tsc thermo sensors corporation

Address: P.O. Box 461947 Garland, TX 75046
Phone: 972-494-1566 **Toll Free:** 1-800-889-5478
Website: www.thermosensors.com

A Leading Manufacturer of Quality Thermocouple and RTD Assemblies Since 1972

Thermowells

Thermowells are used to provide an isolation between a temperature sensor and the environment, either liquid, gas or slurry. A thermowell allows the temperature sensor to be removed and replaced without compromising either the ambient region or the process.

Care must be taken in determining the material used for the thermowell as well as other factors.Thermo Sensors offers design assistance that includes pressure, temperature and or corrosion as well as vibration effects of the fluids. This vibration can cause well stem failure.

Thermo Sensors thermowell materials include:

- Carbon Steel
- 304 & 316 Stainless Steel
- Monel
- Brass

Please refer to our order guide to assist in determining your needs. We can also provide technical design assistance and application suggestions. Give us a call.

Design Procedure***

The purpose of this design procedure is to enable the user to determine if a well selected for thermometry considerations is strong enough to withstand specific application conditions of temperature, pressure, velocity, and vibration. Well failures are caused by forces imposed by static pressure, steady state flow, and vibration. Separate evaluations of each of the above effects should be made in order to determine the limiting condition. This design procedure does not allow for effects due to corrosion or erosion.

The natural frequency of a well-designed in accordance with Fig. 1.1 and of the dimensions given in Table 1.1 is given by the following equation:

$$f_n = \frac{K_f}{L^2}\sqrt{\frac{E}{g}} \cdots\cdots [1]$$

where
f_n = natural frequency of the well at use temperature, cycles per sec
L = length of well as given in Fig. 1.1, in.
E = modulus of elasticity of well material at use temperature, psi
g = specific weight of well material at use temperature, lb per cu in.
K_f = a constant obtained from Table 1.2

The wake or Strouhal frequency is given by:

$$f_w = \frac{V}{B} 2.64 \quad \ldots\ldots\ldots\ldots [2]$$

where f_w = wake frequency, cycles per sec
V = fluid velocity, fps
B = diameter at tip (Fig. 1.1), in.

The ratio of wake to natural frequency (f_w/f_n) shall not exceed 0.8, and when this condition is met, the Magnification Factor, relationship of dynamic to static amplitude is given by:

$$F_M = \frac{(f_w/f_n)^2}{1-(f_w/f_n)^2} = \frac{r^2}{1-r^2} \ldots\ldots [3]$$

For r ≤ 0.8
where
F_M = magnification factor, dimensionless
r = frequency ratio, (f_w/f_n), dimensionless

Stress Analysis

The maximum pressure that a thermometer well can withstand for a given material at a given temperature shall be computed from the following:

$$P = K_1 S \ldots\ldots\ldots\ldots [4]$$

where
P = maximum allowable static gage pressure, psi
S = allowable stress for material at operating temperature as given in the ASME Boiler and Pressure Vessel or Piping Codes, psi
K_1 = a stress constant obtained from Table 1.3.

The maximum length that a thermometer well can be made for a given service is dependent upon both vibratory and steady state stress. The necessity for keeping the frequency ratio at 0.8 or less imposes one limitation on maximum length. The other limitation is one of steady state stress considerations, as given by the following equation:

$$L_{max} = \frac{K_2}{V}\sqrt{\frac{v(S-K_3P_0)}{1+F_M}} \ldots\ldots [5]$$

where
L_{max} = maximum value of L (as shown in Fig. 1.1) for a given service, in.
V = fluid velocity, fps
v = specific volume of the fluid, cu ft per lb.
S = allowable stress for material at operating temperature as given in the ASME Boiler and Pressure vessel or Piping Codes, psi
P_0 = static operating gage pressure, psi
FM = magnification factor as computed from Eq [3]
K_2, K_3 = stress constants obtained from Table 1.3

Table 1.1 well dimensions, in Inches

Dimension	Nominal Size of Sensing Element (1/4)
A (minimum)	13/16
B (minimum)	5/8
d (minimum)	0.254
d (maximum)	0.262

Fig. 1.1 power test code
Thermometer wells

Well Length L, in.	K_f	Stress Constant	
2-1/2	2.06	K_1	0.412
4-1/2	2.07	K_2	37.5
7-1/2	2.08	K_3	0.116
10-1/2	2.09		
16	2.09		
24	2.09		
Table 1.2 values of K_f		Table 1.3 values of stress constants	

*** Power Test Code Thermometer Wells, J. W. Murdock, Journal of Engineering for Power, Trans. ASME, vol. 81, 1959