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Radiation and Vapour Pressure Thermometry

Promita Ghosh,
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Abstract:

This article is about radiation thermometry and vapour pressure thermometry.

Radiation thermometry:

Radiation thermometry is based on the measurement of thermal radiation. It includes optical pyrometry, radiation pyrometry, total radiation pyrometry etc.

The well known Planck's radiation law that relates thermodynamics temperature to spectral radiance is exploited in radiation thermometry. The thermal radiation enclosed in a cavity depends solely on the temperature of the walls and in no way on their shape or composition provided the dimensions of the cavity are much larger than the wavelength of the radiation. By carefully designing a black body radiator, equilibrium radiation may be obtained for measurement. In principle, therefore one can measure very precisely the thermodynamic temperature by radiation thermometry.

Radiation thermometers are generally known as pyrometers designed and developed for measuring high temperatures. Optical pyrometers measure temperatures of bodies by comparing visible radiation from the hot body over and narrow band of wavelength with radiation from a standard at known temperature, using a photoelectric detector rather than our eyes. Proper correction for the emissivity of the source must be made. Total radiation pyrometers, generally employed above 3000°C, however measure the entire spectrum of electromagnetic waves including the infrared radiated by the object. They are less accurate compared to the optical pyrometers. However they are capable of measuring much lower temperatures including even the triple point of water.

Radiation thermometers have the unique advantage that they are non contact thermometer.

Vapour Pressure Thermometry:

The the vapour pressure of a liquid is an unique function of the temperature. The actual relation is p= —A/T + B ln T — CT + D Where p is the vapour pressure and A, B, C, D are constants and T is the absolute temperature.

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Saturation vapour pressure thermometry is generally used to measure low temperatures in the range 0.3 to 5.2 K because of the sensitivity and convenience of measurement.

In vapour pressure thermometer, the thermometric substance is the vapour in equilibrium with the liquid of either of the two isotopes of helium: ^{3}He or ^{4}He. Helium vapour pressure is the thermometric parameter as it depends entirely on a physical property of a pure element. Further, it is reproducible at any time and requires no interpolation device. In addition it can be readily measured with enough precision over much of the temperature range.

The useful range of ^{4}He vapour pressure scale is from about 1.0 to 5.2 K. Above 5.2 K the liquid does not exist and below 1.0 K complications arise due to the superfluidity and small pressure variation with temperature. For ^{3}He scale the temperature range is from about 0.30 K to 3.32K (which is the critical point).

Reference:

Thermal physics —A.B. Gupta , H.P. Roy.