

The hair hygrometer consists of from one to several strands of hair with a mechanism whereby changes in length of the strands, due to changes in humidity, cause an indicator to move across a dial. In the recording instrument, a pen is moved across and marks a moving paper ribbon, indexed in relative humidity. In a controller, or humidistat, the motion makes or breaks an electric contact governing the air conditioning equipment. Such devices require initial calibration and, for precise work, frequent recalibration or setting especially if they are exposed to extremes of either high or low humidity. For continuous operation with only slight changes in humidity some operators report satisfactory reproducibility of results.

Electrolytic Hygrometers

The dampness and therefore the electrical resistance of a salt film varies with the humidity of the atmosphere to which the film is exposed and at least two types of instruments based on this fact have been developed. The Dunmore hygrometer was originally designed for use in radio-sondes or small balloons and means were devised whereby the device transmits humidity data back to earth in the form of a radio signal. In the more usual form this hygrometer consists of a dual winding of small wire on a non-conducting tube. The whole is coated with an electrolytic film, usually containing a salt such as lithium chloride, which forms an electric connection between the windings. Means are provided for determining the electrical resistance of the film which is an indication of the humidity. In the radio-sonde, variations in the resistance of the film affect the frequency of an oscillating circuit. These hygrometers are usually calibrated by comparison with a wet and dry bulb psychrometer. For calibration for some purposes, particularly for use at sub zero temperatures, means have been provided for producing atmospheres of known humidity⁴¹. Advantages of instruments of this type for some scientific and industrial purposes are becoming apparent and some forms of it are on the market.

The Weaver type hygrometer is particularly useful for determining the humidity of air or other gas in pipes or closed vessels at various pressures and temperatures. It consists of a threaded plug carrying a central electrode insulated from the plug except for a gelatinous electrolytic film. The film is exposed to the air or gas from the pipe or vessel and provision is made for determining its electrical resistance. The hygrometer, or detector, is mounted in a manifold equipped with valves whereby the film can be alternately exposed to the test gas and to a standard gas having a known absolute humidity. The pressure of the standard gas is varied until contact with it establishes the same resistance in the film as the test gas and the humidity of the test gas is then determined by computation based on the gas laws.

Chemical Hygrometry

The humidity of an atmosphere can be measured directly by extracting and weighing the water vapor from a known sample. For precise laboratory work, powerful desiccants such as sulphuric acid and phosphorus pentoxide are used for the extraction process while for some purposes, calcium chloride, lithium chloride or silica gel are satisfactory. Freezing the water vapor out of a measured stream of air or gas with solid carbon dioxide and weighing the resulting ice is a similar operation. A thermal conductivity method for gas analysis can be used for temperatures above 212 F or for very low humidities⁴².

DUST DETERMINATION AND AIR CLEANER TESTING

Two absolute measures of air dustiness are in use; particles per unit volume of air and weight per unit volume of air. A comparative method is also used consisting in drawing known samples of air through a known area of filter cloth or paper and comparing the density of the resulting spots with blackness charts or with spots from other sources.

For counting, particles are captured in a device such as the Smith-Greenburg impinger, the Owens jet dust counter or in an electrostatic or a thermal precipitation device designed for the purpose⁴³. Counting is done with a microscope and the method yields important results when the nature or constituents of the dust are of interest.

For a weight determination, a known volume of air is drawn through a porous crucible or thimble and the weight gained by the thimble during the operation is the weight of the dust captured from the air sample⁴⁴. For precise work, the thimble must be dried in a desiccating chamber before weighing each time. The test method specified in the A.S.H.V.E. Code for Testing and Rating Air Cleaning Devices Used in General Ventilating Work is based on a weight method for evaluating the cleanliness of air after passing through an air cleaner⁴⁵.

The Code has not filled all needs for an air cleaner testing method and the subject is now under investigation by the A.S.H.V.E. Research Laboratory. At the *National Bureau of Standards* a test method was developed for interested Government agencies under which measured samples of the uncleaned air and of the air cleaned by a device under test are passed through filter papers⁴⁶. The ratio of the flow rates through the two filter papers are adjusted during successive tests until the resulting dust spots approach equality in density as shown by a photometer. The ratio of the flow rates is then indicative of the effectiveness of the cleaner in arresting dust.

Other instruments for evaluating air dustiness are described by Drinker and Hatch⁴⁷.

A statement of an air cleaner's efficiency by any test method, is meaningless unless the test dust is specified.

HEAT TRANSFER THROUGH BUILDING MATERIALS

Thermal Conductivity

Use of the guarded hot plate apparatus for determining the thermal conductivity (k value) of homogeneous materials was adopted by A.S.H.V.E. in 1942, and has become practically universal and the apparatus is described in an A.S.T.M. publication^{47,48}. It consists essentially of an electrically heated plate and two water cooled plates. Two identical specimens or slabs of a material are required for a test and one is mounted on each side of the hot plate. A cold plate is then pressed against the outside of each specimen by a clamp screw. Hot plate apparatus accommodating specimens on the order of one foot square and an inch or more thick is common. The apparatus at the *National Bureau of Standards* takes specimens 8 in. square while plates as large as 3 ft square have been used. The heated plate is divided into two portions: the central or measuring section and the outer or guard section. During tests the two sections are maintained as nearly as possible at the same temperature and the purpose of the guard section is to minimize errors due to edge effects. The electric energy required to heat the measuring section is carefully observed and, converted to Btu per hour, is divided by the area and the temperature gradient to obtain the conductivity of a material tested.