

REPORT

THE 1963 SYMPOSIUM ON HUMIDITY AND MOISTURE.

20-23 MAY 1963, WASHINGTON, D.C.

THE 1963 Symposium on Humidity and Moisture-Measurement and Control in Science and Industry attracted over 850 scientists and engineers from five continents to Washington, D.C., from 20 to 23 May. The Symposium was sponsored by the National Bureau of Standards and the U.S. Weather Bureau, both of which are agencies of the U.S. Department of Commerce, together with the Instrument Society of America, the American Meteorological Society, and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. These five organizations joined in sponsoring the Symposium because of their interest in humidity and moisture, ranging from the meteorologist's interest in air humidity to the engineer's concern with humidity in cryogenic materials.

The more than 230 papers presented in thirty-two sessions at the Symposium dealt with topics ranging from humidity standards and fundamentals, through means of measuring and controlling humidity and moisture, to specific applications. These applications varied from measurement of air humidity for meteorological purposes to determination of moisture in grain, an important factor in storage. Of particular interest were papers on applications in biology and medicine, describing the use of controlled humidity in treatment and the relationship of symptoms to humidity level.

Moisture has always been the essential, though often invisible ingredient in most processes of science, industry, and agriculture—in fact, virtually every field of human endeavor. Today humidity measurements are being extended in two dimensions—to include more processes, and to obtain more accurate values. It is now sometimes necessary to know an accuracy of a fraction of a per cent how much moisture is included in a cryogenic material, a refrigerant, or a storage enclosure.

All five of the organizations sponsoring the Symposium are concerned with problems of measuring and controlling humidity and moisture. Both the Weather Bureau and the American Meteorological Society deal with humidity measurements for weather prediction, including the recording and transmission of humidity data from unattended stations. The American Society of Heating, Refrigerating and Air-Conditioning Engineers is concerned with measurement and control of humidity not only for personal comfort but also in industrial and agricultural processes and in the preservation of materials. Members of the Instrument Society of America are interested in the design and applications of hygrometers, psychrometers, and other humidity transducers. And finally, the National Bureau of Standards is faced with

the need for new techniques in humidity measurement and for more accurate and easily used standards of humidity.

The Symposium was opened on 20 May with a plenary session presided over by W. A. Wildhack, Associate Director of the National Bureau of Standards and Chairman of the General Committee for the Symposium. The keynote address was delivered by Dr. J. H. Hollomon, Assistant Secretary of Commerce for Science and Technology. Dr. Hollomon noted that man's advances in science and technology now permit him to exercise control over his environment, including humidity and moisture. He saw man's own abilities as a neglected or undeveloped natural resource, noting that the number of engineers to be graduated in the United States this year is the same as five years ago. The remainder of the plenary session was devoted to papers on basic concepts and of general interest in the field of humidity. A second plenary session held later in the Symposium consisted of papers surveying the state of the hygrometry art in selected fields.

At a banquet held on the evening of 21 May the assembly of scientists was addressed by officers of the five sponsoring groups. J. H. Fox, President of ASHRAE, described the activities of his Society, emphasizing the research activities it supports, such as studies of the effect of humidity on milk production and the habitability of survival shelters. He expressed the Society's concern that the number of students going into applied science is dropping, although the number of college registrants is rising.

The AMA was represented by its Vice-President, Dr. Helmut E. Landsberg, who commented briefly on personalities and instruments prominent in the history of humidity measurement. The wide variety of indicating materials used in early hygrometers was a surprise even to those well versed in hygrometry.

The activities of the ISA were noted by its President, Nathan Cohn, who also suggested that honor is due to the only American whose name has been given to a fundamental electrical unit. Mr. Cohn described Joseph Henry's concern that scientists be able to communicate and cooperate with each other and cited the present Symposium as one which would have had Henry's approval.

U.S. Weather Bureau Chief F. W. Reichelderfer discussed humidity as being of widespread interest as a factor in forming the world's weather. He described the World Meteorological Organization as a particularly effective means of transmitting useful meteorological data.

NBS Director Dr. A. V. Astin, noted the necessity that measurements made by all scientists and engineers be compatible and interchangeable. He emphasized the Bureau's concern with devising standard measurement techniques that can be applied at local levels.

FUNDAMENTALS

The Symposium sessions devoted to fundamentals included papers and discussion on the fundamental laws, principles and relationships governing the behavior of water-vapor-gas mixtures, mainly moist air, and on the properties of water as basic to instruments and processes involving humidity. With the increasing demand for more accurate humidity measurements, a need has arisen for theoretical foundations provided by real gas behavior, rather than an assumed ideal gas. The papers that were presented provided important new information on real gas behavior of mixtures of which water vapor is an important constituent, and on the transport and thermodynamic properties of moist air.

HUMIDITY MEASURING INSTRUMENTS

The water vapor content of gases is measured by a wide diversity of instrumentation, the methods spanning a broad realm in the fields of physics, chemistry and engineering. A major portion of the Symposium was devoted to important methods used in modern hygrometry.

Three sessions were concerned entirely with electric hygrometry, which is employed in many areas of science and industry because of its high sensitivity, its use of small sensors, and its adaptability to recording or remote indication. Among the sensors considered were those based on electrolytic solutions, carbon films, poly-electrolytic films, ceramics, thin vacuum deposited salt films, oxide films, and plastics.

Psychrometry has a history that goes back to the early part of the nineteenth century. Still a major method for measuring the humidity of air, it finds extensive application in meteorology, air conditioning and industry. Both theoretical and experimental papers treated the use of psychrometers under such unusual conditions as temperatures below freezing and hot, arid atmospheres. Other hygrometric instruments that were described included those employing spectroscopic methods, infra-red and ultra-violet radiation, and, operating in another area of the spectrum, microwave refractometers and hygrometers.

In dew-point and frost-point hygrometers humidity is measured as the temperature at which dew or frost is deposited on a cooled surface, usually a highly polished mirror. Theoretical aspects of this method of measurement and improved versions of dew-point and frost-point instruments were described. Considerable interest was shown in hygrometers utilizing the Peltier effect to cool the mirror and others providing high accuracy with automatic operation and continuous recording.

Unusual measuring methods were also described, among them a chemical technique for measurements of low water-vapor pressure. Another paper described an

instrument detecting the heat generated with water absorption by a desiccant and still others the design of cells that absorb and electrolyse water vapor for measurement of humidity as a function of the electrolysing current. Critical discussions of the advantages and shortcomings of thermal conductivity methods and hair hygrometers were presented in review papers.

MOISTURE MEASUREMENTS

The latest advances in the art of measuring moisture in solids and liquids also had a place in the Symposium, since moisture critically affects the behavior of many materials. A session devoted to physical and chemical methods included papers describing gas chromatography, spectrophotometry, chemical extraction, and infra-red analysis. Further sessions treated dielectric, resistive and capacitance methods, as well as nuclear methods, nuclear magnetic resonance in particular. The papers described equipment, methods of calibration, and typical uses and presented data on accuracy.

STANDARDS

The session on humidity standards were of special interest to NBS staff members, several of whom presented papers in this area, and in general to scientists needing accurate hygrometry devices. Two of the papers described for the first time the use of the gravimetric hygrometer in making humidity measurements to a degree of accuracy suitable for the most demanding humidity calibrations. Other papers described pneumatic bridges developed at NBS which make possible calibration-level hygrometric determinations as a function of the pressure differential across the bridge. Also of interest in this area were papers discussing the use of fixed humidity points in hygrometer calibrations.

APPLICATIONS

The sessions concerned with the application of humidity and moisture measurements included the topics of meteorology, agriculture, biology and medicine, air conditioning, humidification and dehumidification, environmental chambers, and radio propagation and atmospheric refraction. In these sessions, particularly, scientists and engineers had an opportunity to learn about each other's measurement problems and to exchange information among widely separated fields and disciplines.

The part played by humidity in meteorological phenomena was covered in detail by the papers presented. The distribution of moisture in the atmosphere was discussed and special techniques reported for its determination in the stratosphere. A state-of-the-art survey on the application of hygrometry to meteorology was also presented.

Humidity and moisture are important in agriculture in many ways. Examples discussed were storage of agricultural products, particularly grain, flour, and tobacco; curing peanuts and tobacco; the physiological responses of dairy cattle to humidity; the moisture content of butter, dehydrated foods, and dry milk; and the moisture content of soils and its influence on plant growth.

The session on biology and medicine included papers on the effects of humidity on man, plants, and biological systems. Humidity affects personal comfort and imposes a stress on those working in hot environments; when controlled it can be used in treating lung disorders, for example.

The papers presented in the area of air conditioning, humidity control, humidification, and dehumidification were of a highly practical and engineering nature. Typical of the problems discussed were air conditioning calorimetry, moisture in small refrigerating systems, residential humidification, chemical dehumidification, moisture control in drycleaning solutions, monitoring moisture in sealed electronic modules, and humidity levels in environmental cabinets and chambers.

Propagation of radio signals, observations of missile trajectories, and monitoring atmospheric turbulence depend to a large extent on the refractive index of the atmosphere which, in turn, is a function of the ambient vapor pressure. Research in this area also was presented. Included were a paper on the potential of radio refractometry for humidity studies and one on the use of radio refractometers to measure water vapor turbulence. Papers on the use of radio, optical and microwave techniques for humidity measurements also were delivered.

The papers delivered at the Symposium are being gathered into proceedings, to be published in three volumes by the Reinhold Publishing Corp., New York, and are expected to become available early in 1964.

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