The Kata Thermometer

The measurement of air current velocities within enclosed spaces, such as the rooms of a house, is usually a tedious undertaking. However, useful data can be obtained by using the instruments described in following paragraphs if they are maintained in calibration, and the user understands the operation and limitations of the instruments.[32]

One of the instruments useful for determining the velocity of air currents in free spaces is the Kata thermometer which is essentially an alcohol thermometer with a large bulb. The instrument is heated above 100 F, and then the time in seconds required for it to cool from 100 to 95, when located in the air current, gives a measure of the air speed. It is important to have the Kata thermometer dry before taking the reading. Each Kata has its own factor etched on the stem, and this factor must be used with its cooling formula or chart for obtaining the velocity. The Kata thermometer is useful in exploring ventilated spaces to determine whether the proper air movement and distribution are being maintained. It is also used in determining the cooling power of the atmosphere, since it loses heat by radiation and convection when dry, and by radiation, convection, and evaporation when the bulb is equipped with a wetted cloth covering.[33]

Thermal Anemometers

If a suitable sensing element is heated electrically at a fixed rate and exposed to an air stream, the temperature difference between the element and the stream becomes a measure of velocity by calibration. In the *hot-wire anemometer*, a very fine heated wire is employed as a resistance-thermometer element whose temperature may be determined accurately.[34, 35] In the *heated-bulb thermometer* type, a heating wire is wound around the bulb of a mercury-in-glass thermometer, and the temperature difference between this thermometer and a similar unheated one serves as an index of air speed.[36] The *heated-thermocouple anemometer* is calibrated to give velocity in terms of the differential *emf* between heated and unheated thermo-junctions exposed to an air stream.[34, 37] Combined measurements of air temperature and velocity are particularly useful for air distribution studies, and automatic recording potentiometers or resistance-thermometer devices facilitate spatial traverses. A correct calibration of thermal anemometers requires consideration of the effects of temperature, humidity and pressure upon the air properties which influence convective heat transfer.[37] With sensing elements of simple shapes for which convection data are known, thermal anemometers may be designed, both thermally and electrically, for desired characteristics. Directional sensitivity is controllable. Thermal anemometers are convenient and practical for low velocities.

Infiltration or Air Change Measurement

In the past, efforts have been made to determine the rate of air change in buildings by impregnating the air with CO_2, hydrogen, water vapor or another substance, and then observing the rate of decrease in concentration[38] with an Orsat apparatus, a psychrometer or another suitable means. Success has not been attained in a satisfactory degree, chiefly because building materials absorb or reject the substances used to impregnate the air, thus impairing the precision of the tests. Recent experiments in England are described in a paper by Dick.[39]

HUMIDITY MEASUREMENT

Psychrometers

Any instrument capable of measuring the humidity or hygrometric state of the air is a hygrometer. A psychrometer is a particular kind of hygrometer which consists of two mercury thermometers, one of which has a cloth wick or *sock* applied to its bulb. For use, the wick is wetted with water and ventilated with air moving at a recommended rate of 900 fpm or more, relative to the instrument.[40] In the simpler and more common type, known as the sling psychrometer, the two thermometers are mounted side by side on a frame fitted with a handle by which the device can be whirled through the air. The motion is arrested for reading the thermometers, and continued until the thermometer readings become steady. Due to evaporation, the wet-bulb thermometer will indicate a lower temperature than the dry-bulb thermometer, and the difference is known as the wet-bulb depression. Charts and tables are available showing the relation between the thermometer readings and the humidity.[41,42] Data are usually based on a total pressure of one standard atmosphere. For precise work, a correction is necessary for barometric pressure and is usually made by multiplying the observed relative humidity by the ratio of the observed to the standard atmospheric pressure.

For air temperatures below 32 F, the water on the wick may either freeze or super-cool, and its state must be known and a proper table or chart used, since the wet-bulb temperature is different for ice and for water. Some operators remove the wick from the wet-bulb for freezing conditions and dip the bulb in water a few times, allowing the water to freeze on the bulb between dips and to form a film of ice. Since wet-bulb depression is slight at low temperatures, precise temperature readings are essential.

In the ventilated or aspirated psychrometer, the thermometers remain stationary, and a small fan or blower or a syringe is used to move the air across the thermometer bulbs. Various designs have been employed in the laboratories, and several more or less standardized models are on the market.

The Dew-Point Hygrometer

In the usual form of these instruments, means are provided for cooling, and of observing the temperature of, a surface which is exposed to air. The temperature at which visible condensation occurs on the surface is considered the dew-point of the air. With the dew-point temperature known, the relative humidity and other properties of the air can be taken from tables and charts (See Chapter 3). A bright surface or metallic mirror is usually employed to improve the visibility of the dew deposit, and various means are used to cool the mirror from the back, including evaporating ether or another refrigerant, or a stream of air passed through dry ice. Dew-point temperatures, in some cases, are observed by means of thermometers in fluids in contact with the back of the mirror, but in modern instruments thermocouples are used, and are soldered or welded to the mirror itself. The dew-point apparatus is not so commonly used as the psychrometer, probably because it is less convenient. It is usable, however, for higher temperatures than the wet-and dry-bulb psychrometer, and should be considered for dew-points near or above the boiling point, as in the case of flue gases. Special apparatus for high precision has been constructed, in which the photronic cell and a light source are used for dew or frost detection instead of visual inspection.