Measurement Performance within a Sanitary Elbow Thermowell – The Impact of Sensor Construction on Time Response

Introduction

Time response is a significant source of measurement error in many installations. It becomes especially important in thermowell applications, as the increased mass around the sensing element can cause delays of several minutes before a temperature change is fully realized by a sensing device.

The Burns Sanitary Well Elbow (SWE) was designed to reduce the mass around the sensing element while still ensuring the proper sensor immersion required for an accurate measurement. This evaluation will investigate the impact of sensor construction on time response when a sensor is used with a typical SWE.

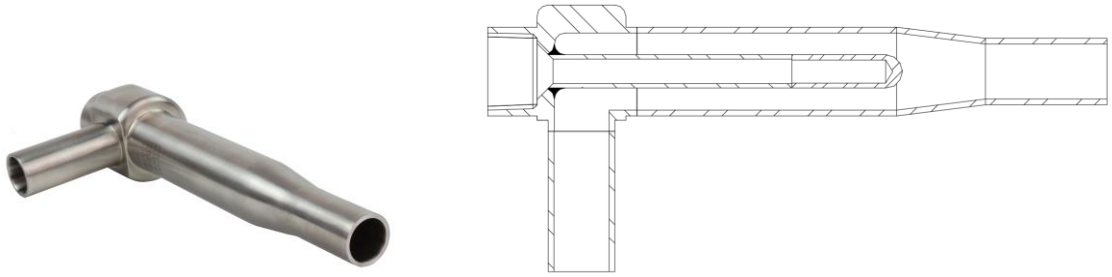

Figure 1: Product Image and Cross Section View for Burns SWE Thermowell

Determining Sensor Constructions to Evaluate

Commercially available sensors were selected for testing. The SWE has a bore diameter of Ø0.260", spring-loaded sensors with 6 mm and ¼" sheath diameters and thin film or coil element construction are commonly used.

Time Response Performance

The direct immersion time response for each sensor was recorded per ASTM E644-11. To test the SWE time response, each sensor was attached to the thermowell and ice water was pumped through the process line at approximately 15 ft/s until full response was achieved. The pump was then changed to room temperature water and the time response was recorded. Multiple sensors were tested for each construction, and the average 63.2% response times for both tests are shown below.

	63.2% SWE Time Response (s)	63.2% Direct Response Time (s)
6 mm Thin Film Sensors	44	8.0
6 mm Coil Sensors	47	6.7
Burns 6 mm Thin Film Sensors	32	5.4
Burns 1/4" Thin Film Sensors	25	5.7
Burns 1/4" Coil Sensors	28	2.8

Table 1: Average Time Response for Each Sensor Construction

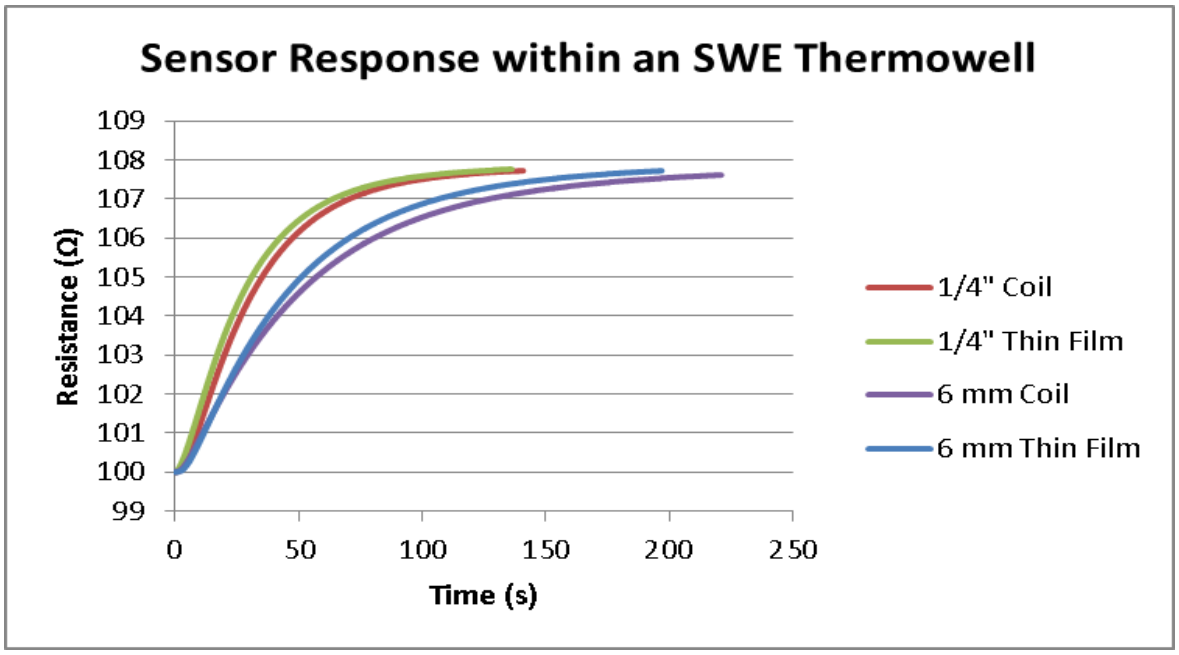

Figure 2: Sample Time Response Curve for Each Construction with an SWE Thermowell

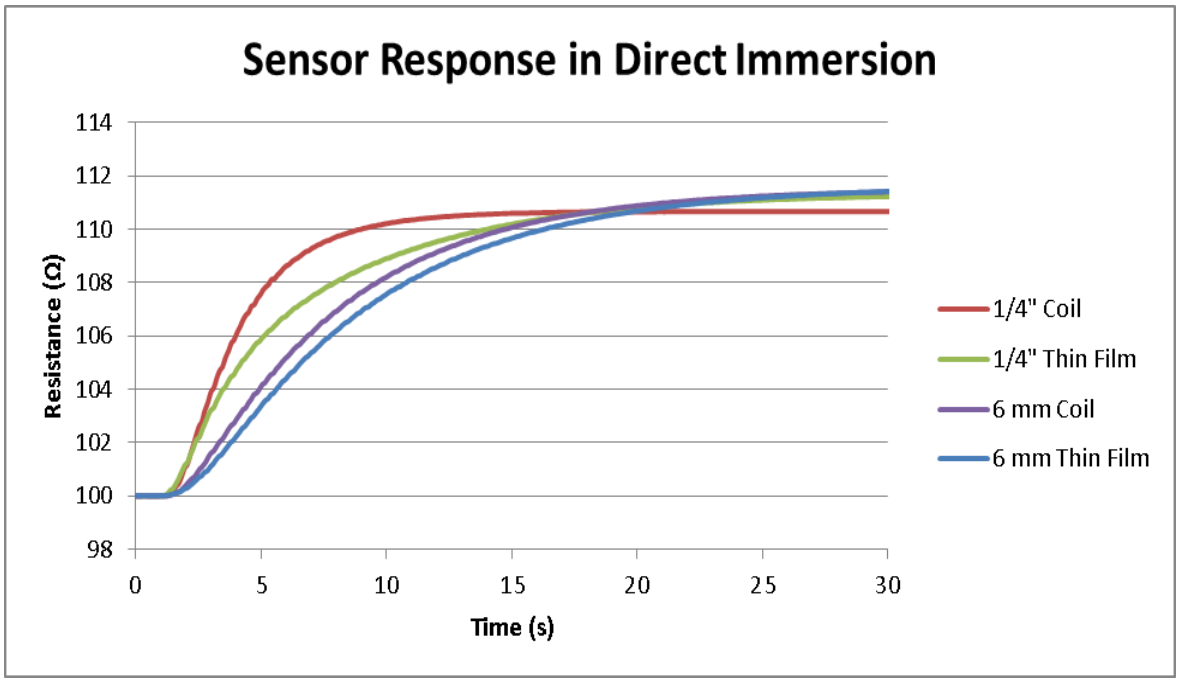

Figure 3: Sample Time Response Curve for Each Construction in Direct Immersion

Summary

The results show that ¼" diameter sensors should be used with SWE thermowell applications to optimize time response. The improved fit between the sensor and the Ø0.260 SWE bore diameter results in a time response improvement of up to 60%, which will provide a more consistent, reliable and accurate temperature measurement. If time response is especially critical in a given application, there may be an additional performance benefit to using ¼" sensors with a thin film design, assuming that a thin film sensor can meet the other application requirements.

Other factors that could further negatively influence the measurement accuracy include:

- Lower flow rates
- Larger difference between process and ambient temperatures
- Sensor constructions with lower thermal conductivity around the sensing element

Additional research would be necessary to quantify additional application variables.

The Burns Engineering Team

www.burnsengineering.com/BENews
www.burnsengineering.com