Thermowells: Why They Fail

The following is the most common cause of failure for threaded or flanged bar stock thermowells:

- Improper process application
- Improper material selection
- Improper installation
- Higher than anticipated temperatures
- Ignoring velocity considerations

Generally there are warnings associated with the impending failure for all of the failure considerations except for velocity. This failure can result in the thermowell moving unrestricted to a most undesirable alternative location in the process.

This most catastrophic cause of failure comes from improper velocity considerations. When a well is installed in a pipe or vessel and as fluid flows past the well's tip it forms a turbulent wake, this wake is called the Von Karman Trail. This wake has a defined frequency based on the diameter of the well and the velocity of the fluid flowing past it. The well must posses sufficient stiffness so that it's frequency would never equal the wake frequency of the Von Karman Trail. If these frequencies are equal to one another it causes the well to vibrate to the point of breaking.

The following table provides the maximum velocity for a 1" NPT threaded well, tapered construction, either 304 or 316SS. The medium is water at 200 degrees F in a pressurized (2500 psi) vessel. The maximum velocity and corresponding U length should be used as a guide only.

The calculations for determining U length are sophisticated and complete. Never use a guide or guess when it comes to determining whether velocity can cause a catastrophic failure. Call Smart Sensors for complete calculations based on your specific criteria.

U Length in inches	Maximum velocity (fps)
3.5	109
6	64
8	47
10	38
12	31
18	18
24	10

Smart Sensors can perform the velocity calculations that will determine the maximum U length and type of well. To make this recommendation we will need the following information:

1) Design U length in inches
2) Maximum velocity in feet per second
3) Maximum temperature
4) Well material
5) Process fluid or gas

Ceramic and Metal Protection Tubes

These protection tubes are generally used in industrial furnace applications where the temperature prohibits use of a metal tube. The characteristics of Alumina, Mullite, Silicon Carbide and Metal Ceramic protection tubes are as different as the applications they perform well in. Selection of the type of tube is application dependent, the following is a broad definition of some of the successful applications:

Molten Metal	Molten Glass	Oil fired furnaces
Calcining kilns	Ethylene Crackers	Blast furnaces

Alumina
The chemical composition consists of greater than 99.6% of sintered Alumina Oxide. They are the toughest ceramic tube when compared to Mullite. Alumina is extremely versatile and can be used in all atmospheres with selected preference in oxidizing atmospheres where in general Mullite would be a better choice. This tube can be used with any thermocouple calibration including all noble metal calibrations.

Mullite
Silica/Alumina protection tubes are a low cost alternative to Alumina. They have a low tolerance to thermal shock and can only be used with J,K, and N thermocouples. It is recommended that the tubes are evenly heated to 800 degrees F prior to use.

Silicon Carbide
Silicon Carbide, Carbon and Silica comprise the majority of the chemical composition and provide a excellent resistance to shock. Resistance to corrosion and abrasion at temperatures above the range of nickel chrome alloys is a feature that allows use in the most demanding corrosive application – which includes molten salt. An inner alumina tube must be used when noble metal thermocouples are employed.

Metal Ceramic
Consisting of chromium and alumina oxide this tube holds its strength even under load conditions. In most applications it can be mounted horizontally without drooping. The conductivity of this composite is comparable to most stainless steels. Its' use in molten metal applications is recommended since it has good resistance to wetting.

KEY
E - Excellent
G - Good
A - Average
P - Poor
Y - Yes
N - No

	Temp Rating °C	Gas Tight	Corrosion Resistance	Resistance to Thermal Shock	Thermal Conductivity	Hardness	Droop	Water Absorption Resistance	Cost	Oxidizing Atmosphere
Alumina Oxide (99.7% Pure)	1950	Y	A	P	P	P	P	E	$$	N
Mullite (Silica/Alumina)	1750	Y	A	P	P	A	P	E	$	Y
Metal Ceramic (Chromium/ Aluminum Oxide)	1320	Y	G	E	E	G	E	E	$$$	N
Hexaloy (Silicon Carbide)	1650	Y	E	E	E	E	G	E	$$$$	Y

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