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CHAPTER 11

Instruments and Measurements

Temperature Measurement, Pressure Measurement, Measurement of Air Movement, Air Change Measurements, Measurement of Relative Humidity, Dust Determination, Heat Transfer Through Building Materials, Measurement of Heat Exchange for Comfort Conditions, Combustion Analysis, Smoke Density Measurements

THIS chapter presents a description of many test instruments used for heating, ventilating and air conditioning tests and presents a discussion of their use.

TEMPERATURE MEASUREMENT

Changes in the intensity of heat may be determined by several methods [1] such as measuring the change in volume of a liquid, the change in internal pressure of a confined gas, the current set up between dissimilar metals joined in a circuit, or the change in resistance of an electrical circuit.

Thermometers

The most common method used is the change in volume of a liquid such as mercury or alcohol enclosed in glass. Mercurial thermometers may be used for measuring temperatures from −40 F to approximately 1000 F. The lower limit is set by the freezing point of mercury. Since the boiling point of mercury is only about 675 F, the space above the mercury in thermometers designed for higher temperatures must be filled with an inert gas under pressure. Alcohol thermometers may be used for temperatures from −94 F to +248 F.

The more accurate thermometers have divisions etched on the stem and are preferred for test purposes due to their low heat capacity. During their manufacture, the freezing and boiling points of water are first marked while the thermometer is immersed in a test bath. The required divisions between these points, whether Centigrade or Fahrenheit, are then marked and etched on the stem. In spite of these precautions the probable error in etched stem thermometers is plus or minus one scale division, which makes calibration after manufacture necessary for most test work. Such thermometers are usually calibrated for complete stem immersion.

When incompletely immersed, a stem correction should be made. At ordinary atmospheric temperatures the correction is negligibly small, but it usually is important when measuring high temperatures such as those of steam and flue gas. The emergent stem correction may be calculated by the equation:

$$K = 0.00009\, D\, (t_1 - t_2) \tag{1}$$

where

K = correction to be added, Fahrenheit degrees.
D = number of degrees on the thermometer scale which are not immersed.
t_1 = temperature indicated on the thermometer, Fahrenheit degrees.
t_2 = temperature of the non-immersed mercury column, Fahrenheit degrees.
0.00009 = difference in the coefficient of expansion of the mercury and glass.