A COMPREHENSIVE GUIDE TO TEMPERATURE

Temperature: Its Measurement and Control in Science and Industry

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THE American Institute of Physics, associated with the National Bureau of Standards and other organizations, has sponsored a series of symposia on temperature measurement. So far there have been four symposia, in 1919, 1939, 1954 and 1961, and the proceedings of the last three have been published as volumes 1–3 of *Temperature: Its Measurement and Control in Science and Industry*. The first volume, of 1362 pages, was so comprehensive and authoritative that it immediately established itself as essential in any laboratory concerned with the measurement of temperature. The second volume did not, perhaps, fully justify the title. It ran to 467 pages, and industrial applications were only very lightly touched on.

The third volume has now appeared and is so large that it has had to be published in three parts, totalling 2625 pages, and one can say at once that it is going to be fully the equal of the famous Volume 1 as an essential reference work. Volume 1, however, has lost none of its usefulness, for little of its contents has become obsolete, but the new volume introduces much new matter. It is clear that many of the recent developments arise from space research, which has posed many problems, notably in the measurement of gas and flame temperatures and in the physiological questions involved in space travel.

The new volume contains 242 papers, ranging from accounts of particular instruments or investigations to general survey papers. In the field of optical pyrometry, for example, we have papers by R. D. Lee of the National Bureau of Standards in Washington and by J. Middlehurst and T. P. Jones of the National Standards Laboratory of Australia, each describing the photoelectric instruments developed in those laboratories, while from Canada D. R. Lovejoy contributes a notable survey paper under the title "Recent Advances in Optical Pyrometry". In this we have an account of work carried out by the author, who also considers the work of many other investigators. References to fifty-three related papers are given. The large number of references is a feature of the book as a whole: there are, on the average, about twenty-five to each paper, and they add greatly to the value of the book as a work of reference.

Part 1, *Basic Concepts, Standards and Methods*, is notable for the contributions from national laboratories in the United States, the United Kingdom, the Soviet Union, Germany, the Netherlands, Canada and Australia, dealing with the relationship between the thermodynamic and practical scales of temperature. One of the main problems in this field at the present time is the method to be used for extending the International Practical Scale of Temperature below 90° K (the boiling point of oxygen) and a group of five papers is devoted to it. Another group of eight papers deals with the establishment of the thermodynamic scale by both traditional and novel methods. "A Review of Recent Determinations of Thermodynamic Temperatures of Fixed Points above 419° C" is another important survey paper. It is contributed by Dr. H. Moser, of the Physikalisch-Technische Bundesanstalt, and summarizes the results obtained by gas thermometry in Germany, Japan, the United States and the U.S.S.R., and discusses possible sources of error.

Notable among a group of papers on platinum resistance thermometry is "Potentiometric Methods of Resistance Measurement", by T. M. Dauphinee, of the National Research Council, Ottawa. Like Lovejoy's optical pyrometer paper from the same laboratory, it is a valuable survey and incorporates some of the author's recent work, notably the design of a resistance comparator utilizing a circuit in which the terms of the quadratic law of a platinum thermometer can be set so that the bridge reads directly in temperature with an accuracy of 0·001° C from −50° to 700° C with a thermometer having a fundamental interval of approximately 10 ohms.

Part 1 also includes several papers on the measurement of plasma temperatures by spectroscopic and other methods, on temperature measurement in astrophysics and in geophysics.

Nearly all the papers on thermoelectric methods are to be found in Part 2, Applied Methods and Instruments. The contribution "Thermocouple Materials", by F. R. Caldwell, of the National Bureau of Standards, is very comprehensive, and includes most of the physical properties of the metals and alloys which are ever used in thermocouples. This paper gives 124 references. In all, there are 24 papers in the sections on thermoelectric thermometry, dealing with such matters as couples for very high temperatures, e.m.f. stability and performance when exposed to nuclear reaction. There are, however, further papers in other sections on the use of thermocouples for special purposes, such as the measurement of surface temperatures, gas temperatures, transient temperatures, etc. There is also a paper by S. D. Raezer and H. L. Olsen on "The Intermittent Thermometer: A New Technique for the Measurement of Extreme Temperature", which discusses the application of a chromel-alumel thermocouple to the measurement of temperatures well above its melting point by a method of intermittent exposure. Temperature measurements of a plasma jet up to nearly 4,000° K by this method are reported, and the work is being continued in the hope of further extending the range of the method.

Clarence R. Droms reports on an extensive series of tests on the stability of thermistors, while other papers concerned with semi-conductor devices range from the use of thermistors and carbon resistance thermometers at low temperatures to the possible use of ceramic elements for temperatures above 2,300° R (1,000° C).

Radiation thermometry is also well covered in Part 2. There are four papers devoted to both monochromatic and radiation ratio pyrometers, and to their uses in the measurement of gas and plasma temperatures.

Part 3 is concerned with biology and medicine, but many of the experimental techniques will find use in more extended fields. There are, for example, papers on microcalorimetry by T. H. Benzinger and Charlotte Kitzinger and by Robert L. Berger, and a study of the conditions required for accurate surface temperature measurement with thermocouples by George W. Molnar and Joseph C. Rosenbaum, jun. The paper by T. H. Benzinger and G. W. Taylor on "Cranial Measurements of Internal Temperature in Man" gives an ingenious brush design for a thermocouple to maintain light contact on the eardrum which could find other uses. The importance of the measurement of cranial temperatures is clear from the paper on "The Human Thermostat", by T. H. Benzinger, C. Kitzinger and A. W. Pratt. This paper is a very thorough investigation of the mechanism of temperature control in the human body. Other sections of Part 3 are devoted to thermal sensation, hypothermia and the physiological responses to heat and cold.

The three parts of Volume III of *Temperature: Its Measurement and Control in Science and Industry* should all find a place in any laboratory in which the problems of measuring temperature are encountered. The sponsors, publishers, editors and contributors are to be congratulated on a valuable piece of work.

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