Selecting Proximity Sensors for High Temperature Applications

Considering three aspects — sensor design, materials of construction and process parameters — will help yield the best choice for difficult applications.

Following the introduction of proximity sensors in the early ’90s, this relatively simple device has played an integral role in most applications in the automation industry. Since then, proximity sensors have evolved and are offered in an endless range of sizes, types, materials of construction, and options to suit a multitude of applications.

Automation is an integral aspect of industries such as burn-in ovens, composite board manufacturing, molding operations, steel and glass production and heat treating. As these applications have grown and expanded, so too has the need for proximity sensors that can withstand rigorous, high temperature environments. Standard proximity sensors fall under the industry-standard specification IEC-60947-5-2, which defines the ambient operating temperature range of such devices to be -3 to 158°F (-25 to 70°C). In many cases, this is well below the necessary temperature requirements of high temperature applications. As a result, sensors with the ability to operate at 212, 302, 356 and 482°F (100, 150, 180 and 250°C) have emerged to meet these process applications.

Selecting the proper sensor for a high temperature application takes some careful consideration. The three most important considerations are the sensor’s materials of construction, key process parameters and sensor design.

1. Select Materials of Construction Wisely

To meet high temperature requirements, new materials of construction have been introduced. In addition, in very high temperature devices, the electronic circuitry has been removed from the sensor body and is mounted remotely out of the high ambient area. These devices use high performance plastics, low expansion silicone, Teflon or, in the case of 482°F (250°C) models, ceramic rather than plastic.

2. Take Key Process Parameters into Account

When selecting a high temperature sensor, one must really understand the application and pay attention to four key process parameters:

- Operational temperature range.
- Distance to the target (SN) value.
- Target material.
- Target size to be detected.
The selected operational temperature should represent a measured temperature over a period of time to include any peaks. Normally, it is recommended that one should allow for a thermal safety factor of at least 10 percent up to 392°F (200°C) — and 15 to 20 percent for higher temperature ranges — to account for fluctuations.

The distance to the target, or SN value, can be impacted by the size of the sensor selected, the size of the target and whether a flush-mounted or non-flush-mounted sensor is employed. Ideally, it is best to use the largest sensor available that matches the target size and that also is capable of detecting the target with the defined SN value. The flush-mounted sensor means that the coil, which emits the electromagnetic field, is fully encased in the stainless steel housing. To increase the SN, or sensing distance, one can use a non-flush version, which is a type where the head and the internal coil extend beyond the end of the metal housing. Care must be taken with the non-flush version because they require more space around the head of the sensor. However, this kind can increase the sensing distance by as much as 30 percent.

3. Design

Normally, all high temperature sensors up to 356°F (180°C) are classified as Type 1 sensors, and the temperature-compensating circuit, the coil and the amplifier are all encased in the stainless steel metal housing. Once the temperature is greater — say, 446 or 482°F (230 or 250°C) — a Type 2 high temperature sensor is required. These higher temperature sensors are made up of two parts: the sensor metal body with the coil, temperature-compensation circuit, and a remotely mounted oscillator and amplifier away from the higher ambient temperatures. Separating the sensor into two packages ensures that the device is protected from thermal transients, which, if prolonged, could damage the operation of the sensor. Additionally, the separation of the electronics from the sensor head provides for meeting temperatures of 482°F (250°C) and higher.

The options available for these higher temperature sensors include having the amplifier mounted in-line with the cable assembly or mounted in a housing that can be easily mounted onto a DIN rail. The cable jacket for all high temperature sensors can be ordered in either Teflon, to protect against the high heat, or in silicone, to provide protection against breaking down at these higher temperatures.

In conclusion, the sensor choices that exist for an engineer working on an automation project where high ambient temperatures are present are endless. Applications such as burn-in ovens, rolling mills, automated paint systems, molding equipment, heat treating and hardening ovens have driven the need for proximity sensors that will stand up to these demanding environments. Sensor construction, materials and designs have met the challenge, permitting consistency without quality issues even in high temperature applications.