Thermowell and Protection Tube Specification

Common Materials:

The following materials are the most common alloys used as thermowells or protection tubes. (Temperature ratings in the following guideline are expressed in °F)

Carbon Steel (A105, A350, CF2) - Commonly used in oxidizing environments. Its melting point is 2500° and maximum operating temperature is 1300°.

304 SS - Used in applications up to 1650°. This nickel based alloy has good corrosion resistance and can be used in both reducing and oxidizing atmospheres.

310 SS - Better than 304 in many high temperature applications. Good resistance to carburizing and reducing environments. Subject to carbide precipitation in the 900° to 1600° range. Continuous service to 2100°.

316 SS - Operating temperature is the same as 304 but has a higher corrosion resistance and creep strength. OK to use in both reducing and oxidizing atmospheres.

446 SS - Most commonly used ferritic stainless steel. Maximum operating temperature is 2000°. Selected for use in reducing, oxidizing, vacuum and neutral atmospheres.

Low Carbon Stainless Steels - Are available from SSi in 304L and 316L. The operating and melt temperatures of these alloys are the same as the standard 304 and 316SS. They are generally used to reduce the effect of carbide precipitation.

Alloy 600 - Maximum rating of 2100°. This alloy has excellent corrosion resistance at elevated temperatures. Not recommended in reducing or high sulfur environments.

Alloy 800 - Same elevated temperature resistance to oxidation as Alloy 600. Good sulfur and corrosion resistance. Same operating temperature as Alloy 600.

Hastelloy B - Can be used up to 1500° in inert atmospheres and 1500° in oxidizing environments. Excellent resistance to pitting, stress-corrosion cracking.

Hastelloy C - Excellent corrosion resistance to ferric and cupric chlorides, contaminated mineral acids, wet chlorine gas. Oxidation resistance to 1800°F. Continuous service to 2200°.

Monel - Good resistance to sea water and not subject to chloride stress cracking. Not recommended for oxidizing atmospheres. Upper temperature range is 1000°.

Nickel - Use in sulfur free environments and in oxidizing atmospheres. Operating temperature not to exceed 1400°.

Tantalum - Upper temperature range is 5000°. Most commonly used as a sheath material for stainless flanged wells. Has good resistance to corrosion to most chemicals and a high heat conductivity coefficient.

Design Considerations:

Material - Cost versus Corrosion
In general the most important consideration in selecting the proper thermowell is the material of construction. Given that pressure is not a consideration, the wrong material selection can cause premature failure due to corrosion. In a perfect world, tantalum would be the same price as carbon steel and consequently seldom would there be a cost versus corrosion consideration. But then, a perfect world would have eliminated the nice little corrosion chart guide on pages 69 and 70 of this manual. The high polish on all stainless steel and nickel alloys reduces the risk of corrosion.

Connection - The Process Decides
The industry has standardized on five different types of process connections. They are: Threaded, Flanged, Socket Weld, Weld-In, and Van Stone. *Threaded Wells* are provided in one piece construction (up to 36") and have an NPT connection. *Flanged Wells* (other than Van Stone) consist of a stem welded to an ANSI rated flange. The weld is commonly referred to as a double weld that eliminates crevice corrosion since no open joints are exposed. *Socket Weld Wells* fit all A.S.A. standard couplings and flanges, are easy to install and have a very tight fit. *Weld-In Wells* are more expensive to install and are used where flanges are not practical or desired. *Van Stone Wells* are a one-piece construction well installed with a lap joint flange.

Length - More than just a “U” dimension
The immersion length of a well typically referred to as the “U” dimension is measured from the bottom of the threads or flange to the tip of the well. Accuracy of the sensor can be affected by the immersion length of the well. Thermocouples, which are tip sensitive, are less likely to be affected by short “U” lengths; while RTD’s which are stem sensitive would require a longer “U” for the same process condition. A rule of thumb is to immerse a thermocouple at least 3" in gases and 1" in liquids. Add 2" to this rule for RTD’s.

Bore Size - Standardization is the Key
The standard bore size for all wells offered in this catalog is .260 with .385 available as an option. Delivery is not generally affected by the .385 Wide Bore (WB) option. These bore sizes will accommodate most sheathed thermocouples, RTD’s and thermometers.

Well Shank - Strength is the Key
Tapered wells provide greater protection against breaking in high velocity fluid applications. The higher strength to weight ratio makes tapered the choice over straight wells due to their natural higher frequency. Reduced tip or step down wells provide increased sensitivity.

Vibration - Sometimes very dangerous
Excess pressure, temperature and corrosion are the major causes of well failure. Vibration, although less common, is significantly more dangerous. A condition called the Von Karman Trail can be caused by fluid flowing by the well which forms a turbulent wake. This wake has a frequency which is based on the diameter of the well and the velocity of the fluid. If this wake frequency is the same as the natural frequency of the well, the resonance could cause the well to vibrate to the extent that the stem fractures and breaks. It is difficult to provide specific information in chart form to assist you in well selection when vibration is a consideration. Maximum allowable velocities will change depending on the “U” length, well material, temperature, type of fluid and well construction. For example a 316SS well with a 3-1/2" U can handle a maximum velocity of 100 feet per second in water at 200°F. The same well in 1000°F superheated steam allows 375 feet per second. Smart Sensors can perform the necessary calculations to assist you with design criteria in cases where vibration may be a factor. Smart Sensor assumes no responsibility other than repair or replacement of a well.