IR pyrometers: specify your needs before you buy

Are there universal pyrometers? How can some models cost only 30 or 40 euros while others are many times more expensive? How do the low-price versions differ from the industrial ones? We discuss these issues here.

There are no universal pyrometers that cover all measurement needs. To think there are is about the same as expecting a universal vehicle that can cover all transport needs from a sports car to a truck. However, within well-defined limits the term ‘universal’ can suffice.

Fundamentally, all IR pyrometers consist of similar functions. See Figure 1. An IR pyrometer measures the intensity of the radiation that enters its opening (1). In the simplest case, a plastic window provides enough protection against dirt, which creates a diverging field of view and a target surface that increases along with the distance to the measurement object. If you want to measure small objects you need a lens system to zoom in on a small target surface (the “spot”). A pyrometer normally measures the average temperature across the entire spot, so the measurement object itself should be considerably larger than the spot. See Figure 2. Even with these few factors, the complexity of the possible components already varies widely, and thereby so does the price of the pyrometer.

The lens is the sensitive part

If the radiation intensity encountered by the lens is high, then the lens must be able to withstand it, that is, it must be made of a material that is not deformed by high temperatures but allows the desired wavelength interval to pass through. The need to cool the pyrometer and repel dirt can require an air purge, sometimes accompanied by bursts of compressed air. In very hot environments, the pyrometer housing may also need water cooling jackets. Industrial pyrometers are often already prepared to take these accessories. In general, the higher the temperature you want to measure, the shorter are the wavelengths that the wavelength filter (2) must let through. A high temperature gives the highest signal output, for instance of metals, typically within 0.7–4.5 µm of the infrared spectrum, which comprises the wavelengths 0.7–20 µm. Organic materials under 500 °C have the best resolution within 8–14 µm. Wavelength filters can of course be manufactured with various precisions.

Varying response times

The IR detector (3) is the heart of the measuring device. Various types exist, from simple thermopiles to photoelectric versions. Thermopiles must be physically heated by the radiation, which takes some time, whilst electrons in industrial photoelectric versions are excited directly by the radiation. This means that the photoelectric response times can be at the level of ≤ 1 ms. For the best reproduction of the radiation intensities across the spot, the detector and filter must be precision manufactured. Here, too, there is a lot of room for large variations in quality. Signal processing (4) can be solved in various ways. A small amount of drift improves the measurement performance, as does expensive compensation for the temperature of the pyrometer housing. (Compare with the cold junction used when measuring with thermocouples). Before the measurement data is displayed (5) the signal must be linearised and digitised. There are also various control possibilities, such as an adjustable emissivity factor for adapting to the emissivity of the measurement object. An object normally emits its own radiation as well as reflecting other radiation. The emissivity is the proportion of the object’s own radiation at the object’s thermal equilibrium.

The power supply (6) can, in the simplest case, consist of dry batteries, but industrial pyrometers often need continuous operation powered by an external source.

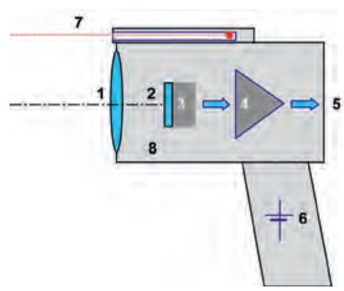

Figure 1. Hypothetical construction of an IR pyrometer: 1) Lens or window, 2) Wavelength filter, 3) IR detector, 4) Amplification and digitalisation, 5) Readings display and settings, 6) Power supply, 7) Laser sights, 8) Housing. See further in the text.

The laser sights (7) can differ in their design. The diagram shows a simple type of laser, which aims in parallel with the radiation’s sight path and gives some indication to within a few centimetres of where the target surface’s centre lies. A more effective version is found on some industrial instruments. It is a laser beam that is reflected into the radiation’s sight path and thereby indicates the target surface’s true centre regardless of the distance.

The IR pyrometer’s housing (8) can be made of plastic or metal. Plastic most often involves a fixed construction with basic equipment for use at low temperatures, and can therefore be manufactured in large series at low cost. Pyrometers designed for industrial use are more rugged and customers can choose the components, such as the lens system and cooling devices, to best suit their measurement requirements.

Specify the requirements first

Because the quality of pyrometers can vary widely in a number of ways, it is not surprising that prices can differ a great deal between simple handheld devices and lavishly equipped industrial IR pyrometers. It is therefore important to first draw up a specification of your measurement requirements with regard to the measurement environment, measurement object, performance, required settings, and similar factors before you select your IR pyrometer. Only then can you determine what quality level is required for your particular measurement task.

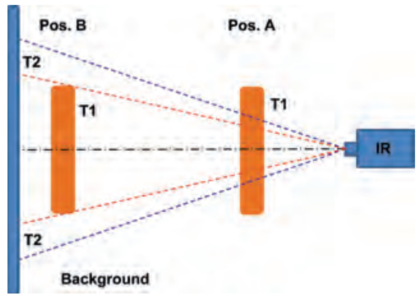

Figure 2. The pyrometer (IR) measures what it perceives inside the blue sector. With the measurement object at Position A, the pyrometer only perceives the surface temperature T1. If the measurement object is moved to Position B, the pyrometer perceives the temperature T1, inside the red sector, but also the temperature T2 from the background. In this case, Position B gives a mean temperature across the total measurement surface inside the blue sector. With a lens system a pyrometer can also zoom in on small details from a long distance away.

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