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KIMAX®

Corrosion Resistance of Acid Waste Drainline Piping and Vent Materials

Corrosion Resistance of Acid Waste Drainline Piping and Vent Materials

Maximum Operating Temperature[1]

Materials:
A – Very Good Service to oper. limit of material. (see table)
B – Moderate Service
C – Limited or Variable Service
F – Unsatisfactory

Chemicals:
Solids assumed in solution.
Room temperatures assumed unless otherwise stated.
Data represented is to be used as a guide only. For specific information, test under actual operating conditions.

	KIMAX® Borosilicate Glass 250°F	High Silicon Iron 250°F	304 Stainless Steel; Fe. 18 Cr, 8 Ni 250°F	Teflon® 250°F	Polyethylene 150°F	Polyvinyl Chloride rigid or unplasticized 150°F	Polypropylene 180°F
Acetaldehyde CH_3CHO	**A**	A	A	A	F	A	B
Acetic Acid, 100%, CH_3COOH	**A**	A	F	A	F	F	C
Acetic Acid, (Dilute) 50%	**A**	A	B	A	C	C	A
Acetic Anhydride, $(CH_3CO)_2O$	**A**	A	B	A	B	F	C
Acetone, CH_3COCH_3	**A**	A	A	A	F	F	B
Alcohol, Amyl $CH_3(CH_2)_4OH$	**A**	B	B	A	C	F	C
Alcohol, Butyl C_4H_9OH	**A**	A	A	A	B	F	B
Allyl Chloride CH_2CHCH_2CL	**A**	A	B	A	F	F	F
Aluminium Chloride, $AlCl_3$	**A**	B	F	A	A	A	A
Aluminium Hydroxide, $AL(OH)_3$	**A**	B	A	A	B	A	A
Aluminium Sulfate, $Al_2(SO_4)_3$	**A**	B	F	A	A	A	A
Alums, Conc., $Al_2(SO_4)_3 \cdot K_2SO_4$, etc.	**A**	A	F	A	A	F	A
Ammonium Carbonate, $(NH_4)_2CO_3$	**A**	B	B	A	A	A	A
Ammonium Chloride, NH_4Cl	**A**	B	F	A	A	A	A
Ammonium Fluoride NH_4F 25%	**F**	F	C	A	A	A	A
Ammonium Hydroxide, NH_4OH	**A**	B	A	A	A	A	A
Amyl Acetate, $C_5H_{11}COOCH_3$	**A**	A	A	A	F	F	F
Amyl Chloride, $C_5H_{11}Cl$	**A**	B	A	A	F	F	F
Antimony Trichloride, $SbCl_3$	**A**	B	F	A	A	A	B
Aniline $C_6H_5NH_2$	**A**	B	A	A	F	F	B
Aniline Hydrochloride $C_6H_5NH_2 \cdot HCl$	**A**	B	F	A	B	F	F
Ammonia (Gas), (Moist), NH_3	**A**	B	A	A	A	A	B
Arsenic Acid, $HAsO_3$	**A**	B	F	A	A	A	C
Barium Carbonate, $BaCO_3$	**A**	B	B	A	A	A	A
Barium Chloride, $BaCl_2$	**A**	B	C	A	A	A	A
Barium Hydroxide, $Ba(OH)_2$	**A**	B	B	A	A	A	A
Barium Sulfate, $BaSO_4$	**A**	B	B	A	A	A	A
Barium Sulfide, BaS	**A**	B	B	A	A	A	A
Benzaldehyde, C_6H_5CHO 100%	**A**	B	B	A	F	F	C
Benzene, C_6H_6	**A**	A	B	B	F	F	F
Benzoic Acid, C_6H_5COOH	**A**	B	B	A	A	A	B
Borax, $Na_2B_4O_7 \cdot IOH_2O$	**A**	B	B	A	A	A	A
Boric Acid, H_3BO_3	**A**	B	B	A	A	A	A
Bromine, (Wet), Br_2	**A**	F	F	A	F	F	F
Butane C_4H_{10}	**A**	A	A	A	F	F	F
Butyl Acetate, $C_4H_9COOCH_3$	**A**	B	B	A	F	F	F
Butyric Acid, C_3H_7COOH	**A**	A	F	A	F	F	A
Calcium Bisulfite, $Ca(HSO_3)_2$	**A**	F	B	A	A	A	A
Calcium Carbonate, $CaCO_3$	**A**	B	A	A	A	A	A
Calcium Chlorate, $CaClO_3$	**A**	B	B	A	A	A	A
Calcium Chloride, $CaCl_2$	**A**	B	F	A	A	A	A
Calcium Hydroxide, $Ca(OH)_2$	**A**	C	B	A	A	A	A
Calcium Hypochlorite, $Ca(OCl)_2$	**A**	B	F	A	A	C	B
Carbon Disulfide, CS_2	**A**	A	B	A	F	F	F
Carbon Tetrachloride (Moist) CCl_4	**A**	A	F	A	F	F	F
Chloracetic Acid, $ClCH_2CO_2H$	**A**	B	F	A	F	F	F
Chloralhydrate $CCl_3CH(OH)_2$	**A**	A	F	A	F	A	F
Chloric Acid, $HCLO_3$	**A**	B	F	A	C	A	F

Maximum Operating Temperature[1]

Materials:
A – Very Good Service to oper. limit of material. (see table)
B – Moderate Service
C – Limited or Variable Service
F – Unsatisfactory

Corrosion Rate Code:
A = < 2 mm Penetration / Yr.
B = < 20
C = < 50
F = > 50

	KIMAX® Borosilicate Glass 250°F	High Silicon Iron 250°F	304 Stainless Steel; Fe. 18 Cr, 8 Ni 250°F	Teflon® 250°F	Polyethylene 150°F	Polyvinyl Chloride rigid or unplasticized 150°F	Polypropylene 180°F
Chlorine (Dry), Cl_2	**A**	B	B	A	F	F	F
Chlorine (Wet), Cl_2+H_2O	**A**	B	F	A	F	F	F
Chlorobenzene, C_6H_5Cl	**A**	B	B	A	F	F	F
Chloroform, $CHCl_3$	**A**	B	A	A	F	F	F
Chlorosulfonic Acid, 100% $ClSO_3OH$	**A**	A	B	A	F	F	F
Chlorox' Bleach, SOL, 5,5% Cl_2	**A**	A	A	A	F	F	F
Chromic Acid, CrO_3 sol'n	**A**	B	F	A	C	F	B
Copper Chloride, $CuCl_2$	**A**	B	F	A	A	A	B
Copper Nitrate $Cu(NO_3)_2$	**A**	A	A	A	A	A	B
Copper Sulfate $CuSO_4$	**A**	A	B	A	A	A	B
Cresol	**A**	B	A	A	F	F	B
Cyclohexanone	**A**	B	B	A	F	F	F
Dimethylamine $(CH_3)_2NH$	**A**	A	A	A	F	F	B
Dioctyl Phthalate	**A**	A	A	A	F	F	F
Dioxane	**A**	B	B	A	F	F	F
Ethers (Various)	**A**	A	B	A	F	F	F
Ethyl Acetate, $C_2H_5COOCH_3$	**A**	A	B	A	F	F	F
Ethylene Bromide, $C_2H_5Br_2$	**A**	B	A	A	F	F	F
Ethyl Chloride, C_2H_5Cl	**A**	A	A	A	F	F	F
Ethyl Ether $(C_2H_5)_2O$	**A**	A	B	A	F	F	F
Ethylene Chlorohydrin, $Cl(C_2H_4)OH$	**A**	B	B	A	F	F	C
Ethylene Dichloride, $C_2H_4Cl_2$	**A**	B	B	A	F	F	F
Ethylene Glycol, CH_2OHCH_2OH	**A**	B	B	A	A	A	A
Ethylene Oxide, CH_2OCH_2	**A**	A	B	A	F	F	F
Fatty Acids (Various)	**A**	A	B	A	F	A	B
Ferric Chloride, $FeCl_3$	**A**	C	F	A	A	A	A
Ferrous Chloride, $FeCl_2$	**A**	B	F	A	A	A	A
Ferrous Sulfate $FeSO_4$	**A**	B	B	A	A	A	A
Fluorine, F_2	F	F	A	A	F	B	F
Formaldehyde, CH_2O 37%	**A**	A	A	A	A	A	B
Formic Acid, HCOOH	**A**	A	C	A	C	F	B
Fuel Oil	**A**	A	A	A	F	A	F
Furfural, C_4H_3OCHO	**A**	B	B	A	F	F	F
Gallic Acid, $(OH)_3C_6H_2COOH$	**A**	A	B	A	A	A	A
Gasoline (Refined)	**A**	A	A	A	F	A	F
Glycerol, $CH_2OH.CHOHCH_2OH$	**A**	A	A	A	A	A	A
Heptane, $CH_3(CH_2)_5CH_3$	**A**	A	A	A	F	C	C
Hexane, C_6H_{14}	**A**	A	A	A	F	F	C
Hydrobromic Acid, HBr	**A**	F	F	A	A	A	C
Hydrocarbons (Aliphatic)	**A**	A	A	A	F	F	C
Hydrocarbons (Aromatic)	**A**	A	A	A	F	F	F
(Check individual listing)							
Hydrochloric Acid (Conc.), HCl	**A**	F	F	A	A	F	C
Hydrochloric Acid (Dilute)	**A**	F	F	A	A	A	B
Hydrofluoric Acid (Conc.), HF	F	F	F	A	B	C	C
Hydrofluoric Acid (Dilute)	F	F	F	A	A	C	B
Hydrofluosilicic Acid, H_2SIF_6	C	F	F	A	A	A	C
Hydrogen Peroxide (Conc.), H_2O_2	**A**	B	B	A	C	F	C

[1] For operating pressures see Drainline Catalog.
See back page for Physical and Chemical Data of KIMAX® Glass Drainline.

Corrosion Resistance of Acid Waste Drainline Piping and Vent Materials

Maximum Operating Temperature[1] **Materials:** A – Very Good Service to oper. limit of material. (see table) B – Moderate Service C – Limited or Variable Service F – Unsatisfactory **Chemicals:** Solids assumed in solution. Room temperatures assumed unless otherwise stated. Data represented is to be used as a guide only. For specific information, test under actual operating conditions.	250°F KIMAX® Borosilicate Glass	250°F High Silicon Iron	250°F 304 Stainless Steel; Fe. 18 Cr, 8 Ni	250°F Teflon®	150°F Polyethylene	150°F Polyvinyl Chloride rigid or unplasticized	180°F Polypropylene
Iodine, I_2 (Wet)	**A**	F	F	A	F	F	C
Isopropyl Ether $(Ch_3)_2$ $CHOCH(CH_3)_2$	**A**	A	A	A	F	F	C
Kerosene	**A**	A	A	A	F	A	F
Ketones (Various), RCOR'	**A**	A	A	A	F	F	C
Lauryl Chloride	**A**	A	A	A	F	A	C
Lead Acetate, $Pb(CH_3COO)_2$	**A**	B	B	A	A	A	A
Magnesium Chloride, $MgCl_2$	**A**	B	C	A	A	A	A
Magnesium Hydroxide, $Mg(OH)_2$	**A**	B	A	A	A	A	A
Magnesium Sulfate, $MgSO_4$	**A**	A	B	A	A	A	A
Mercury, Hg	**A**	A	A	A	A	A	A
Methanol (Conc.), CH_3OH	**A**	A	A	A	A	A	B
Methyl Chloride, CH_3Cl	**A**	A	A	A	F	F	F
Methylene Chloride, CH_2Cl_2	**A**	A	B	A	F	F	F
Methyl Ethyl Ketone, $CH_3COC_2H_5$	**A**	B	B	A	F	F	C
Methyl Isobutyl Ketone, $C_6H_{12}O$	**A**	B	B	A	F	F	C
Naphtha	**A**	B	A	A	F	A	C
Nickel Chloride, $NiCl_2$	**A**	B	C	A	A	A	A
Nickel Sulfate, $NiSO_4$	**A**	B	B	A	A	A	A
Nitric Acid (Conc.), HNO_3	**A**	A	F	A	F	F	F
Nitric Acid (Dilute)	**A**	A	A	A	A	C	B
Nitrobenzene, $C_6N_5NO_2$	**A**	A	B	A	F	F	C
Nitrous Oxide	**A**	B	B	A	F	A	C
Oleum	**A**	F	B	A	F	F	F
Oxalic Acid, CO_2HCO_2H	**A**	B	F	A	A	A	C
Perchloric Acid 70% $HClO_4$	**A**	A	F	A	A	F	C
Phenylhydrazine $C_6H_5NHNH_2$	**A**	A	A	A	F	F	C
Phosphoric Acid (100%), H_3PO_4	**A**	B	F	A	A	A	B
Phosphoric Acid (> 45% Cold) 80°F	**A**	B	F	A	A	A	A
Phosphoric Acid(< 45% Cold) 80°F	**A**	A	B	A	A	A	A
Phosphorus, Trichloride, PCl_3	**A**	A	B	A	B	F	C
Picric Acid, (Sol'n.), HO. C_6H_2 $(NO_2)_3$	**A**	B	B	A	C	F	C
Potassium Bromide, KBr	**A**	B	B	A	A	A	A
Potassium Carbonate, K_2CO_3	**A**	B	A	A	A	A	A
Potassium Chlorate, $KClO_3$	**A**	B	B	A	A	A	A
Potassium Chloride, KCl	**A**	A	B	A	A	A	A
Potassium Cyanide, KCN	**A**	B	B	A	A	A	A
Potassium Dichromate, $K_2Cr_2O_7$	**A**	A	A	A	A	A	A
Potassium Ferrocyanide, $K_4Fe(CN)_6$	**A**	A	A	A	A	A	A
Potassium Hydroxide, KOH	**A**	F	B	A	A	A	A
Potassium Nitrate, KNO_3	**A**	A	A	A	A	A	A
Potassium Permanangate, $KMnO_4$	**A**	B	B	A	B	B	C
Potassium Sulfate, K_2SO4	**A**	A	B	A	A	A	A
Potassium Sulfide, K_2S	**A**	A	B	A	A	A	A
Propylene Dichloride	**A**	A	A	A	F	F	F
Silver Nitrate, Ag NO_3	**A**	A	B	A	A	A	A
Sodium Acetate, CH_3COONa	**A**	B	B	A	A	A	A
Sodium Azide NaN_3	**A**	A	A	A	A	A	A
Sodium Bicarbonate, $NaHCO_3$	**A**	A	A	A	A	A	A

Maximum Operating Temperature[1] **Materials:** A – Very Good Service to oper. limit of material. (see table) B – Moderate Service C – Limited or Variable Service F – Unsatisfactory **Corrosion Rate Code:** A = < 2 mm Penetration / Yr. B = < 20 C = < 50 F = > 50	250°F KIMAX® Borosilicate Glass	250°F High Silicon Iron	250°F 304 Stainless Steel; Fe. 18 Cr, 8 Ni	250°F Teflon®	150°F Polyethylene	150°F Polyvinyl Chloride rigid or unplasticized	180°F Polypropylene
Sodium Bisulfate, $NaHSO_4$	**A**	A	F	A	A	A	A
Sodium Bisulfite, $NaHSO_3$	**A**	F	C	A	A	A	A
Sodium Bromide, NaBr	**A**	B	F	A	A	A	A
Sodium Carbonate, NA_2CO_3	**A**	B	B	A	A	A	A
Sodium Chlorate, $NaClO_3$	**A**	A	B	A	A	C	A
Sodium Chloride, NaCl	**A**	B	F	A	A	A	A
Sodium Cyanide, NaCN	**A**	A	A	A	A	A	A
Sodium Fluoride, NaF	B	F	F	A	A	A	A
Sodium Hydroxide, NaOH < 85°F	**A**	F	C	A	A	A	A
Sodium Hydroxide NaOH < 140°F	B	F	C	A	A	A	A
Sodium Hydroxide NaOH, > 160°F	F	F	A	A	A	A	A
Sodium Hypochlorite, NaOCl	**A**	B	F	A	C	A	B
Sodium Hyposulfate, $Na_2S_2O_4$	**A**	B	B	A	A	A	B
Sodium Nitrate, $NaNO_3$	**A**	A	A	A	A	A	A
Sodium Sulfate, Na_2SO_4	**A**	A	A	A	A	A	A
Sodium Sulfide, Na_2S	F	B	F	A	A	A	A
Sodium Sulfite, Na_2SO_3	**A**	F	B	A	A	A	A
Stannic Chloride, $SnCl_4$	**A**	A	F	A	A	A	A
Stannous Chloride, $SnCl_2$	**A**	B	F	A	A	A	A
Stearic Acid, $CH_3(CH_2)_{16}COOH$	**A**	B	B	A	F	A	B
Sulfur, (Molten), S	**A**	A	A	A	C	A	B
Sulfur Chloride (Wet), S_2Cl_2	**A**	F	F	A	F	F	F
Sulfur Dioxide (Wet), SO_2+H_2O	**A**	F	F	A	C	F	C
Sulfur Trioxide, SO_3	**A**	F	B	A	A	A	F
Sulfuric Acid (Fuming to 98%)	**A**	F	A	A	F	F	F
Sulfuric Acid (Hot Conc.) H_2SO_4	**A**	A	F	A	F	F	F
Sulfuric Acid (Cold Conc.)	**A**	A	F	A	F	F	C
Sulfuric Acid (75% – 95%)	**A**	A	F	A	F	F	F
Sulfuric Acid (10% – 75%)	**A**	A	F	A	C	A	C
Sulfuric Acid (> 10%)	**A**	A	F	A	A	A	C
Sulfurous Acid, H_2SO_3	**A**	F	F	A	A	A	B
Sulfuryl Chloride, SO_2Cl_2	**A**	B	B	A	F	F	F
Tetrahydrofuran (75%)	**A**	A	A	A	F	F	F
Tetralin	**A**	B	A	A	F	F	F
Thionyl Chloride, $SOCl_2$	**A**	B	B	A	F	F	C
Toluene, $CH_3C_6H_5$	**A**	A	A	A	F	F	F
Tributyl Phosphate $(C_4H_9)_3PO4$	**A**	B	A	A	F	C	F
Trichlorethylene, (Dry), $Cl_2C.CHCl$	**A**	A	B	A	F	F	F
Tricresylphosphate, $(CH_3C_6H_4O)_3PO$	**A**	A	A	A	F	F	C
Turpentine	**A**	B	B	A	F	F	F
Vinyl Acetate, $C_4H_6O_2$	**A**	B	B	A	F	F	F
Water, (Distilled Lab)	**A**	A	A	A	A	A	A
Xylene, C_8H_{10}	**A**	B	B	A	F	F	F
Zinc Phosphate, $Zn_3(PO_4)_2$	**A**	B	B	A	A	A	A
Zinc Sulfate, $ZnSO_4$	**A**	A	B	A	A	A	A

[1] For operating pressures see Drainline Catalog.
See back page for Physical and Chemical Data of KIMAX® Glass Drainline.

Teflon® is a registered trademark of DuPont.
KIMAX® is a registered trademark of Gerresheimer Glass, Inc.

Summary of Tests

	KIMAX®	Duriron	Polypropylene
A	179	81	72
B	2	81	27
C	1	2	35
F	6	24	54
Total Chem. Tested	188	188	188

References:
Corrosion Data Survey, 1969 edition, Nace
Corrosion Data Survey – Nonmetals, 1975, Nace
Chemical Engineering Handbook, Perry & Chilton, 5th edition, McGraw Hill, 1973
"Super Corrosion Control", The Carpenter Steel Company, 1965
"A Guide to the Selection of Durco Corrosion Resisting Materials for Process Industries Service", The Duriron Company, Inc., 1964
"Corrosion Resistant Lined Pipe and Fittings", Corrosion Resistance Rating, Resistoflex Corporation, 1975
"Chemical Resistance Guide", Asahi / America, 1977
"Chemical Resistance of Plastic Piping Materials", Cabot Corporation, 1971

Physical and Chemical Properties of KIMAX® Piping Systems

Chemical Durability: KIMAX® Glass Pipe is measureably affected by only one acid, hydrofluoric, or strong caustics such as sodium or potassium hydroxide.

Under continuous exposure of 1 % hydrofluoric acid at 70° F will require approximately 30 to 35 years to destroy one-half the wall thickness of KIMAX® pipe. Ten percent HF at 70° F will require approximately five years of continuous exposure to destroy one-half the wall thickness.

When KIMAX® Glass is exposed to NaOH or KOH in concentrations up to 50 % at room temperature, the pipe should last from 90 to 100 years. All other chemicals exhibit little or no effect on KIMAX® Piping Systems.

General Chemical Composition	Approximate Percentage
Silica (SiO_2)	80.5 %
Boric Acid (B_2O_3)	13.0 %
Sodium Oxide (Na_2O)	4.0 %
Aluminium Oxide (Al_2O_3)	2.0 %
Potassium Oxide (K_2O)	0.5 %

Chemical Properties	
Thermal Coefficient of Linear Expansion	18 x 10^{-7} in / in / ° F
Thermal Expansion	KIMAX® brand drainline will expand only 0.22" per 100 ft. of length when temperature increases 100 ° F
Thermal Shock (Instantaneous)	1½" to 3" pipe – 200 ° F 4" pipe – 175 ° F 6" pipe – 160 ° F

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Tubing
SCHOTT AG
Erich-Schott-Strasse 14
95666 Mitterteich
Germany
Phone +49 (0)9633/80-0
Fax +49 (0)9633/80-614
info.tubing@schott.com

www.schott.com/tubing

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