PYROMETER

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INTRODUCTION

A pyrometer is a type of thermometer used to measure high temperatures. Various forms of pyrometers have historically existed. In the modern usage, it is a non-contacting device that intercepts and measures thermal radiation, a process known as pyrometry. The thermal radiation can be used to determine the temperature of an object's surface.

The word pyrometer comes from the Greek word for fire, "πυρ" (*pyro*), and *meter*, meaning to measure. The word pyrometer was originally coined to denote a device capable of measuring the temperature of an object by its incandescence, or the light that is emitted by the body as caused by its high temperature

You can feel a fire some distance away because it gives off heat radiation in all directions. In theory, if the fire behaves exactly according to the laws of physics, the radiation it produces is related to its temperature in a very predictable way. So if you can measure the radiation, you can precisely measure the temperature even if you're standing some way off. That's the theory behind a pyrometer: a very accurate kind of thermometer that measures something's temperature from the heat radiation it gives out.

HISTORY OF PYROMETER

Modern pyrometers became available when the first disappearing filament pyrometer was built by L. Holborn and F. Kurlbaum in 1901 . This device superimposed a thin, heated filament over the object to be measured and relied on the operator ’ s eye to detect when the filament vanished. The object temperature was then read from a scale on the pyrometer. The temperature returned by the vanishing filament pyrometer and others of its kind, called Brightness Pyrometers, is dependent on the emissivity of the object. With greater use of brightness pyrometers, it became obvious that problems existed with relying on knowledge of the value of emissivity. Emissivity was found to change, often drastically, with surface roughness, bulk and surface composition, and even the temperature itself. To get around these difficulties, the ratio or two-color pyrometer was developed. They rely on the fact that Planck's Law , which relates temperature to the intensity of radiation emitted at individual wavelengths, can be solved for temperature if Planck ’ s statement of the intensities at two different wavelengths is divided. This solution assumes that the emissivity is the same at both wavelengths and cancels out in the division. This is known as the gray body assumption . Ratio pyrometers are essentially two brightness pyrometers in a single instrument. The operational principles of the ratio pyrometers were developed in the 1920s and 1930s, and they were commercially available in 1939 . As the ratio pyrometer came into popular use, it was determined that many materials, of which metals are an example, do not have the same emissivity at two wavelengths . For these materials, the emissivity does not cancel out and the temperature measurement is in error. The amount of error depends on the emissiveties and the wavelengths where the measurements are taken. Two-color ratio pyrometers cannot measure whether a material ’ s emissivity is wavelength dependent.

TYPES Of GYROMETER

1. Broadband Pyrometer

A broadband pyrometer is one of the most-used pyrometers by scientists. The broadband pyrometer registers the broadband wavelengths of radiation, usually around 0.3 microns. Though most often used, they can have large errors in readings. Since they are only registering a small amount of heat from an object, everything from water vapor to dust can create a reading error.

2. Optical Pyrometers

Although all pyrometers are optical in the sense they can read an object's heat from a distance, an optical pyrometer allow a scientist to see heat. An optical pyrometer measures the infrared wavelengths of heat and directly shows the user the heat distribution of an object. Other pyrometers usually have a screen that provides the results of an optical scan.

An optical pyrometer is like a telescope wherein scientists can look through a lens and see the infrared wavelengths of an object. Optical pyrometers are one of the oldest pyrometer types and are able to see the wavelength levels up to 0.65 microns.

How Optical Pyrometers Work
Optical Pyrometers work on the basic principle of using the human eye to match the brightness of the hot object to the brightness of a calibrated lamp filament inside the instrument. The optical system contains filters that restrict the wavelength-sensitivity of the devices to a narrow wavelength band around 0.65 to 0.66 micons (the red region of the visible spectrum).

Other filters reduce the intensity so that one instrument can have a relatively wide temperature range capability. Needless to say, by restricting the wavelength response of the device to the red region of the visible, it can only be used to measure objects that are hot enough to be incandescent, or glowing. This limits the lower end of the temperature measurement range of these devices to about 700 °C.Some experimental devices have been built using light amplifiers to extend the range downwards, but the devices become quite cumbersome, fragile and expensive.

3. Radiation Pyrometer

A radiation pyrometer measures pure radiation wavelengths. The device has an optical scanner that can see 0.7 to 20 microns on the wavelength range, the general range for radioactive heat. The optical scanner helps scientists measure radiation levels without putting the pyrometer up to the object, which could endanger the individual to radiation exposure.

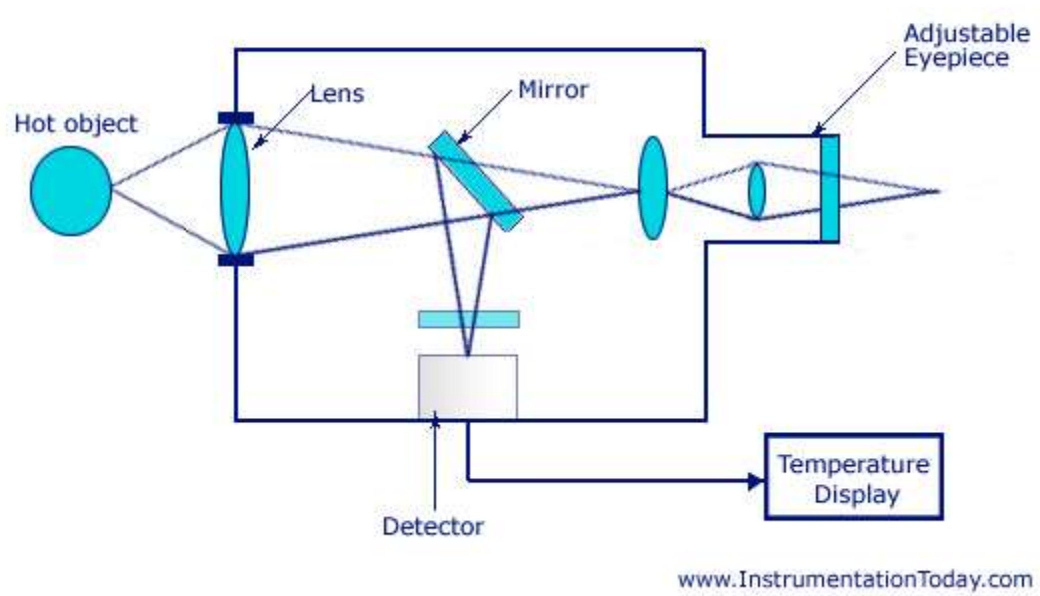
How Radiation Pyrometer Works

The main theory behind a radiation pyrometer is that the temperature is measured through the naturally emitted heat radiation by the body. This heat is known to be a function of its temperature. According to the application of the device, the way in which the heat is measured can be summarized into two:

1. Total Radiation Pyrometer – In this method, the total heat emitted from the hot source is measured at all wavelengths.
2. Selective Radiation Pyrometer – In this method, the heat radiated from the hot source is measured at a given wavelength.

As shown in the figure below, the radiation pyrometer has an optical system, including a lens, a mirror and an adjustable eye piece. The heat energy emitted from the hot body is passed on to the optical lens, which collects it and is focused on to the detector with the help of the mirror and eye piece arrangement. The detector may either be a thermistor or photomultiplier tubes. Though the latter is known for faster detection of fast moving objects, the former may be used for small scale applications. Thus, the heat energy is converted to its corresponding electrical signal by the detector and is sent to the output temperature display device.

Block Diagram of Radiation Pyrometer



Radiation Pyrometer

WHO INVENTED THE FIRST PYROMETER?

Long before disappearing filament and electronic pyrometers were invented, potters needed to measure the temperature of their kilns to make sure their clay pots would fire properly. So it comes as no suprise to find that the first pyrometer was invented by the great English potter Josiah Wedgwood (1730–1795), some time in the late 1770s or early 1780s. Now Wedgwood knew that porcelain contracts when it's fired and the amount of shrinkage depends on the kiln temperature, so he figured out that he could easily measure the temperature of a kiln by putting pieces of porcelain inside and measuring how much they'd shrunk. (Here's a photo of Wedgwood's porcelain pyrometer from the Science and Society picture library.) In those days, pottery was a hugely important industry in Britain and this invention earned Wedgwood a Fellowship of the Royal Society (FRS)—one of England's most prestigious scientific honors—in 1783. But there is some doubt about whether he deserved the credit: in an 1837 book titled The Chemistry of the Several Natural and Artificial Heterogeneous Compounds used in Manufacturing Porcelain, Glass, and Pottery, Dr Simeon Shaw suggests the idea might actually have come from Thomas Massey, a man who worked in Wedgwood's factory, and at least one other book I've found from the early 19th century (Sir D.K. Sandford's Popular Encyclopedia, from 1836) also credits Massey with the idea.

REFRENCES

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