

SCIENCE NEWS

*Science Service, Washington, D. C.*PAPERS READ AT THE SYMPOSIUM ON
TEMPERATURE OF THE INSTITUTE
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A SYMPOSIUM on "Temperature, Its Measurement and Control in Science and Industry," was held on November 2, 3 and 4 at the Hotel Pennsylvania, New York City, under the auspices of the American Institute of Physics, with the cooperation of the National Bureau of Standards, the National Research Council and officers and committees of scientific and technical societies. The symposium, the largest in its field to be held during the past twenty years, has gathered engineers, physicists, chemists and medical men from all over the country. Representing all fields of investigations, 127 scientific reports were presented, showing how temperature affects man directly or can be used to do new things and disclose new knowledge.

That athletes in severe muscular exercise can show body temperatures that normally would mean high fevers, was stated by Dr. Eugene F. DuBois, of the Russell Sage Institute of Pathology, Cornell University Medical School. He showed that the familiar 98.6 degrees Fahrenheit the clinical thermometer registers normally, is only one single spot between internal temperature and skin temperatures of 93.2 and lower. In severe exercise the temperature may run up to 104 degrees Fahrenheit. Just as the earth has broad zones of temperature, so, too, does the body have its temperature levels or zones. The torrid zone in man might be classed as that with temperatures of more than 105.2 degrees F., which can only be obtained by artificial fevers or when the body's temperature-regulating mechanism fails. Just below this, in what might be called the semi-tropics, is the familiar "fever" zone that is higher in temperature than normal and which comes from illness. With fever the skin temperature is warm. Here, too, come the higher temperatures of severe exercise which are accompanied, however, by cool skin. The body's normal temperature zone, corresponding to the temperate zone on the earth, is fairly wide. Below it come those body temperatures which are restored to normal values by shivering. And finally, analogous to the polar region on earth, is the body's zone of semi-hibernation where temperature regulation fails.

By turning their cells into a kind of living "glass" some microorganisms are able to withstand immersion into liquid air at temperatures of 190 degrees below zero Centigrade, was reported by Professor Basil J. Luyet, professor of biochemistry at St. Louis University. He stated that matter can exist in four physical states: as a gas, as a liquid, as a crystal and as a glass. Death by freezing comes because the temperature is lowered slowly. If an organism can be dipped into liquid air and pass on to the so-called vitreous state, some living tissues can be returned to a degree of vitality by quick warming to make them pass again through the danger stage of crystallization. Professor Luyet reported that he and his col-

laborators had used this rapid cooling to chill tissues from the epidermal cells of plants, moss leaves, frog's spermatozoa, isolated muscle fibers and myxamoebae. All these regained vitality on rewarming. He said: "Other protozoa or tissues experimented upon did not survive. One of the reasons for the lower resistance of the latter seems to be their too-high water content and the impossibility of sufficiently dehydrating them. These observations and those of other investigators . . . favor the theory that the structure required for vital activities is such that it is not destroyed by a lowering of molecular motion while it is destroyed by the withdrawal of some water molecules as when crystallization takes place."

Professor Otto Rahn, of Cornell University, pointed out that temperature is one of the three greatest physical factors controlling all life on earth. Not only are growth and synthesis speeded up by high temperature but also the processes of old age and decay. In all climates there is a balance between life and death and between development and deterioration. He said: "While the laws of temperature are inexorable, the ever-active powers of evolution have found a way around these laws by the creation of one of the great marvels of nature, the warm-blooded mammals and birds. All plants and all animals which can not control their body temperature display three cardinal points in regard to temperature: the optimum at which they thrive best, the maximum, which is the highest temperature at which they can still live, and the minimum or the lowest temperature at which existence is possible. Besides these three cardinal points . . . other temperatures are frequently mentioned, namely the temperatures at which an organism is killed either by excessive heat or by excessive cold. Neither of these points is very definite. At maximal temperature, the organism ceases to grow, but absence of this function does not mean death. If the temperature is raised slightly above the maximum, injury will set in very slowly, but the organism is capable of recovery for a long while. The higher the temperature, the sooner is the repairable stage passed, but the length of exposure will always remain a factor. With death by freezing, so many possibilities are open that general statements are entirely impossible. Death may be due to chemical causes, to solidification of lipids in the plasma membrane preventing diffusion, to a mechanical tearing of cells or tissues through ice formation, to a change of the colloid state of the protoplasm or to still other causes. Very rapid freezing causes 'vitrification' of the cell moisture with serious injury. Microorganisms can be cooled in liquid air to -190 degrees Centigrade without being killed, while they may die during slow freezing at -2 degrees C. Thus, life as well as death is intimately dependent upon temperature because the rate of most chemical and physical reactions is controlled by temperature. Though we can not explain all the observed facts, and though especially the causes of inhibition by low temperature are still obscure, we have no reason to assume that they will always remain unexplained."

Drs. M. Nielsen, W. H. Forbes, J. W. Wilson and D. B. Dill, of Harvard University, described Harvard's four trained dogs, which will lie quietly on a net in a cold room at temperatures of from 32 to 53 degrees Fahrenheit and wear oxygen masks. Exact physiological studies were made of their body activity. Skin temperatures, respiratory rate, pulse rate were tested and blood tests were made. Three of the four dogs withstood the chilling tests well. They lay quietly, though not narcotized, in a semi-conscious condition most of the time. At these low temperatures the dogs shivered moderately while breathing room air and thus increased their heat production and maintained their body temperature. When they breathed gas mixtures with lowered oxygen content through their masks the shivering soon stopped and their metabolism returned to the basal level and the body temperature fell about two degrees Centigrade per hour. The greatest total drop in temperature was six degrees Centigrade. The temperature fell gradually until the dogs were switched over to breathing the air in the cold room. Then the body's metabolism suddenly increased four times and within a half hour the body temperature was back to normal. It is concluded that "The ability of the dog to withstand low oxygen depends more on the toughness of his central nervous system than on an unusual ability to take oxygen in the lungs."

Homeothermy, the ability to maintain an even temperature in the body within the range of optimum biological activity, is the major mark of superiority of the higher animals, according to Dr. H. G. Barbour, of the Yale School of Medicine. The hypothalamus and endocrine glands are actively concerned with heat production and control in the body, he said. The mechanisms for enabling the body to lose heat become effective later than those of heat production, he added. At birth or hatching neither heat production nor heat-losing mechanisms appear to be present in the mouse or pigeon. In rabbits, man and cats heat production means is present but no means of losing heat. In guinea pigs and in chickens both mechanisms are present at the start. The body uses water to store and transport heat because of its high heat capacity. Water too appears to have insulation value against cold when blood is withdrawn from the surface of the body down into the deeper regions as in digestion of food in the stomach.

The difficulties of measuring the temperatures of stars was described by Dr. G. P. Kuiper, of the University of Chicago. By knowledge of the laws of radiation the relation between the color of a star and its effective temperature can be obtained. This is the amount of radiation leaving the star per unit area of surface. "For less than a dozen stars" are the basic assumptions of this way of getting stellar temperatures fulfilled. For the very hot stars with temperatures of over 10,000 degrees absolute the ionization of stellar gases and the resulting spectra enable ideas of star temperatures to be obtained. The complications of this method are so great that only when the temperatures are over 10,000 degrees K. can the necessary simplifying conditions be introduced into the calculations.

THE traditional explanation of the skin's sensitivity to heat and cold was discounted by new findings reported by Dr. William Leroy Jenkins, instructor in psychology at Lehigh University. The thought that temperature sensitivity of the skin was concentrated in small warm and cold spot receptors arose from the discovery that the locations of these spots could be mapped with a small stimulator. Dr. Jenkins has carried forward the mapping technique and by the process of seriatim, or repeated mapping, has found that the single warm and cold spots do not exist. "Seriatim mapping," Dr. Jenkins stated, "reveals hills and valleys of sensitivity. Warm and cold spots are found only in clusters, and mapping with smaller and smaller sizes does not resolve these clusters into discrete units; they simply disintegrate without being resolved." As a new and better way to explain the temperature sensitivity of the skin, Dr. Jenkins proposes a "concentration hypothesis," which suggests that the sensitivity depends primarily upon the concentration of the receptors. Where the receptors are highly concentrated, the skin's sensitivity is high. Where they are sparse, the sensitivity is low. According to this view, the traditional warm and cold spots are merely peaks of sensitivity and do not mark the locus of individual receptors.

Strong emotions like anger are found to make the fingers cold, according to Drs. Bela Mittelman and H. G. Wolff, of the New York Hospital and the Cornell University Medical School. Temperature differences of more than 12 degrees Centigrade were noted in some cases.

That the fingers and arms are one of the body's first means of maintaining comfort was reported by Drs. Charles Sheard, Marvin M. D. Williams and Bayard T. Horton, of the Mayo Clinic and the Mayo Foundation. Studies of skin temperature under various environmental conditions show that the enlargement of the blood vessels, known as vasodilatation, helps to bring more blood to the surface of the body and aids in its cooling if the temperature becomes too warm. As the temperature on the test subjects was increased step by step it was found that vasodilatation occurred first in the fingers and upper extremities and then later a similar action began in the feet, toes and lower extremities.

A method of oil prospecting by measuring temperatures in the earth at depths of 100 to 200 feet was described by Melvin C. Terry. It is not necessary to take the temperature measurements at extreme depths because the intrusion of high conductivity materials will disturb the pattern of normal temperature gradients. Working over the ground of producing Texas oil fields at Hastings and Friendswood, it was found that the line of constant temperature at 23 degrees Centigrade ran about 100 feet higher over the oil salt domes than it did in the region between them.

The world is getting warmer. There appears to be a trend to higher temperature, according to J. B. Kincer, of the U. S. Weather Bureau, Washington, D. C. He stated "That there have been major changes in geologic climate has long been known, but that climatologists have con-

sidered historic climate as a rather stable thing, with short period variations of considerable magnitude, but without especially significant secular trends covering long periods of time. However, since the turn of the century there has been such a persistent trend to higher temperatures, world-wide in scope, as to suggest that the orthodox conception of the stability of climate needs some revision at least." Mr. Kincer cited as examples the records at Portland, Ore., where 17 of the past 20 years have been warmer than normal. And at Washington, D. C., 17 years in the last 20 have been warmer than normal and every year since 1926 above normal. Capetown, South Africa, has had 19 of its last 20 years warmer than normal. The world's lowest naturally occurring temperature yet observed is minus 90.4 degrees Fahrenheit measured in Siberia in the month of February, 1892. The highest temperature ever recorded on the earth's surface was observed in Tripolitania in September, 1922, when the thermometer reached 136.4 degrees Fahrenheit.

Skin temperatures of women are higher in warm atmosphere and lower in the cold than are those of men, according to a report made by Drs. James D. Hardy, A. T. Millhorat and E. F. DuBois, of the Russell Sage Institute of Pathology, New York Hospital and Cornell University Medical College. This is one of the first investigations to be made on heat production in women. Most prior work on this question has been done on men. The temperature difference at the higher temperature is accounted for both by the level of skin temperature required to induce sweating and by the amount of sweat. "The women did not begin to sweat until the calorimetric temperature was two degrees above the threshold for sweating in the men, and the amount of sweating was less. The lower skin temperature of the women in the cold is apparently due to a thicker insulating layer of superficial tissue." Up to temperatures of about 81 degrees Fahrenheit, the heat production of the body for both men and women was essentially the same. Above that temperature the women showed a significant decrease in heat produced by their bodies.

How blocks of different metals are being used to help to control high temperatures with thermostats was described by Drs. C. L. Thomas and Gustav Egloff, of the Universal Oil Products Company. These blocks are used for temperatures above 200 degrees Centigrade. A hole is drilled in the block and a porcelain rod is inserted. The differential contraction and expansion between the rod and the metal block creates a tiny motion which, by levers, throws on and off switches that control temperature. Aluminum blocks are used for temperatures up to 500 degrees Centigrade, while aluminum bronze works up to 800 degrees. Stainless steel (18 per cent. chromium and 8 per cent. nickel) is used for temperatures up to 1,000 degrees Centigrade.

ITEMS

SCIENTIFIC research has become so important to American industry that it is something to advertise instead of an activity that is kept hidden, Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry*, the journal of the American Chemical Society, told the Ohio State

University Research Foundation's Fourth Industrial Research Conference on November 4. In the past twenty-five years research has produced so many new products and earned so much money for important industries that now some chemical concerns invest 7 per cent. of their gross sales in hiring brains and equipment to renew continuously their business. About \$100,000,000 is spent annually in America for industrial research, Dr. Howe estimated. If the cost of development of research findings into commercial processes and products were included, this figure would probably be doubled. Now there are over 2,000 laboratories doing industrial research, compared with a hundred or so a couple of decades ago.

THE San Francisco and the New York World's Fairs have enabled science to make its greatest analysis of deafness among the population ever undertaken, H. C. Montgomery, of the Bell Telephone Laboratories, reported to the meeting of the Acoustical Society of America at Iowa City on November 4. Over half a million people took the hearing tests at the telephone exhibits of the fairs. The largest previous survey on deafness was that of the U. S. Public Health Service in 1936, which studied the results on 9,000 persons. If the World-Fair visitors are a fair sample of the population, then eight people out of every thousand you meet have difficulty in hearing direct conversation. Forty people out of a thousand have trouble hearing in auditoriums. Only one in 400 will have difficulty in hearing over a telephone.

MORE food value per potato, per egg, per any-food-unit will be the objective of a new program of basic research initiated by the U. S. Department of Agriculture, to be centered on land adjacent to Cornell University, and to be conducted under the supervision of Dr. L. A. Maynard, professor and head of the laboratory of animal nutrition at Cornell. Hitherto, researches aimed at increasing agricultural production have striven primarily to boost the quantity of plant or animal material to be obtained from a given acreage. The new program will have as its first objective the improvement in quality, in terms of availability in human digestion and nutrition. First thing to be undertaken, according to the new plan, will be an investigation of soil minerals as they affect the yield and quality of crops. Scheduled for examination are not only the major mineral nutrients, like phosphorus, but also the so-called trace elements like cobalt, manganese and boron, which are necessary for good plant and animal health, but which need be present in only a few parts per million of the soil water.

"CRAZY TOP," a recently discovered disease of corn, has been found afflicting stalks in the wetter parts of fields in Iowa, Illinois and Indiana, Dr. Benjamin Koehler, of the Illinois Agricultural Experiment Station, reports in *Phytopathology*. The disease, cause of which is still unknown, changes the normal tassel at the top of the stalk into a mass of small, branching stems and leaves. Sometimes the ear is affected as well. Search for a possible causal organism has been hampered by the fact that the abnormal stalks were not noticed until late in the season.