Accessories

Thermowells

Thermowell Material Selection Guide

Application	Protecting Tube Material
Heat treating	
Annealing	
Up to 704°C (1300°F)	Black steel
Over 704°C (1300°F)	Inconel® 600, Type 446 SS
Carburizing hardening	
Up to 816°C (1500°F)	Black steel, Type 446 SS
816 to 1093°C (1500 to 2000°F)	Inconel® 600, Type 446 SS
Over 1093°C (2000°F)	Ceramic*
Nitriding salt baths	Type 446 SS
Cyanide	Nickel (CP)
Neutral	Type 446 SS
High speed	Ceramic*
Iron and steel	
Blast furnaces	
Downcomer	Inconel® 600, Type 446 SS
Stove dome	Silicon carbide
Hot blast main	Inconel® 600
Stove trunk	Inconel® 600
Stove outlet flue	Black steel
Open hearth	
Flues and stack	Inconel® 600, Type 446 SS
Checkers	Inconel® 600, Cermets
Waste heat boiler	Inconel® 600, Type 446 SS
Billet heating slab heating and butt welding	
Up to 1093°C (2000°F)	Inconel® 600, Type 446 SS
Over 1093°C (2000°F)	Silicon ceramic carbide*
Bright annealing batch	
Top work temperature	Not required (use bare Type J thermocouple)
Bottom work temperature	Type 446 SS
Continuous furnace section	Inconel® 600, ceramic*
Forging	Silicon carbide, ceramic*
Soaking pits	
Up to 1093°C (2000°F)	Inconel® 600
Over 1093°C (2000°F)	Silicon ceramic carbide*
Nonferrous metals	
Aluminum	
Melting	Hexoloy®
Heat treating	Black steel
Brass or bronze	Not required (use dip-type thermocouple)
Lead	Type 446 SS, black steel
Magnesium	Black steel, cast iron
Tin	Extra heavy carbon steel
Zinc	Extra heavy carbon steel
Pickling tanks	Chemical lead
Cement	
Exit flues	Inconel® 600, Type 446 SS
Kilns, heating zone	Inconel® 600
Ceramic	
Kilns	Ceramic* and silicon carbide*
Dryers	Silicon carbide, black steel
Vitreous enameling	Inconel® 600, Type 446 SS
Barium chloride, all concentration, 21°C (70°F)	Monel®, Hastelloy C®

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* Due to susceptibility to cracking, sudden thermal shocks should be avoided.

Inconel® and Monel® are registered trademarks of the Special Metals Corporation.

Hexoloy® is a registered trademark of Carborundum Company.

Hastelloy C® is a registered trademark of Haynes International.

Note: All accessories subject to minimum purchase quantities.

Accessories

Thermowells

Thermowell Material Selection Guide

Continued

Application	Protecting Tube Material
Barium hydroxide, all concentration, 21°C (70°F)	Low carbon steels
Barium sulphite	Nichrome®, Hastelloy C®
Brines	Monel®
Bromine	Tantalum, Monel®
Butadiene	Type 304 SS
Butane	Type 304 SS
Butylacetate	Monel®
Butyl alcohol	Type 304 SS
Calcium chlorate, dilute, 21 to 66°C (70 to 150°F)	Type 304 SS
Calcium hydroxide	
10 to 20%, 100°C (212°F)	Type 304 SS, Hastelloy C®
50%, 100°C (212°F)	Type 316 SS, Hastelloy C®
Carbolic acid, all, 100°C (212°F)	Type 316 SS
Carbon dioxide, wet or dry	2017-T4 aluminum, Monel®, nickel
Chlorine gas	
Dry, 21°C (70°F)	Type 316 SS, Monel®
Moist, -7 to 100°C (20 to 212°F)	Hastelloy C®
Chromic acid, 10 to 50% 100°C (212°F)	Type 316 SS, Hastelloy C® (all concentrations)
Citric acid	
15%, 21°C (70°F)	Type 304 SS, Hastelloy C® (all concentrations)
15%, 100°C (212°F)	Type 316 SS, Hastelloy C® (all concentrations)
Concentrated, 100°C (212°F)	Type 316 SS, Hastelloy C® (all concentrations)
Copper nitrate	Types 304 SS, 316 SS
Copper sulphate	Types 304 SS, 316 SS
Cresols	Type 304 SS
Cyanogen gas	Type 304 SS
Dow therm®	Low carbon steels
Ether	Type 304 SS
Ethyl acetate	Monel®, Type 304 SS
Ethyl chloride, 21°C (70°F)	Type 304 SS, low carbon steel
Ethyl sulphate, 21°C (70°F)	Monel®
Ferric chloride, 5%, 21°C (70°F)to boiling	Tantalum, Hastelloy C®
Ferric sulphate, 5%, 21°C (70°F)	Type 304 SS
Ferrous sulphate, dilute, 21°C (70°F)	Type 304 SS
Formaldehyde	Types 304 SS, 316 SS
Formic acid, 5%, 21 to 66°C (70 to 150°F)	Type 316 SS
Freon	Monel®
Gallic acid, 5%, 21 to 66°C (70 to 150°F)	Monel®
Gasoline, 21°C (70°F)	Type 304 SS, low carbon steel
Glucose, 21°C (70°F)	Type 304 SS
Glycerine, 21°C (70°F)	Type 304 SS
Glycerol	Type 304 SS
Hydrobromic acid, 98%, 100°C (212°F)	Hastelloy B®
Hydrochloric acid	
1%, 5% 21°C (70°F)	Hastelloy C®
1%, 5% 100°C (212°F)	Hastelloy B®
25%, 21 to 100°C (70 to 212°F)	Hastelloy B®
Hydrofluoric acid, 60%, 100°C (212°F)	Hastelloy C®, Monel®
Hydrogen peroxide, 21 to 100°C (70 to 212°F)	Types 316 SS, 304 SS
Hydrogen sulphide, wet and dry	Type 316 SS

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Nichrome® is a registered trademark of the Driver-Harris Co.

Dow therm® is a registered trademark of the Dow Chemical Corporation.

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Accessories

Thermowells

Thermowell Material Selection Guide

Continued

Application	Protecting Tube Material
Glass	
Fore hearths and feeders	Platinum thimble
Lehrs	Black steel
Tanks	
Roof and wall	Ceramic*
Flues and checkers	Inconel® 600, Type 446 SS
Paper	
Digesters	Type 316 SS, Type 446 SS
Petroleum	
Dewaxing	Types 304, 310, 316, 321, 347 SS, carbon steel
Towers	Types 304, 310, 316, 321, 347 SS, carbon steel
Transfer lines	Types 304, 310, 316, 321, 347 SS, carbon steel
Factioning column	Types 304, 310, 316, 321, 347 SS, carbon steel
Bridgewall	Types 304, 310, 316, 321, 347 SS, carbon steel
Power	
Coal-air mixtures	304 SS
Flue gases	Black steel, Type 446 SS
Preheaters	Black steel, Type 446 SS
Steel lines	Types 347 or 316 SS
Water lines	Low carbon steels
Boiler tubes	Types 304, 309, or 310 SS
Gas producers	
Producer gas	Type 446 SS
Water gas	
Carburetor	Inconel® 600, Type 446 SS
Superheater	Inconel® 600, Type 446 SS
Tar stills	Low carbon steels
Incinerators	
Up to 1093°C (2000°F)	Inconel® 600, Type 446 SS
Over 1093°C (2000°F)	Ceramic (primary) Hexoloy® (secondary)*
Food	
Baking ovens	Black steel
Charretort, sugar	Black steel
Vegetables and fruit	Type 304 SS
Chemical	
Acetic acid	
10 to 50%, 21°C (70°F)	Type 304, Hastelloy C®, Monel®
50%, 100°C (212°F)	Type 316, Hastelloy C®, Monel®
99%, 21 to 100°C (70 to 212°F)	Type 430, Hastelloy C®, Monel®
Alcohol, ethyl, methyl	
21 to 100°C (70 to 212°F)	Type 304
Ammonia	
All concentration 21°C (70°F)	Types 304, 316 SS
Ammonium chloride	
All concentration 100°C (212°F)	Types 316 SS, Monel®
Ammonium nitrate	
All concentration 21 to 100°C (70 to 212°F)	Type 316 SS
Ammonium sulphate, 10% to saturated	
100°C (212°F)	Type 316 SS

CONTINUED

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Thermowells

Thermowell Material Selection Guide

Continued

Application	Protecting Tube Material
Iodine, 21°C (70°F)	Tantalum
Lactic acid	
5%, 21°C (70°F)	Type 304 SS, 316 SS
5%, 66°C (150°F)	Type 316 SS
10%, 100°C (212°F)	Tantalum
Magnesium chloride	
5%, 21°C (70°F)	Monel®, nickel
5%, 100°C (212°F)	Nickel
Magnesium sulphate, hot and cold	Monel®
Muriatic acid, 21°C (70°F)	Tantalum
Naptha, 21°C (70°F)	Type 304 SS
Natural gas, 21°C (70°F)	Types 304 SS, 316 SS, 317 SS
Nickel chloride, 21°C (70°F)	Type 304 SS
Nickel sulphate, hot and cold	Type 304 SS
Nitric acid	
5%, 21°C (70°F)	Types 304 SS, 316 SS
20%, 21°C (70°F)	Types 304 SS, 316 SS
50%, 21°C (70°F)	Types 304 SS, 316 SS
50%, 100°C (212°F)	Types 304 SS, 316 SS
65%, 100°C (212°F)	Type 316 SS
Concentrated, 21°C (70°F)	Types 304 SS, 316 SS
Concentrated, 100°C (212°F)	Tantalum
Nitrobenzene, 21°C (70°F)	Type 304 SS
Oleic acid, 21°C (70°F)	Type 316 SS
Oleum, 21°C (70°F)	Type 316 SS
Oxalic acid	
5% hot and cold	Type 304 SS
10%, 100°C (212°F)	Monel®
Oxygen	
21°C (70°F)	Steel
Liquid	SS
Elevated temperatures	SS
Palmitic acid	Type 316 SS
Pentane	Type 340 SS
Phenol	Types 304 SS, 316 SS
Phosphoric acid	
1%, 5%, 21°C (70°F)	Type 304 SS
10%, 21°C (70°F)	Type 316 SS
10%, 100°C (212°F)	Hastelloy C®
30%, 21 to 100°C (70 to 212°F)	Hastelloy B®
85%, 21 to 100°C (70 to 212°F)	Hastelloy B®
Picric acid, 21°C (70°F)	Type 304 SS
Potassium bromide, 21°C (70°F)	Type 316 SS
Potassium carbonate, 1%, 21°C (70°F)	Types 304 SS, 316 SS
Potassium chlorate, 21°C (70°F)	Type 304 SS
Potassium hydroxide	
5%, 21°C (70°F)	Type 304 SS
25%, 100°C (212°F)	Type 304 SS
60%, 100°C (212°F)	Type 316 SS
Potassium nitrate	
5%, 21°C (70°F)	Type 304 SS
5%, 100°C (212°F)	Type 304 SS

CONTINUED

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Accessories

Thermowells

Thermowell Material Selection Guide

Continued

Application	Protecting Tube Material
Potassium permanganate, 5%, 21°C (70°F)	Type 304 SS
Potassium sulphate, 5%, 21°C (70°F)	Types 304 SS, 316 SS
Potassium sulphide, 21°C (70°F)	Types 304 SS, 316 SS
Propane	Type 304 SS, low carbon steel
Pyrogallic acid	Type 304 SS
Quinine bisulphate, dry	Type 316 SS
Quinine sulphate, dry	Type 304 SS
Seawater	Monel® or Hastelloy C®
Salicylic acid	Nickel
Sodium bicarbonate All concentration, 21°C (70°F) 5%, 66°C (150°F)	 Type 304 SS Types 304 SS, 316 SS
Sodium carbonate, 5%, 21 to 66°C (70 to 150°F)	Types 304 SS, 316 SS
Sodium chloride 5%, 21 to 66°C (70 to 150°F) Saturated, 21 to 100°C (70 to 212°F)	 Type 316 SS Type 316 SS, Monel®
Sodium fluoride, 5%, 21°C (70°F)	Monel®
Sodium hydroxide	Types 304 SS, 316 SS, Hastelloy C®
Sodium hypochlorite, 5% still	Type 316 SS, Hastelloy C®
Sodium nitrate, fused	Type 316 SS
Sodium peroxide	Type 304 SS
Sodium sulphate, 21°C (70°F)	Types 304 SS, 316 SS
Sodium sulphide, 21°C (70°F)	Type 316 SS
Sodium sulphite, 30%, 66°C (150°F)	Type 304 SS
Sulphur dioxide Moist gas, 21°C (70°F) Gas, 302°C (575°F)	 Type 316 SS Types 304 SS, 316 SS
Sulphur Dry molten Wet	 Type 304 SS Type 316 SS
Sulphuric acid 5%, 21 to 100°C (70 to 212°F) 10%, 21 to 100°C (70 to 212°F) 50%, 21 to 100°C (70 to 212°F) 90%, 21°C (70°F) 90%, 100°C (212°F)	 Hastelloy B®, 316 SS Hastelloy B® Hastelloy B® Hastelloy B® Hastelloy D®
Tannic acid 21°C (70°F)	Type 304 SS, Hastelloy B®
Tartaric acid 21°C (70°F) 66°C (150°F)	 Type 304 SS Type 316 SS
Toluene	2017-T4 aluminum, low carbon steel
Turpentine	Types 304 SS, 316 SS
Whiskey and wine	Type 304 SS, nickel
Xylene	Copper
Zinc chloride	Monel®
Zinc sulphate 5%, 21°C (70°F) Saturated, 21°C (70°F) 25%, 100°C (212°F)	 Types 304 SS, 316 SS Types 304 SS, 316 SS Types 304 SS, 316 SS

Reference charts and tables on pages 139 to 143 courtesy of the American Society for Testing and Materials. Taken from publication MNL 12, ***"Manual on the Use of Thermocouples in Temperature Measurement."***

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