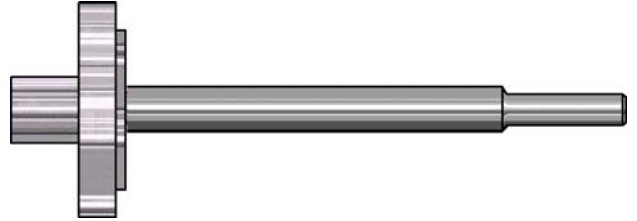


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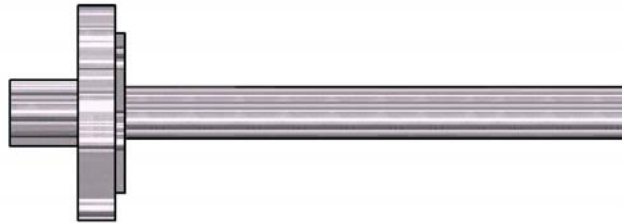
TW-FT



TW-FS



TW-FP



THERMOWELLS FABRICATED FROM TUBE OR PIPE-SCREWED

TW-SPF



TW-SSF

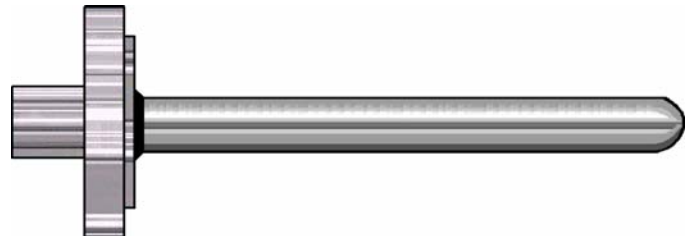


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PLAIN

TW-RF



ROLLED CLOSED
PROTECTION SHEATH

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THERMOWELL MATERIAL SELECTION GUIDE

APPLICATION	PROTECTING TUBE MATERIAL
Heat Treating	
Annealing Up to 704°C Over 704°C	Black steel Inconel® 600, Type 446SS
Carburising hardening Up to 816°C 816 to 1093°C Over 1093°C Nitriding salt baths Cyanide	Black steel, Type 446SS Inconel® 600, Type 446SS Ceramic* Type 446SS Nickel (CP)
Neutral	Type 446SS
High speed	Ceramic*

Iron and steel	
Blast furnaces Downcomer Stove dome Hot blast main Stove trunk Stove outlet flue	Inconel® 600, Type 446SS Silicon carbide, LT-1 Inconel® 600 Inconel® 600 Black steel
Open hearth Flues and stack Checkers Waste heat boiler	Inconel® 600, Type 446SS Inconel® 600, LT-1 Inconel® 600, Type 446SS
Billet heating slab heating and butt welding Up to 1093°C Over 1093°C	Inconel® 600, Type 446SS Silicon carbide, ceramic*
Bright annealing batch Top work temperature Bottom work temperature	Not required (use bare Type J thermocouple) Type 446SS
Continuous furnace section	Inconel® 600, ceramic*
Forging	Silicon carbide, ceramic*
Soaking pits Up to 1093°C Over 1093°C	Inconel® 600 Silicon carbide, ceramic*

Nonferrous metals	
Aluminium Melting Heat treating	Hexoloy®, Syalon®, 1100, Cast iron Black steel
Brass or bronze	Not required (use dip-type thermocouple)
Lead	Type 446SS, black steel
Magnesium	Black steel, cast iron
Tin	Extra heavy carbon steel
Zinc	Extra heavy carbon steel

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

THERMOWELL MATERIAL SELECTION GUIDE

APPLICATION	PROTECTING TUBE MATERIAL
Nonferrous metals (continued)	
Pickling tanks	Chemical lead
Cement	
Exit flues	Inconel® 600, Type 446SS
Kilns, heating zone	Inconel® 600
Ceramic	
Kiln	Ceramic, and silicon carbide*
Dryers	Silicon carbide, black steel
Vitreous enamelling	Inconel® 600, Type 446SS
Glass	
Forehearths and feeders	Platinum thimble
Lehrs	Black steel
Tanks Roof and wall Flues and checkers	Ceramic* Inconel® 600, Type 446SS
Paper	
Digesters	Type 316SS, Type 44SS
Petroleum	
De-waxing	Types 304, 310, 316, 321, 347SS, carbon steel
Towers	Types 304, 310, 316, 321, 347SS, carbon steel
Transfer lines	Types 304, 310, 316, 321, 347SS, carbon steel
Factioning column	Types 304, 310, 316, 321, 347SS, carbon steel
Bridgewall	Types 304, 310, 316, 321, 347SS, carbon steel
Power	
Coal-air mixtures	304SS
Flue gases	Black steel, Type 446SS
Pre-heaters	Black steel, Type 446SS
Steel lines	Types 347 or 316SS
Water lines	Low carbon steels
Boiler tubes	Types 304, 309, or 310SS
Gas producers	
Producer gas	Type 446SS
Water gas Carburettor Superheater Tar stills	Inconel® 600, Type 446SS Inconel® 600, Type 446SS Low carbon steels

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

THERMOWELL MATERIAL SELECTION GUIDE

APPLICATION	PROTECTING TUBE MATERIAL
Incinerators	
Up to 1093°C	Inconel® 600, Type 446SS
Over 1093°C	Ceramic (primary), Hexoloy® (secondary)*
Food	
Baking ovens	Slack steel
Charretort, sugar	Slack steel
Vegetables and fruit	Type 304SS
Chemical	
Acetic acid 10 to 50%, 21°C 50%, 100°C 99% 21 - 100°C	Type 304, Hastelloy C®, Monel® Type 316, Hastelloy C®, Monel® Type 430, Hastelloy C®, Monel®
Alcohol, ethyl, methyl 21 to 100°C	Type 304SS
Ammonia All concentration 21°C	Types 304SS, 316SS
Ammonium chloride All concentration 100°C	Types 316SS, Monel®
Ammonium nitrate All concentration 21 to 100°C	Type 316SS
Ammonium sulphate, 10% to saturated 100°C	Type 316SS
Barium chloride, all concentration, 21°C	Monel®, Hastelloy C®
Barium hydroxide, all concentration, 21°C	Low carbon steels
Barium sulphite	Nichrome® Hastelloy C®
Brines	Monel®
Bromine	Tantalum, Monel®
Butadiene	Type 304SS
Butane	Type 304SS
Butyl acetate	Monel®
Butyl alcohol	Type 304SS
Calcium chlorate, dilute 21 to 66°C	Type 304SS
Calcium hydroxide 10 to 20%, 100°C 50%, 100°C	Type 304SS, Hastelloy C® Type 316SS, Hastelloy C®
Carbolic acid, all, 100°C	Type 316SS
Carbon dioxide, wet or dry	2017-T4 Aluminium, Monel®, Nickel
Chlorine gas Dry, 21°C Moist, -7 to 100°C	Type 316SS, Monel® Hastelloy C®
Chromic acid, 10 - 50% 100°C	Type 316SS, Hastelloy C® (all concentrations)

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

THERMOWELL MATERIAL SELECTION GUIDE

APPLICATION	PROTECTING TUBE MATERIAL
Chemical (continued)	
Citric acid 15%, 21°C 15%, 100°C Concentrated, 100°C	Type 304SS, Hastelloy C®(all concentrations) Type 316SS, Hastelloy C® (all concentrations) Type 316SS, Hastelloy C® (all concentrations)
Copper nitrate	Types 304SS, 316SS
Copper sulphate	Types 304SS, 316SS
Cresols	Type 304SS
Cyanogen gas	Type 304SS
Dow therm®	Low carbon steels
Ether	Type 304SS
Ethyl acetate	Monel®, Type 304SS
Ethyl chloride, 2°C	Type 304SS, low carbon steel
Ethyl sulphate, 2°C	Monel®
Ferric chloride, 5%, 2°C to boiling	Tantalum, Hastelloy C®
Ferric sulphate, 5%, 21°C	Type 304SS
Ferrous sulphate, dilute, 21°C	Type 304SS
Formaldehyde	Types 304SS, 316SS
Formic acid, 5%, 21 to 66°C	Type 316SS
Freon	Monel®
Gallic acid, 5%, 21 to 66°C	Monel®
Gasoline, 21°C	Type 304SS, low carbon steel
Glucose, 21°C	Type 304SS
Glycerine, 21°C	Type 304SS
Glycerol	Type 304SS
Hydrobromic acid, 98%, 100°C	Hastelloy B®
Hydrochloric acid 1%, 5% 21°C 1%, 5% 100°C 25%, 21 to 100°C	Hastelloy C® Hastelloy B® Hastelloy B®
Hydrofluoric acid, 60%, 100°C	Hastelloy C®, Monel®
Hydrogen peroxide, 21 to 100°C	Types 316SS, 304SS
Hydrogen sulphide, wet and dry	Type 316SS
Iodine, 21°C	Tantalum
Lactic acid 5%, 21°C 5%, 66°C 10%, 100°C	Type 304SS, 316SS Type 316SS Tantalum
Magnesium chloride 5%, 21°C 5%, 100°C	Nickel, Monel® Nickel
Magnesium sulphate, hot and cold	Monel®
Muriatic acid, 21°C	Tantalum
Naptha, 21°C	Type 304SS

THERMOWELL MATERIAL SELECTION GUIDE

APPLICATION	PROTECTING TUBE MATERIAL
Natural gas, 21°C	Types 304SS, 316SS, 317SS
Nickel chloride, 21°C	Type 304SS
Nickel sulphate, hot and cold	Type 304SS
Nitric acid 5%, 21°C 20% 21°C 50% 21°C 50% 100°C 65% 100°C Concentrated, 21°C Concentrated, 100°C	Types 304SS, 316SS Types 304SS, 316SS Types 30 SS, 316SS Types 304SS, 316SS Type 316SS Types 304SS, 316SS Tantalum
Nitrobenzene, 21°C	Type 304SS
Oleic acid, 21°C	Type 316SS
Oleum, 21°C	Type 316SS
Oxalic acid 5% hot and cold 10%, 100°C	Type 304SS Monel®
Oxygen 21°C	Steel
Palmitic acid	Type 316SS
Pentane	Type 340SS
Phenol	Types 304SS, 316SS
Phosphoric acid 1%, 5%, 21°C 10%, 21°C 10%, 100°C 30%, 21 - 100°C 85%, 21 - 100°C	Type 304SS Type 316SS Hastelloy C® Hastelloy B® Hastelloy B®
Picric acid, 21°C	Type 304SS
Potassium bromide, 21°C	Type 316SS
Potassium carbonate, 1%, 21°C	Types 304SS, 316SS
Potassium chlorate, 21°C	Type 304SS
Potassium hydroxide 5%, 21°C 25%, 100°C 60%, 100°C	Type 304SS Type 304SS Type 316SS
Potassium nitrate 5%, 21°C 5%, 100°C	Type 304SS Type 304SS
Potassium permanganate, 5%, 21°C	Type 304SS
Potassium sulphate, 5%, 21°C	Types 304SS, 316SS
Potassium sulphide, 21°C	Types 304SS, 316SS
Propane	Type 304SS, low carbon steel
Pyrogalllic acid	Type 304SS
Quinine bisulphate, dry	Type 316SS
Quinine sulphate, dry	Type 304SS

THERMOWELL MATERIAL SELECTION GUIDE

APPLICATION	PROTECTING TUBE MATERIAL
Chemical (continued)	
Seawater	Monel®, Hastelloy C®
Salicylic acid	Nickel
Sodium bicarbonate All concentration, 21°C 5%, 66°C	Type 304SS Types 304SS, 316SS
Sodium carbonate, 5%, 21 - 66°C	Types 304SS, 316SS
Sodium chloride 5%, 21 - 66°C Saturated, 21 to 100°C	Type 316SS Type 316SS, Monel®
Sodium fluoride, 5% 21°C	Monel®
Sodium hydroxide	Types 304SS, 316SS, Hastelloy C®
Sodium hypochlorite, 5% still	Type 316SS, Hastelloy C®
Sodium nitrate, fused	Type 316SS
Sodium peroxide	Type 304SS
Sodium sulphate, 21°C	Types 304SS, 316SS
Sodium sulphide, 21°C	Type 316SS
Sodium sulphite, 0%, 66°C	Type 304SS
Sulphur dioxide Moist gas, 21°C Gas, 302°C	Type 316SS Types 304SS, 316SS
Sulphur Dry molten Wet	Type 304SS Type 316SS
Sulphuric acid 5%, 21 - 100°C 10%, 21 - 100°C 50%, 21 - 100°C 90%, 21°C 90%, 100°C	Hastelloy B®, 316SS Hastelloy B® Hastelloy B® Hastelloy B® Hastelloy D®
Tannic acid 21°C	Type 304SS, Hastelloy B®
Tartaric acid 21°C 150°C	Type 304SS Type 316SS
Toluene	2017-T4 aluminium, low carbon steel
Turpentine	Types 304SS 316SS
Whisky and wine	Type 304SS, nickel
Xylene	Copper
Zinc chloride	Monel®
Zinc sulphate 5%, 21°C Saturated 21°C 25%, 100°C	Types 304SS, 316SS Types 304SS, 316SS Types 304SS, 316SS

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 Syalon® is a registered trademark of Cookson.
 Incoloy® is a registered trademark of INCO Alloys International Inc.
 Monel® is a registered trademark of INCO Alloys International Inc.
 Hastelloy C® is a registered trademark of Haynes International

Hexoloy® is a registered trademark of Carborundum Company
 Dow therm® is a registered trademark of Dow Chemical Corporation
 Nichrome® is a registered trademark of Driver-Harris Company
 Hastelloy B® is a registered trademark of Haynes International
 Hastelloy D® is a registered trademark of Haynes International

THERMOWELL MATERIAL SPECIFICATIONS

Carbon Steels

Low cost materials with little corrosion resistance. Used in low temperature and stress applications where the measured medium protects it from corrosion, oils, petroleum, tars, etc.

Maximum temperature: 530°C

Chrome/Moly Steels (F11, F22)

High strength steels used in pressure vessels and industrial boiler plants. Resistant to chloroform, cleaning agents, food products and carbon disulphide.

Maximum temperature: 600°C.

304 Stainless Steel

Low cost corrosion resistant material, used extensively used in food, beverage and chemical processing where good corrosion resistance is required. A low carbon grade, 304L is available which can be welded without impairing its corrosion resistance.

Maximum temperature: 900°C.

321 Stainless Steel

Similar properties to 304SS above, except that this grade is titanium-stabilised to prevent intergranular corrosion when welded.

316 Stainless Steel

Best corrosion resistance of the austenitic stainless steels due to the addition of molybdenum, widely used in chemical processing, offers useful resistance to H₂S. As with 304, a low carbon grade, 316L is available for welded applications.

Maximum temperature: 900°C.

310 Stainless Steel

Heat resistant material, which can be used up to 1150°C with useful resistance in sulphur bearing atmospheres. Corrosion resistance is slightly better than 304SS, but not as good as 316SS. Can be welded with caution.

446 Stainless Steel

Ferritic stainless steel with excellent resistance to sulphurous atmospheres at high temperature, however, due to its low strength at high temperature, thermowells made from this material should be mounted vertically. Used in heat treatment processes, iron and steel furnaces, gas production plants, it has some useful resistance to molten lead. Good corrosion resistance to nitric acid, sulphuric acid and most alkalis gives it some limited use in chemical plants.

Maximum temperature: 1150°C.

Duplex Stainless Steel

These grades combine high strength with excellent corrosion resistance, especially to chloride stress corrosion cracking, however a tendency to brittleness limits their use to approx 300 to 315°C maximum, sub-zero use is also restricted to approx 50°C because of brittleness due to the ferrite content. Main uses include offshore piping, chemical tanks, flue gas scrubbers, and chimneys.

Super Duplex Stainless Steel

Similar qualities and limitations to duplex grades above. These grades are widely used to handle seawater and other brackish waters. Marine pumps, oil and gas production and desalination plants are typical applications.

Inconel® 600

A widely used nickel-chromium-iron alloy with excellent high temperature strength and oxidation resistance. However, it is highly vulnerable to attack in sulphurous atmospheres above 500°C. Good resistance to chloride-ion stress corrosion cracking and nitriding environments. Used extensively in chemical industries for its strength and corrosion resistance. Easily welded, and can normally be used without post-weld heat treatment.

Maximum temperature: 1212°C.

THERMOWELL MATERIAL SPECIFICATIONS

Inconel® 625

A nickel-chromium alloy with excellent resistance to pitting and crevice corrosion, unaffected by radiation embrittlement; widely used in aerospace applications and in marine environments. Good weldability, can be used in the as-welded condition.

Maximum temperature: 1093°C.

Incoloy® 800

Superior to alloy 600 in sulphur, cyanide salts and neutral salts. Extensively used in steam/hydrocarbon reforming plants for pigtail piping, manifolds and waste heat boilers, and in the internal components of secondary reformers. Widely used in heat treatment equipment and as a heater sheath material.

Maximum temperature: 1093°C.

Incoloy® 825

A nickel-iron-chromium alloy with exceptional resistance to many corrosive environments. Superior to almost all metallic materials for handling sulphuric acid and shows excellent resistance to phosphoric acid. Widely used in chemical processing, oil and gas recovery, acid production, pickling operations, nuclear fuel reprocessing, and handling of radioactive wastes.

Maximum temperature: 540°C.

Incoloy® MA956

An iron-chromium-aluminium alloy produced by mechanical alloying, it features great strength at high temperatures with excellent resistance to oxidation, carburisation, and hot corrosion. These properties make it especially suitable for gas-turbine combustion chambers and other aggressive environments containing sulphur and chloride salts.

Maximum temperature: 1350°C.

Monel® 400

Nickel-copper alloy with very good corrosion resistance, commonly used to handle sea water, hydrofluoric acid, sulphuric acid, hydrochloric acid and most alkalis. Typical applications include marine fixtures, chemical processing equipment,

gasoline and water tanks, process vessels and piping and boiler feedwater heaters.

Maximum temperature: 538°C.

Hastelloy® C276

Nickel-molybdenum-chromium alloy with excellent corrosion resistance especially in chlorinated environments. Widely used in chemical plants where it tolerates ferric and cupric chlorides, solvents, chlorine, formic acid, acetic acid, brine, wet chlorine gas and hypochlorite. Can be easily welded and maintains its properties in the as-welded condition.

Maximum temperature: 1093°C.

Hastelloy® B3

A development of the well-established B2 alloy with improved thermal stability, fabricability and stress corrosion cracking resistance. It is the alloy of choice for handling hydrochloric acid in all concentrations and temperatures; it also withstands hydrogen chloride, sulphuric, acetic, hydrofluoric and phosphoric acids.

Maximum temperature: 538°C, up to 816°C in reducing or vacuum environment.

Hastelloy® C22

A nickel-chromium-molybdenum-tungsten alloy with outstanding resistance to pitting, crevice corrosion and stress corrosion cracking. It shows exceptional resistance to a wide range of chemical process environments, such as ferric and cupric chlorides, chlorine, hot contaminated solutions, formic and acetic acids and seawater or brine solutions. The material has superior weldability, and retains its properties in the as-welded state.

THERMOWELL MATERIAL SPECIFICATIONS

Hastelloy® X

A high temperature alloy with excellent resistance to oxidising, reducing and neutral atmospheric conditions. Is widely used in aircraft jet engine components. Very good high temperature strength makes it ideal for furnace applications. Resistant to stress corrosion cracking in petrochemical applications. Maximum Temperature: 1204°C.

Haynes alloy 214

Excellent high temperature material, with the highest resistance to oxidation and carburisation of almost any alloy, it is recommended for temperatures of 950°C and above, it shows useful resistance up to 1315°C but its strength is severely reduced. Applications include ceramic firing furnace parts, automotive catalytic converter internals and in the industrial heating industry furnace flame hoods and rotary calciners. Has good resistance to chlorine contaminated environments, which allows its use in hospital waste incinerators. Maximum temperature: 1204°C.

Haynes alloy 230

Excellent high temperature strength, oxidation resistance and long term thermal stability. Used in aerospace, chemical processing and high temperature heating applications. Recommended for use in nitriding environments. Maximum temperature: 1149°C.

Haynes alloy 556

A multipurpose alloy which offers good resistance to sulphidising, carburising and chlorine bearing atmospheres. Common applications include waste incinerators, petroleum processes where sulphur is present, chloride salt baths, exhaust gas probes, the alloy is one of very few that can survive in molten zinc, making it ideal for galvanising processes. Maximum temperature: 1093°C.

Haynes alloy HR160

A high temperature alloy with outstanding resistance to high temperature corrosion, it has

excellent resistance to sulphidation, and chloride attack in both reducing and oxidising atmospheres. Its resistance to attack by the products of combustion of low-grade fuels makes it particularly useful in municipal, industrial, hazardous and nuclear waste incinerators.

Maximum temperature: 1204°C.

Titanium

A lightweight material with good strength in the 150 - 470°C range. Excellent resistance to oxidising acids such as nitric or chromic. Also resistant to inorganic chloride solutions, chlorinated organic compounds and moist chlorine gas. Its good resistance to seawater and salt spray allows it to be used in offshore installations. Can be welded with special precautions to protect from atmospheric contamination.

Tantalum

Refractory metal that is ductile. Use only in inert atmospheres or very good vacuums. <10(-3) torr. Hydrogen and nitrogen will react with tantalum above 400°C (750°F) resulting in nitride and hydride formation that will affect life.

Tantalum is almost completely immune to chemical attack at temperatures below 150°C, and is attacked only by hydrofluoric acid, acidic solutions containing the fluoride ion, and free sulphur trioxide. Alkalis attack it slowly. At high temperatures, tantalum becomes much more reactive. Normally used by cladding a thin layer onto a less expensive material, such as steel or stainless steel

Tantalum's corrosion resistance is similar to that of glass, making it the material of choice in critical chemical and pharmaceutical processes requiring maximum corrosion resistance and minimum contamination. Typical applications are: Chemical production (HCl, H₂SO₄), insecticides, pharmaceuticals, fine chemicals, explosives, plastics, dyestuffs, condensation of phosgene derivatives, synthetic fibres, chromic

Tantalum continued

acid plating solutions and operations involving chlorine, bromine, iodine and their compounds, high purity product manufacturing (cosmetics, soaps, perfumes) and separation of high boiling organic acids.

Pressure - Temperature rating: lbs. per square inch

Material	Temperature in °Celsius						
	20	95	205	315	425	540	650
Brass	5000	4200	1000	-	-	-	-
304SS	7000	6200	5600	5400	5200	4500	1650
316SS	7000	7000	6400	6200	6100	5100	2500
Carbon Steel	5200	5000	4800	4600	3500	1500	-
Monel	6500	6000	5400	5300	5200	1500	-

STANDARD THERMOWELL SPECIFICATIONS

	SCREWED	FLANGED	NOTES
Bore	6.5mm	6.5mm	Other as specified
Instrument Connection	1/2"NPSM or 1/2"BSPP	1/2"NPSM or 1/2"BSPP	Other as specified
Process Connection	BSPT or NPT		Other as specified
Standard Head Length	44mm	50mm	Other as specified
Standard Major/Minor OD for Tapered Wells	1/2" Taper 16/12mm 3/4" Taper 22/16mm 1" Taper 27/16mm	25NB Taper 22/16mm 40NB Taper 22/16mm 50NB Taper 22/16mm	
Standard OD for Parallel Wells	1/2" Parallel 16mm 3/4" Parallel 19mm 1" Parallel 22mm	25NB Parallel 20mm 40NB Parallel 20mm 50NB Parallel 20mm	
Step Length/OD	64/12.7mm	64/12.7mm	

- All Fabricated thermowells to be used with RTDs are supplied with drilled solid tip
- Weld procedure and qualifications on request
- All wells can be supplied with lagging extensions
- If hex bar is unavailable for material specified, two spanner flats milled
- Plug and chain available for all constructions
- Maximum machined thermowell length: 1200mm

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