measurement matters

Reliable infrared temperature measurements of food products

Infrared thermometers are becoming increasingly widespread in the food processing and storage industries. Their popularity is not surprising. They are compact and easy to use, they respond quickly, enabling users to make many measurements in a short period of time, and they measure temperature without physical contact, eliminating the possibility of contamination and allowing measurements to be made at a distance.

But beware! In many cases an infrared thermometer's ease of use is deceptive. Often readings for the same object differ depending on its surroundings. This leads to confusion and disputes over what the true temperature actually is.

For example, measuring a product inside a cool store and then in a warm room may give different readings, even if its true temperature remains the same. What's more, both readings may be incorrect!

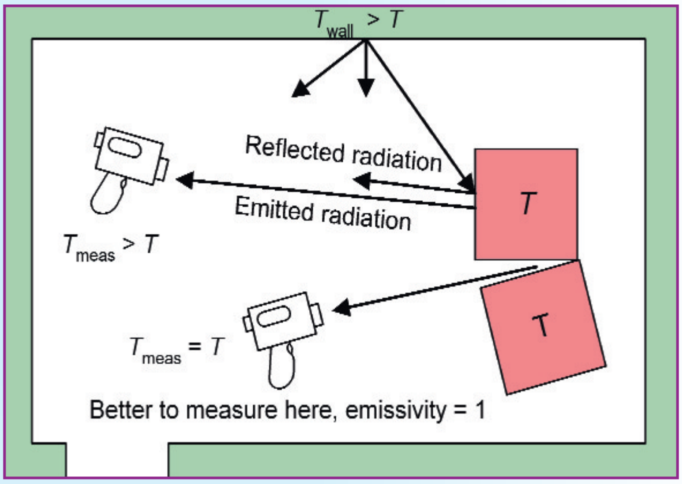
However, with a rudimentary understanding of the thermometer's operating principles and good measurement practice, this confusion can be avoided and reliable measurements made.

All objects at temperatures above absolute zero emit thermal radiation, with the intensity increasing rapidly as the temperature increases. Below about 500 degrees Celsius this radiation is confined to the infrared part of the spectrum, invisible to the human eye. With special lenses and detectors infrared thermometers measure the thermal radiation and convert the signal into temperature. They are calibrated using a device called a blackbody cavity, which is designed to be as close as possible to a perfect emitter of radiation. This means that the reading on an infrared thermometer is only guaranteed to be correct when measuring other blackbodies.

In practice, real objects are not blackbodies. This leads to two closely related practical problems.

Firstly, real objects emit less radiation than a blackbody and, secondly, they reflect radiation from surrounding objects. The ability of a real object to emit radiation is characterised by a factor known as the emissivity. Most infrared thermometers have an emissivity adjustment (a setting between 0 and 1), which is used to compensate for the non-blackbody nature of real objects. Many materials used for food packaging, such as cardboard and plastics, have emissivities around 0.95; that is, they emit 95 percent of the radiation of a blackbody. However, there are some exceptions. In particular, plastics with metalised coatings have quite low emissivity – around 0.6.

Reflections are often a more serious problem. As well as detecting the emitted radiation, the infrared thermometer detects reflected radiation originating from surroundings such as walls, lamps, people, and so on (see figure). This causes the reading to be too high, by as much as five degrees Celsius for frozen goods. The lower the emissivity the more an object reflects and the larger the error.



Fortunately, reflections can be used as a solution to both problems. In cavities or in cracks between objects at the same temperature reflections add up and exactly compensate for emissivities less than 1. The cavity or crack behaves like a blackbody. This is the way blackbody calibration sources are made. Because the object looks like a blackbody, setting the emissivity adjustment to 1 yields an accurate reading.

In summary, to make reliable measurements you should:

- Look for, or make, natural cavities such as the interior of boxes, cracks between stacked boxes, or gaps between piled packages.
- Set the emissivity setting to 1.
- Make sure the infrared thermometer is viewing only the cavity, then take the reading.

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