

How to Install An Infrared Thermometer

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There are many ways to measure temperature in a process. Sensors such as thermocouples, RTDs and infrared thermometers are the most common temperature sensors utilized today.

A noncontact infrared thermometer has the advantage of being able to measure the product temperature while it is moving. Or, if the product is in an oven, the instrument measures the product, not the environment. However, to obtain accurate temperatures with an infrared thermometer requires the consideration of the following factors: aiming and focusing, optical obstructions, interface with other instruments and maintenance.

Aiming and Focusing

One of the questions most often asked during installation is: "Does the thermometer have to be aimed perpendicular to the surface?" The answer is no. For measurements of smooth surfaces such as plastic, glass and paper, the instrument can be aimed from a 45 to 90° angle (figure 1). If you exceed the 45° angle, the surface becomes reflective, which in turn lowers the emissivity and gives the appearance of a lower temperature than it really is. For rough surfaces like steel, textiles and food, the instrument can be aimed as low as 15° from the horizontal and the temperature indication will be accurate (figure 2). It often is advisable in a steel mill or paper mill not to look straight up or down at the target because of the debris that can fall into the lens, and heat and steam can overheat the sensor. By placing the sensor off to the side and looking at an angle, the sensor will survive the environment more easily.

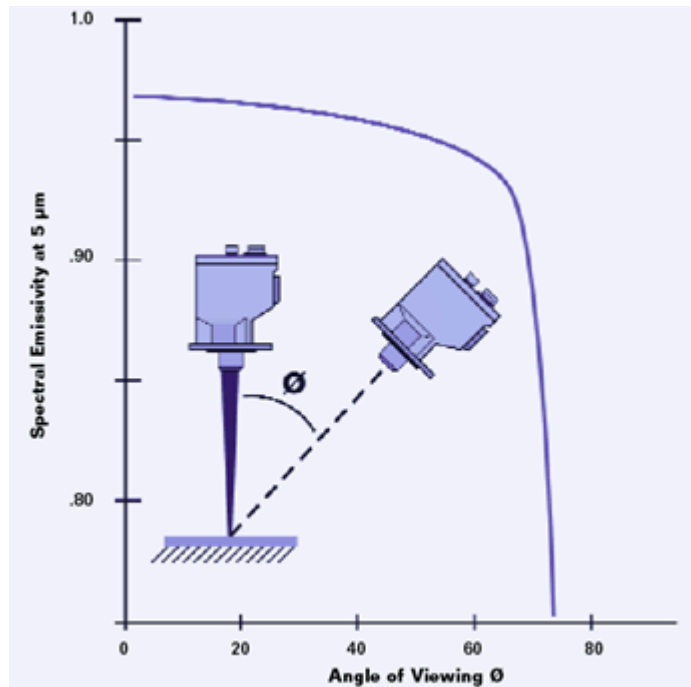


Figure 1. When measuring the temperature of products with smooth surfaces, a viewing angle between 45° and 90° is best.

All infrared thermometers measure temperature within a certain area. To define the target size requires a simple calculation or obtaining the information from the manual.

Figure 3 shows an infrared thermometer that has focusable lens. To determine the target measured, the formula is

$$d = D/F$$

where

d is the spot size

D is the distance from the sensor to the target and

F is the focal factor of the instrument.

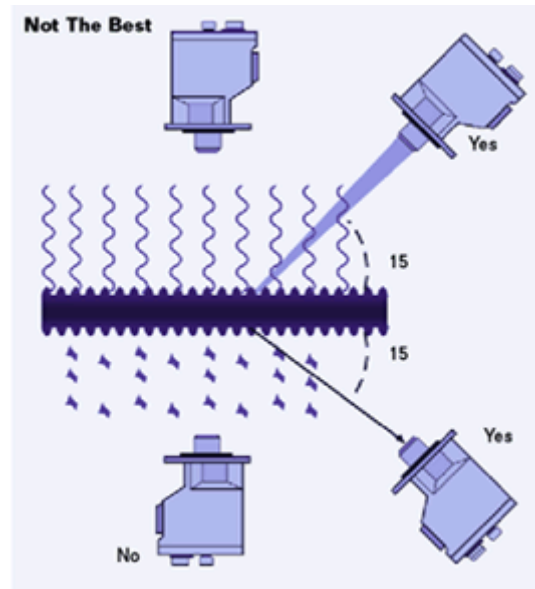


Figure 2. When measuring the temperature of products with rough surfaces, the instrument can be aimed as low as 15° from horizontal. Avoid placing it directly above or below processes with falling debris or intermittent obstructions such as steam.

The focal factor for any instrument is included in the manual and usually varies from a low number of 20 for low temperatures such as 0 to 500°F (-18 to 260°C) to a high of 300 for high temperatures such as 1,500°F (816°C) and higher. As an example, if the focal factor is 50 and the instrument is 100" away, then

$$d = 100/50 = 2.0"$$

If the target is smaller than 2.0", then the sensor must be placed closer or work with an instrument that has a higher resolution factor. The focal factor (F) has no dimension so the formula will work in inches, feet, millimeters or centimeters, and the answer will be in the same dimension.

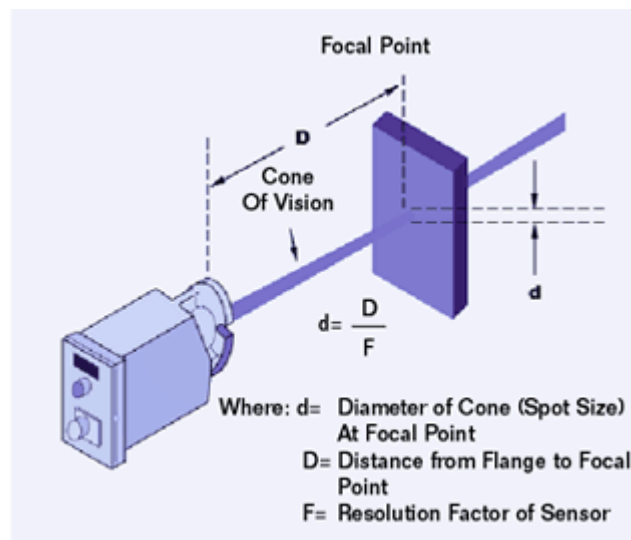


Figure 3. On infrared thermometers with a focusable lens, the sensor-to-target distance and the focal factor of the instrument determine the sensor's spot size.

For instruments with a fixed focus, there are charts in the manual that show the spot size vs. the distance. Figure 4 shows a typical chart, and in this example, it shows that at 50" the spot is 5.7". This means that in order to measure the correct temperature, the target has to be larger than 5.7". Failure to fill the spot size will allow the instrument to measure anything else that is in the spot, and usually this will lead to an incorrect temperature.

Hocus Focus?

Do you have to always be in focus?

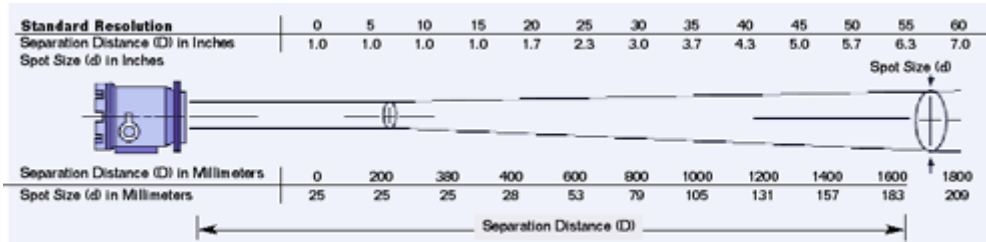


Figure 4. Temperature indication is not affected in applications such as a paper web where the target may move up and down.

No, figure 5 shows an application such as a paper web where the target may move up and down. At the No. 2 location, the instrument is in focus. At locations 1, 3 and 4, they are out of focus. On locations 1 and 2, the target is larger than the spot being measured, and the infrared thermometer just averages the temperature of a larger area. Only the fourth position will not work because the spot size is larger than the target.

For wide targets such as strips of plastic, glass and textiles, wide-angle lens are available to provide an average temperature over the entire width of the web. However, the average temperature usually is not the desired temperature, so many installations use three or four instruments spaced across the web to provide a more accurate temperature profile.

Obstructions

Figure 6 shows that the line of sight -- often called "cone of vision" -- between the sensor and the hot target should be a clear, unobstructed line of sight. However, there are many possible obstructions that can cause problems.

Solid Obstructions. Solid obstructions such as pipes and steel structure can be in the cone of vision. The ideal solution is to remove the obstruction, but often this is not a choice. The solution could be to look at the target at an angle or use an instrument that has a fiber optic cable and lens that goes around the obstruction.

Windows. Some applications require windows to maintain a vacuum in a chamber or pressure in the oven. If a window is necessary, be sure that it is transparent for the wavelength of the instrument that is being used. The window must be kept clean. If it gets dirty, the instrument will measure the temperature of the dirt on the window. In addition, the window must be large enough so the cone of vision is not obstructed by too small of a window opening.

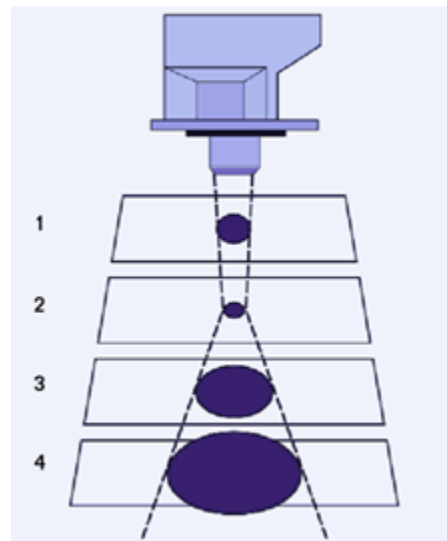


Figure 5. The sensor's line of sight to the product to be measured should be unobstructed. Flames, smoke, steam and solid obstructions may result in an inaccurate temperature reading.

Intermittent Obstructions.

Intermittent targets and obstructions such as smoke, steam and dust cause the instrument to provide erratic temperature indications. An electronic feature called a peak picker solves this problem. The electrical circuit allows the indication to rise as fast as the response time, but a delayed decay rate does not allow the temperature to go down when the interference in the line of sight. Figure 7 shows an application with bottles at different temperatures.

Without the peak picker, the instrument would indicate room temperature when there is no bottle present. With the peak picker, the spaces are ignored and only the product temperature is indicated.

Flames. Clean gas flames are transparent to an infrared thermometer; the infrared thermometer will see right through them and not measure the flame temperature. The same is true of inert gases such as argon, nitrogen or hydrogen -- infrared thermometers will not see the gases but instead measure the temperature of the target immersed in these gases. Dirty flames such as coal, oil or garbage flames are opaque, and the infrared thermometer will measure the actual flame temperature rather than see through it.

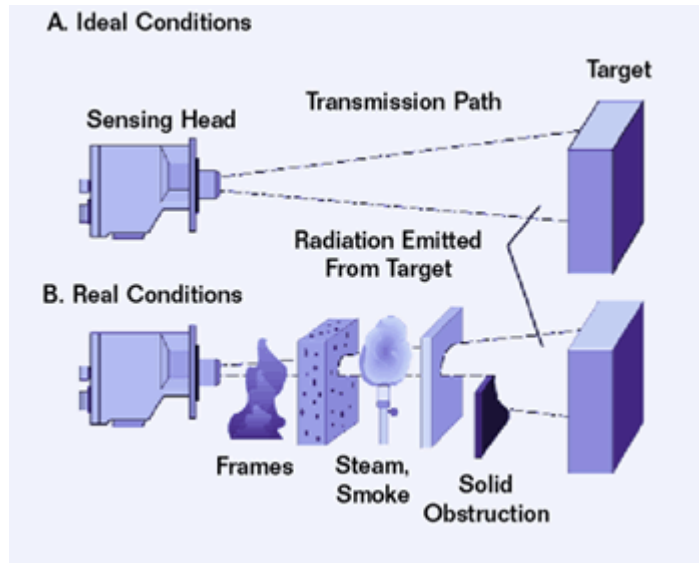


Figure 6. Processes with intermittent targets can be measured with an infrared sensor outfitted with peak picker capabilities.

Instrument Interface

Infrared sensors often interface with computers and other data devices. The outputs from the sensor include linear 4 to 20 mA, 0 to 10 V or RS232 and RS458. All of these outputs need to be ungrounded outputs. Computers like to work with what is known as floating inputs. If the outputs are improperly grounded, the temperature

indications may not even exist or be entirely incorrect. When working with the digital outputs, be sure to match the sensor baud rate with the computer baud rate.

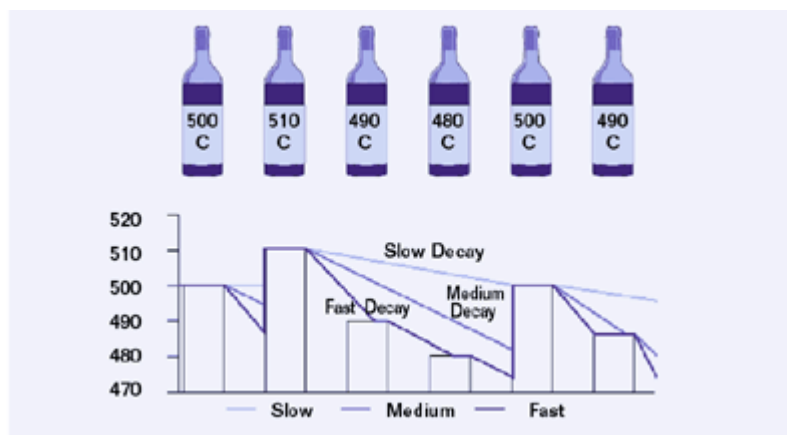


Figure 7. To keep the sensor cool and clean, the infrared thermometer may need to be supplied with a water-cooled jacket and an air purge.

Maintenance

The three points of maintenance include keeping the sensor cool, keeping the lens clean and calibrating the sensor properly.

Cool the Sensor. Most sensors can operate in ambient temperatures of 0 to 145°F (-18 to 63°C). If the ambient air surrounding the sensor is hotter or cooler than these temperatures, the sensor will drift or may even be destroyed.

Overheating the sensor is the most common problem. To keep the sensor cool may require a water-cooled jacket or attachment (figure 8). Do not overcool the sensor. Operate the sensor at about 100 to 110°F and this will be above the dewpoint temperature. If the sensor is too cool, condensation will build up inside of the sensor and destroy it.

Clean the Lens. Keep the lens clean by using an air purge (figure 8). The goal is to maintain enough air pressure to keep the dirt and fumes away from the lens. If the lens gets dirty, the instrument will indicate too low of temperature.

To clean a dirty lens, use isopropyl alcohol to wash the lens. Dry with a soft cloth. On the instruments with focusable lens, be sure to clean both sides of the lens as well as the window behind the lens.

Calibrate the Device. It is common practice to calibrate infrared thermometers once a year. They certainly are rugged enough that they could go several years without calibration, but usually ISO 9000 requires annual calibration.

To calibrate an infrared thermometer requires a blackbody source (figure 9). This is a special oven that is a calibrated temperature source with a specific cavity design. But, before using a blackbody, this source itself should be calibrated annually by an authorized laboratory.

Infrared thermometers can provide accurate temperatures for indication and closed-loop control. When installing these instruments, all of the factors discussed must be considered. If the instrument appears to indicate the incorrect temperature, take the time to review the installation and correct any errors.



Figure 8. Infrared thermometers typically are calibrated annually using a black body.



Figure 9. Infrared thermometers typically are calibrated annually using a black body.