Science ASSIST Information Sheet

Infrared (IR)Thermometers
working principle and safe use

What are Infrared Thermometers?

An infrared (IR) thermometer is an instrument that can rapidly measure the temperature of surfaces of objects and the body from a distance without any contact.[1, 2] These thermometers use the infrared radiation emitted from the surface of objects or the body to determine temperature. They are also known as laser thermometers as most use a laser pointer to help aim at a precise location.

IR thermometers are fast, convenient and easy to use particularly for taking the temperature where conventional thermometers/sensors cannot be used, such as hot surfaces, moving objects and sterile or hard to reach places.[1] There are 2 main types of IR thermometers: clinical and industrial. Both are generally available as handheld portable units or fixed mount versions. IR thermometers have applications across many industries and in the home.[1, 2] IR thermometers are commonly used in schools throughout Australia.

You cannot use medical and industrial IR thermometers interchangeably. Industrial IR thermometers measure surface temperatures over a broad range of temperature to suit industrial applications. Whilst medical IR thermometers have a narrower temperature range of the human body and are far more accurate.

Recommendations and safe procedures for use in schools

Purchase from an Australian supplier is recommended to ensure compliance with the relevant Australian standards. Also, IR thermometers intended for medical purposes in Australia are regulated by the Therapeutic Goods Administration (TGA).[3]

Provide instructions to staff and students regarding safe use. Students should be closely supervised when using IR thermometers.

Here are some simple safety instructions:

- Follow the manufacturer's guidelines and instructions for their intended use.
- Do not deliberately point the laser beam into a person's eyes or stare into the laser beam.
- Lasers can have specular/diffuse reflection off surfaces so care needs to be taken, not to reflect off surfaces into a person's eyes.
- If taking a person's temperature make sure the forehead is clean and dry and they remain stationary during the measurement. Ensure body temperature has not increased by exposure to the sun or heaters or from wearing head covers.
- Caution is required if pointing the thermometer at a person's forehead to take their temperature as this could lead to the laser being shone inadvertently into a person's eyes (i.e., before taking the measurement be near the forehead with the thermometer).
- Always hold the device perpendicular (at 90^{o}) to the surface being measured.

How does an Infrared Thermometer work?

Infrared radiation is part of the electromagnetic spectrum that is emitted in varying degrees by objects and the body. Infrared radiation cannot be seen with the eye but can be focused, reflected and absorbed, similarly to visible light.[1]

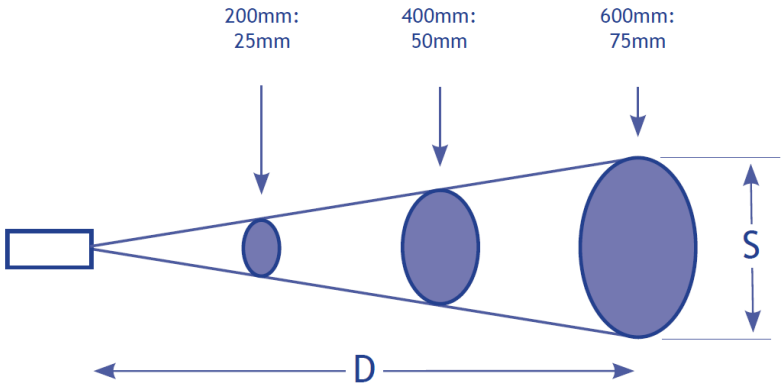
All IR thermometers work on the same basic principle. They use a lens system to focus infrared radiation emitted from a surface onto a detector called a thermopile. The infrared radiation is absorbed by the thermopile which turns it into an electrical signal that is displayed in units of temperature.

The emitted infrared radiation varies depending on the object being measured and the ability of its surface to emit energy as infrared radiation, or its emissivity.

Emissivity is a measure on a scale between 0 and 1 and is relative to a perfect black body which emits at 100% or 1, i.e., absorbs all incoming radiation and reflects none. A highly reflective or shiny surface would have a lower emissivity value.[1] Some IR thermometers have a fixed emissivity setting of around 0.95 which limits the type of materials able to be measured, so would not be able to measure polished aluminium, which has an emissivity of 0.05.[2] Others have adjustable emissivity settings which are best suited to measure a variety of surfaces.

Distance to Spot ratio: The ratio of the distance of the thermometer from the sample surface being measured and the spot (field of view) of the temperature measurement area is called the **distance to spot (D:S) ratio, or D:S ratio**. As the distance increases, the area being measured (spot) increases. The D:S ratio is usually marked on the thermometer. A low distance to spot ratio is required if measuring at close range and a high distance to spot ratio is necessary to measure a small area from a distance.[1]

An IR thermometer with an 8:1 ratio measures the temperature of a 25mm spot of surface area from 200mm away, a 50mm spot of surface area from 400mm away and so on.



IR Thermometer with a D:S ratio of 8:1

An IR thermometer measures the average temperature over the entire spot. Check your user manual to determine the distance and spot size for your IR thermometer.

The **temperature range** which can be measured varies between different models of IR thermometers. Temperatures can be measured anywhere from -50ºC to higher than 800ºC for industrial types and 32-42ºC for clinical versions.[4] The choice of unit and temperature range should be the one that best suits the application.

Laser pointer and safe use: The laser beam allows the user to aim at a precise location; it does not take the temperature. Basic IR thermometers have a single laser, more complex units can have 2 or more lasers.

Most IR thermometers use a Class 2 laser product with an output power below 1 milliwatt which is considered safe for unintentional eye exposure. Eye damage may only occur if a person deliberately stares into the beam.[5] The greater chance of injury occurs the closer you are to the laser and the longer the beam is in the eye. The laser beam must never be directly pointed or reflected off shiny surfaces into the eye.[6] If a laser is shone unexpectedly into people's eyes, it can cause a 'dazzle effect' which may cause them to be disorientated.[5] Laser protective eyewear is not necessary.

Advantages of Infrared Thermometers

- Compact and easy to use.
- Non-contact.
- Rapid results.
- Used where conventional thermometers/sensors cannot, such as hot surfaces, moving objects and sterile or hard to reach places.
- Easy to clean and disinfect.
- Some models can be calibrated and have the capacity to store and save readings.
- Affordable.

Limitations of Infrared Thermometers

- Only the surface temperature and not the internal temperature of materials or objects can be measured.
- The laser beam cannot pass through glass or liquids.
- Cannot measure the temperature of liquids or gases.
- Some models require adjustments depending on the surface being measured and its emissivity.
- Particles in the air such as dust, fog or smoke can affect the readings.
- Rapid changes in ambient temperature, plus proximity to an electromagnetic field and radio frequency can also affect the readings.[7]
- Accuracy can vary between different models.

Cleaning an Infrared Thermometer

For optimal operation IR thermometers should be kept clean and dry. The lens and body of the thermometer should be cleaned regularly with a soft slightly damp cloth. Never use soap or chemicals and never submerge the thermometer in water.

References and further reading

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