

## Thermowells

### General Specifications

#### Material - The Longevity Factor

In general, the thermowell material chosen for the installation is governed mainly by the corrosion conditions the well will face.

Recommended material for various services are given in the Corrosive Service Guide. The high polish given to all stainless and monel wells provides maximum corrosion resistance and strength.

Occasionally, the material consideration is one of strength rather than corrosion. For example, a stainless steel well may be required for high pressure water service where otherwise a brass well would be satisfactory from a corrosion standpoint. Consult the pressure-temperature ratings given for each well type.

The standard materials listed for each well series will cover most requirements. Optional materials include special grades of Stainless Steel, Chrome-molybdenum, Naval Brass, Hastelloy B&C, Nickel and Titanium.

#### Connection - The Installation Factor

In these pages you will find standardized wells of threaded, flanged (A.N.S.I. and Van Stone) and socket weld types with standard bore sizes. Threaded wells are all made in readily welded or brazed materials. This is important for installations requiring seal welding or brazing. The pipe thread provides the mechanical strength, the weld merely seals. Flanged wells (other than Van Stone type) consist of a bar stock well, which is solidly welded to a top quality flange.

Standard construction uses a primary "J" groove weld and a bevel groove secondary weld. Both welds are machined to produce a clean fillet. This double welded construction eliminates the possibility of crevice corrosion and stress problems since no open joints are exposed from either inside or outside the installation. Socket welding types are simple to install by merely welding into place. These wells fit A.N.S.I. standard socket weld couplings or flanges. The resulting installation is clean and tight.

#### Insertion Length - The Accuracy Factor

The distance from the end of the well to the underside of the thread, or other connection means, (designated as "U") is the insertion length. For best accuracy, this length should be long enough to permit the entire temperature sensitive part of the sensor to project into the temperature medium being measured.

A properly installed RTD or thermocouple will project into liquid an amount equal to its sensitive length plus at least one-inch. In air or gas, the bulb should be immersed to its sensitive length plus at least three inches. Thermocouples and thermistors have short sensitive lengths, therefore they can use the smallest insertion lengths. Bi-metal thermometers, resistance thermometers and liquid-in-glass thermometers have bulbs with sensitive portions from one to several inches in length. Determine the sensitive length of the bulb before choosing an insertion length. Above all - be sure that dead length, i.e. - that are required to pass through walls, pipe fittings, etc., is taken into account when choosing the necessary well insertion length.

#### Bore Size - The Interchangeability Factor

Almost any installation uses several types of temperature measuring instruments. The selection of a standard bore diameter can produce maximum flexibility within the plant. The same well can accommodate either thermocouple, RTD, bi-metal thermometer, or test thermometer. The bore size of wells shown in this catalog cover the most commonly used temperature sensing elements as follows:

.260" Diameter Bore

.385" Diameter Bore

#### Tapered or Straight Shank - The Velocity Rating Factor

Tapered shank wells provide greater stiffness for the same sensitivity. The higher strength-to-weight ratio gives these wells a higher natural resonant frequency than for an equivalent length straight shank well, permitting operation at higher fluid velocities. Refer to "Velocity Ratings of Wells" in Thermowell General Specifications.

## **Tapered or Straight Shank - The Velocity Rating Factor (cont.)**

Well failures, in most cases, are not due to the effect of pressure and temperature. The calculations necessary to provide adequate strength, under given conditions, are familiar enough to permit proper choice of wall thickness and material.

Less familiar, and more dangerous, are the vibrational effects to which wells are subjected. Fluid, flowing by the well, forms a turbulent wake (called the Von Karman Trail) which has a definite frequency based on the diameter of the well and velocity of the fluid. It is important that the well have sufficient stiffness so that the wake frequency will never equal the natural frequency of the well itself. If the natural frequency of the well were to coincide with the wake frequency, the well would vibrate to destruction and break off in the piping.

On the following pages, a recommended maximum velocity rating can be found for every standard well length and material cataloged. To reduce the complexity of presenting this information, the ratings given are based on operating temperatures of 1000°F for wells made of Carbon Steel (C-1018), A.I.S.I. 304 & A.I.S.I. 316. Values for brass wells are based on 350°F operation. Limits for Monel wells are based on 900°F service. Slightly higher velocity is possible at lower temperatures.

Where single values appear in the velocity tables, these may be considered safe for water, steam, air or gas. In the shorter insertion lengths, consideration is given to the velocity pressure effect of water flowing at higher velocities. The values in parenthesis, therefore, represent safe values for water flow while the unbracketed value may be used for steam, air, gas and similar density fluids.

It should be pointed out that the values given are extremely conservative and intended primarily as a guide. Wells are also safe if the resonant frequency is below the wake frequency or if the fluid velocity is constantly fluctuating through the critical velocity point. If the installation is not hampered by the use of a sufficiently stiff well, we recommend the values given are not to be exceeded. If you have operating conditions requiring special well designs, our Engineering Staff is available to assist you.

Following are some of the special tests or procedures that we offer. Please contact your sales representative for additional cost and delivery.

### **Tests and Services:**

Hydrostatic test

- Internally for screwed wells  
(specify pressure rating)
- Externally for flanged and Van Stone  
(normally 1.5 times flange rating)

Dye Penetrant test

Ultrasonic test

X-ray

- Per ASME (code UW51)

Stress Calculations

- Per ASME PTC 19.3

### **Procedures:**

Stress Relieving

- Solution Annealing

Heat Treating

- Meets N.A.C.E. MR-01-75 specification

Passivating

Electropolishing

Full Penetration Weld

Positive Material Identification (PMI)

Cleaning for Oxygen Service

Stellite #6 and other wear-resistant coatings

### **Other:**

Source Inspection

Premium Delivery Service

Stamp or Vibro Etch Tag Number or Heat Number

Certified Mill Test Reports (MTR's)

Certified Reproducible drawings

**Maximum Fluid Velocity  
Feet per Second**

Well Type	Material	2 1/2	4 1/2	7 1/2	10 1/2	13 1/2	16 1/2	19 1/2	22 1/2
3/4" - H385 and 3/4" - HL385	Brass	276 (127)	(240) (79)	44	22	13	8	6	4
	Carbon Steel	352 (228)	191 (114)	689	35	21	14	10	7.5
	A.I.S.I. - 304 & 316	415 (99)	203 (154)	73.2	37.3	22.5	15	11	8
	Monel	340	172	62	31	19	12.8	8	6
1" - H385 and 1" - HL385	Brass	321 (150)	129 (83.5)	46.8	23.6	14.5	9.6	6.9	5.1
	Carbon Steel	410 (270)	249 (150)	90.3	45.6	27.8	18.5	13.2	9.8
	A.I.S.I. - 304-316	483 (350)	272 (208)	97.3	49.7	30.4	20.3	14.5	10.7
	Monel	396 (306)	214 (167)	77.5	39.2	23.8	16	10.3	7.7
3/4" - H260 and 3/4" - HL260	Brass	305 (97.5)	93.8 (54.1)	33.9	17.1	10.5	7.0	5.0	3.7
	Carbon Steel	386 (175)	180 (97.2)	65.3 (58.3)	33.0	20.1	13.4	9.6	7.1
	A.I.S.I. - 304-316	440 (243)	197 (135)	71.2	36.0	22.0	14.7	10.5	7.8
	Monel	354 (195)	155 (108)	56.1	28.4	17.3	11.6	7.5	5.6
1" - H260 and 1" - HL260	Brass	354 (161)	108 (89.5)	39.4	19.8	12.2	8.1	5.8	4.3
	Carbon Steel	448 (289)	209 (161)	75.7	38.4	23.3	15.5	11.1	8.2
	A.I.S.I. - 304-316	490 (403)	228 (225)	82.5	41.8	25.5	17.1	12.2	9.1
	Monel	410 (322)	179 (178)	65.1	33.0	20.1	13.5	8.7	6.5
3/4" - W260	Carbon Steel	290	123	44.9	22.8	13.8	9.3		4.9
	A.I.S.I. - 304-316	106	(71.2)	(42.7)					
		(403)	(225)						

# Standard Manufacturing Tolerances

## Lengths:

- ± 1/16" on length 12" or less
- ± 1/8" on length 12" or less

Wells 30" overall length and longer will be drilled through end, plugged and heliarc welded, if solid bored is specified. Built up design must be specified. Built up design must be specified beyond 42 1/4" overall length.

## O. D. Tolerances:

- Fractional: ± .015
- Decimal: ± .005 on .000 place
- ± .010 on .000 place

## Bore I.D. Tolerances:

- + .005
- .003

## End Thickness:

Gun drill Bottom, 1/4" to bottom ± 1/16", 3/16" min. end.

## Concentricity of Bore to O.D.:

- ± 10% of min. wall thickness

## Surface Finish:

- 16-32 Ra standard
- 4-12 Ra available at an extra charge. Must be specified on order.

Wetted surface finish of 80 Ra is available at a savings on some wells.

Must be specified on order.

## Radius under Threads and Flanges:

- 1/8" is standard, ± 1/16"
- 1/16" on Van Stones

## Male Threads: (NPT)

± " on thread gage

## Female Threads:

(1/2" NPSM) standard, 1/2" NPT available upon request.  
Go gage to 5/8" depth of thread.  
No go gage 2 turns max.

## End of Wells:

Break corners - no burrs.

## Threaded Wells:

Round stock with wrench flats will be used if hex stock is not available. Lagging extension may be left as hex or as machined diameter.

## Stamping:

Material code identification and type of material stamped on Hex or round facing open end of well.

## Flanged Wells:

Made in accordance with ANSI B16.5. Raised Face is serrated. 125 RMS Smooth Face must be specified on order if needed.

## Front "J":

Groove welds are 1/4" wide by 1/4" deep. Welds are machined, leaving 1/8" radius. Rear welds are 1/8" wide by 1/8" deep "V". Welds are machined, leaving 1/4" radius. Full penetration welds are available upon request. Must be specified on order if needed.

## Corrosive Service Guide To Materials

Corrodent	Temperature °F	Concentration %	Recom. Material	Corrodent	Temperature °F	Concentration %	Recom. Material
Acetic Acid	212	All	Monel	Chloroform, Dry	212		Monel
Acetic Anhydride	300		Nickel	Chromic Acid	300	All	Hast. C
Acetone	212	All	304 SS	Cider	300	All	304 SS
Acetylene	400		304 SS	Citric Acid	212	All	Hast. C
Alcohols	212	All	304 SS	Copper (10) Chloride	212	All	Hast. C
Alum. (Potassium or Sodium)	300	All	Hast. C	Copper (10) Nitrate	300	All	316 SS
Aluminum Chloride	212	All	Hast. B	Copper (10) Sulfate	300	All	316 SS
Aluminum Sulfate	212	All	316 SS	Copper Plating Solution180 (Cyanide)			304 SS
Ammonia, Dry	212	All	304,	Copper Plating Solution 75 (Acid)			304 SS
316 SS				Corn Oil	200		304 SS
Ammonium	212	All	304,	Creosote	200	All	304 SS
316 Hydroxide SS				Crude Oil	300		Monel
(Ammonia, Aqua)				Ethyl Acetate - SEE LACQUER THINNER			
Ammonium Chloride	300	50%	Monel	Ethyl Chloride, Dry	500		Steel
Ammonium Nitrate	300	All	304 SS	Ethanol - SEE ALCOHOLS			
Ammonium Sulfate	212	All	316 SS	Ethylene Glycol (Uninhibited)	212	All	304 SS
Amyl Acetate	300	All	304 SS	Ethylene Oxide	75		Steel
Aniline	75		Monel	Fatty Acids	500	All	316 SS
Asphalt	250		304 SS	Ferric Chloride	75	All	Hast. C
Atmosphere (Industrial and Marine)			304 SS	Ferric Sulfate	300	All	304 SS
Barium Compounds - SEE CALCIUM				Formaldehyde	212	40%	316 SS
Beer	70		304 SS	Formic Acid	300	All	316 SS
Benzene (Benzol)	212		Steel	Freon	300		Steel
Benzoic Acid	212	All	316 SS	Fluorine, Anhydrous	100		304 SS
Bleaching Powder	70	15%	Monel	Furfural	450		316 SS
Borax	212	All	Brass	Gasoline	300		Steel
Bordeaux Mixture	200		304 SS	Glucose	300		304 SS
Boric Acid	400	All	316 SS	Glue ph 6-8	300	All	304 SS
Bromine	125	Dry	Monel	Glycerine	212	All	Brass
Butane	400	All	Steel	Hydrobromic Acid	212	All	Hast. C
Butyl Alcohol - SEE ALCOHOLS				Hydrochloric Acid (37-38%)	225	All	Hast. B
Butyric Acid	212		Hast. C	Hydrogen Chloride, Dry	500		304 SS
Calcium Bisulphite	75	All	Hast. C	Hydrocyanic Acid	212	All	304 SS
Calcium Chloride	212	All	Hast. C	Hydrofluoric Acid	212	60%	Monel
Calcium Hydroxide	300	20%	Hast. C	Hydrogen Fluoride, Dry	175		Steel
Calcium Hypochlorite - SEE BLEACHING POWDER				Hydrofluogilicic Acid	212	40%	Monel
Carbolic Acid - SEE PHENOL				Hydrogen Peroxide	125	10-100%	304 SS
Carbon Dioxide, Dry	800	All	Brass	Kerosene	300	All	Steel
Carbonated Water	212	All	304 SS	Lacquers & Thinners	300	All	304 SS
Carbonated				Lactic Acid	300	All	316 SS
Beverages	212		304 SS	Lime	212	All	316 SS
Carbon Disulfide	200		304 SS	Linseed Oil	75		Steel
Carbon Tetrachloride	125	All	Monel	Magnesium Chloride	212	50%	Nickel
Chlorine, Dry	100		Monel	Magnesium Hydroxide (or Oxide)	75	All	304 SS
Chlorine, Moist	100	All	Monel	Magnesium Sulfate	212	40%	304 SS
Chloracetic Acid	212	All	Monel	Mercuric Chloride	75	10%	Hast. C

Corrodent	Temperature °F	Concentration %	Recom. Material
Mercury	700	100%	Steel
Methylene Chloride	212	All	304 SS
Methyl Chloride, Dry	75		Steel
Milk, fresh or sour	180		304 SS
Molasses - SEE GLUCOSE			
Natural Gas	70		304 SS
Nitric Acid	75	All	304 SS
Nitric Acid	110	All	316 SS
Oxygen	75	All	Steel
Oleic Acid - SEE FATTY ACIDS			
Oxalic Acid	212	All	Monel
Photographic Bleaching	100	All	304 SS
Palmitic Acid - SEE FATTY ACIDS			
Phosphoric Acid	212	All	316 SS
Phenol	212	All	316 SS
Potassium Compounds SEE SODIUM COMPOUNDS			
Propane	300		Steel
Rosin	700	100%	316 SS
Sea Water	75		Monel
Soap & Detergents	212	All	304 SS
Sodium Bicarbonate	212	20%	316 SS
Sodium Bisulphate	212	20%	304 SS
Sodium Bisulphite	212	20%	304 SS
Sodium Carbinat	212	40%	316 SS
Sodium Chloride	300	30%	Monel
Sodium Chromate	212	All	316 SS
Salt or Brine - SEE SODIUM CHLORIDE			
Sodium Cyanide	212	All	304 SS
Sodium Hydroxide	212	30%	316 SS
Sodium Hypochlorite	75	10%	Hast. C
Sodium Nitrate	212	40%	304 SS
Sodium Nitrite	75	20%	316 SS
Sodium Phosphate	212	10%	Steel
Sodium Silicate	212	10%	Steel
Sodium Sulfate	212	30%	316 SS
Sodium Sulfide	212	10%	316 SS
Sodium Sulfite	212	30%	304 SS
Sodium Thiosulfate	212	All	304 SS
Steam			304 SS
Stearic Acid - SEE FATTY ACIDS			
Sugar Solutions - SEE GLUCOSE			
Sulfur	500		
304 SS			
Sulfur Chloride	75	Dr	316 SS
Sulfur Dioxide	500	Dry	316 SS
Sulfur Trioxide	500	Dry	316 SS
Sulfuric Acid	212	0%	316 SS

Corrodent	Temperature °F	Concentration %	Recom. Material
Sulfuric Acid	212	0-90%	Hast. B
Sulfuric Acid	212	90-100%	Hast. B
Sulfuric Acid, Fuming	175		Carp.20
Sulfurous Acid	75	20%	316 SS
Titanium Tetrachloride	75	All	316 SS
Tannic Acid	75	40%	Hast. B
Toluene	75		Steel
Trichloroacetic Acid	75	All	Hast. B
Trichlorethylene	300	Dry	Monel
Turpentine	75		316 SS
Varnish	150		Steel
Zinc Chloride	212	All	Hast. B
Zinc Sulfate	212	All	316 SS

In recommending the above materials, consideration has been given to providing good service life without undue cost. Where two or more materials are satisfactory, the least expensive is listed. Consult the factory for information on materials or services not given.