD4MCu	ALLOY 2205	HAST B	HAST C	Ti	Zi	TEFZEL (ETFE)	PFA	FRP
Magnesium Chloride, 70° F.	X	X	B	A	B	A	A	A	A	A	A	A	A
Magnesium Chloride, <5%, To Boiling	X	X	X	B	X	B	A	A	A	A	104°C	149°C	
Magnesium Chloride, >5%, To Boiling	X	X	X	X	X	X	B	B	B	B	104°C	149°C	
Magnesium Hydroxide, 70° F.	B	A	B	B	A	B	B	B	A		A	A	A
Magnesium Sulphate	X	X	B	A	B	A	X	X	B	B	A	A	
Maleic Acid	X	X	B	B	B	B	B	B	A		A	A	
Mercaptans	A	X	A	A	A	A					A	A	
Mercuric Chloride, <2%, 70° F.	X	X	X	X	X	X		B	A	A	A	A	
Mercurous Nitrate, 70° F.	X	X	B	B	B	B		C			A	A	
Methyl Alcohol, 70° F.	A	A	A	A	A	A	A	A	A	A	A	A	
Naphthalene Sulphonic Acid, 70° F.	X	X	B	B	B	B	B	B			A	A	
Napthalenic Acid	X	X	B	B	B	B	B	B			A	A	
Nickel Chloride, 70° F.	X	X	X	B	X	B	A		B	B	A	A	A
Nickel Sulphate	X	X	B	B	B	B		B		A	A	A	
Nitric Acid	X	X	B	B	B	B			B	B			
Nitrobenzene, 70° F.	A	X	A	A	A	A	B	B	A		A	A	X
Nitroethane, 70° F.	A	A	A	A	A	A	A	A	A	A	A	A	X
Nitropropane, 70° F.	A	A	A	A	A	A	A	A	A	A	A	A	X
Nitrous Acid, 70° F.	X	X	X	X	X	X					A	A	A
Nitrous Oxide, 70° F.	X	X	X	X	X	X		X			A	A	
Oleic Acid	X	X	B	B	B	B	X	X	X	X	A	A	X
Oleum, 70° F.	B	X	B	B	B	B	B	B	B		A	A	X
Oxalic Acid	X	X	X	B	X	B	B	B	X	A	A	A	X
Palmitic Acid	B	B	B	A	B	A					A	A	
Phenol (see carbolic acid)											A	A	
Phosgene, 70° F.	X	X	B	B	B	B	B	B			A	A	
Phosphoric Acid, <10%, 70° F.	X	X	A	A	A	A	A	A	A	A	A	A	A
Phosphoric Acid, >10-70%, 70° F.	X	X	A	A	A	A	B	X	B	B	A	A	X
Phosphoric Acid, <20%, 175° F.	X	X	B	B	B	B	A	A	X	B	A	A	X
Phosphoric Acid, >20%, 175° F. <85%	X	X	X	B	X	B	B	X	X	X	A	A	X
Phosphoric Acid, >10%, Boil, <85%	X	X	X	X	X	X	X	X	X	X			
Phthalic Acid, 70° F.	X	B	B	A	B	A	B	B	A	A	A	A	
Phthalic Anhydride, 70° F.	B	X	A	A	A	A	A	A			A	A	
Picric Acid, 70° F.	X	X	X	B	X	B		B			A	A	
Potassium Carbonate	B	B	A	A	A	A	B	B	A	A	A	A	A
Potassium Chlorate	B	X	A	A	A	A		B	A	A	A	A	A
Potassium Chloride, 70° F.	X	X	B	A	B	A	B	B	A	A	A	A	A
Potassium Cyanide, 70° F.	B	X	B	B	B	B	B	B			A	A	A
Potassium Dichromate	B	B	A	A	A	A		B	A	A	A	A	
Potassium Ferricyanide	X	B	B	B	B	B	B	B	A	A	A	A	
Potassium Ferrocyanide, 70° F.	X	B	B	B	B	B	B	B		B	A	A	A
Potassium Hydroxide, 70° F.	X	X	B	A	B	A	B	X	B	A	A	A	A
Potassium Hypochlorite	X	X	X	B	X	B		B	A		A	A	
Potassium Iodide, 70° F.	X	B	B	B	B	B	B	B	A	A	A	A	
Potassium Permanganate	B	B	B	B	B	B		B			A	A	A
Potassium Phosphate	X	X	B	B	B	B			B	B	A	A	A
Sea Water, 70° F.	X	B	B	A	B	A	A	A	A	A	A	A	A
Sodium Bisulphate, 70° F.	X	X	X	B	X	B	B	B	B	A	A	A	A
Sodium Bromide, 70° F.	B	X	B	B	B	B	B	B			A	A	A
Sodium Carbonate	B	B	B	A	B	A	B	B	A	A	A	A	A
Sodium Chloride, 70° F.	X	B	B	B	B	B	B	B	A	A	A	A	A
Sodium Cyanide	B	X	B	B	B	B			B		A	A	
Sodium Dichromate	B	X	B	B	B	B			B		100°C	A	
Sodium Ethylate	B	A	A	A	A	A					A	A	

Table 13-2D: Typical pump material selections (pg. 4 of 4)

Corrosive	Steel C.I. D.I.	Brz	316	A-20	CD4MCu	ALLOY 2205	HAST B	HAST C	Ti	Zi	TEFZEL (ETFE)	PFA	FRP
Sodium Fluoride	X	X	B	B	B	B	X	X	B	B	A	A	
Sodium Hydroxide, 70° F.	B	B	B	A	B	A	A	A	A	A	A	A	A
Sodium Hypochlorite	X	X	X	X	X	X		B	A	B	A	A	X
Sodium Lactate, 70° F.	B	X	X	X	X	X	X	X			A	A	A
Stannic Chloride, <5%, 70° F.	X	X	X	X	X	X	B	B	A	A	A	A	A
Stannic Chloride, >5%, 70° F.	X	X	X	X	X	X	B	X	B	B	A	A	
Sulphite Liquors, To 175° F.	X	X	B	B	B	B		B	A				
Sulphur (molten)	B	X	A	A	A	A	X	A	A				
Sulphur Dioxide (spray), 70° F.	X	X	B	B	B	B		B	X		A	A	
Sulphuric Acid, <2%, 70° F.	X	X	B	A	B	A	A	A	B	A	A	A	A
Sulphuric Acid, 2-40%, 70° F.	X	X	X	B	X	B	A	A	X	A	A	A	A
Sulphuric Acid, 40%, <90%, 70° F.	X	X	X	B	X	B	A	A	X	X	A	A	X
Sulphuric Acid, 93-98%, 70° F.	B	X	B	B	B	B	B	B	X	X	A	A	X
Sulphuric Acid, <10%, 175° F	X	X	X	B	X	B	A	X	X	B	A	A	A
Sulphuric Acid, 10-60% & >80%, 175° F.	X	X	X	B	X	B	B	X	X	X	A	A	X
Sulphuric Acid, 60-80%, 175° F.	X	X	X	X	X	X	B	X	X	X	A	A	X
Sulphuric Acid, < 3/4%, Boiling	X	X	X	B	X	B	B	B	X	B			
Sulphuric Acid, 3/4-40%, Boiling	X	X	X	X	X	X	B	X	X	B			
Sulphuric Acid, 40-65% & >85%, Boil	X	X	X	X	X	X	X	X	X	X			
Sulphuric Acid, 65-85%, Boiling	X	X	X	X	X	X	X	X	X	X			
Sulphurous Acid, 70° F.	X	X	X	B	X	B	B	B	A	B	A	A	A
Titanium Tetrachloride, 70° F.	X		X	B	X	B		X			A	A	
Tirchlorethylene, To Boiling	B	X	B	B	B	B	B	B	A	A			
Urea, 70° F.	X	X	B	B	B	B	X	X	B	B	A	A	
Vinyl Acetate	B	B	B	B	B	B		B			A	A	
Vinyl Chloride	B	X	B	B	B	B	X	B	A		A	A	
Water, To Boiling	B	A	A	A	A	A	A	A	A	A			
Zinc Chloride	X	X	B	A	B	A	B		A	A	A	A	A
Zinc Cyanide, 70° F.	X	B	B	B	B	B	B	B	B	B	A	A	
Zinc Sulphate	X	X	A	A	A	A	X	X	A		A	A	A

Table 13-3: Z-direction thermal expansion of DuPont Vespel® CR6100 (Source: DuPont Engineering Polymers, Newark, Delaware)

Process Temperature °F	*Axial Growth at Temperature, per Inch (Based on 68°F Ambient Temperature)*
-40	-0.019
-20	-0.016
0	-0.012
20	-0.009
40	-0.005
60	-0.001
80	0.002
100	0.006
120	0.009
140	0.013
160	0.017
180	0.020
200	0.024
220	0.027
240	0.031
260	0.035
280	0.038
300	0.042
320	0.047
340	0.052
360	0.057
380	0.062
400	0.067
420	0.077
440	0.087
460	0.097
480	0.108
500	0.118