SPECIAL ARTICLES

LONG-TIME TEMPERATURE PREDICTION

AN approximate solution is here given for the probable temperature at any desired place, *e. g.*, Phoenix, Arizona, at any hour of the day such as 10 A.M. on any desired day, *e. g.*, August 12.

It is well known that the air gets warmer as the day advances and cools off during the night, repeating this rather regularly—also that it gets warmer in the spring and cools off in the fall. The normal air temperature therefore is a periodic function of the time with a 24-hour period and an annual period.

The following equation expresses the temperature T as a function of the time of the year t and the time of the day θ.

$$T = Ma + \frac{Ra}{2}\cos t + \frac{Rd}{2}\cos\theta. \qquad (1)$$

It is empirical and assumes that the annual march of the temperature can be represented by a simple cosine function, that the daily march can also be so represented and that the daily range does not appreciably change with the season.

The constants are readily obtained from the U. S. Weather Bureau for any desired locality. The first one, Ma is simply the mean annual temperature of the place in question, the second Ra/2 is one half of the Range of the annual march, or the difference between the mean daily temperatures of the hottest and coldest days of the year and the third constant Rd/2 is one half of the range of the daily march or the difference between the maximum and minimum temperatures for the day. Rd remains approximately constant for the United States, except for the arid west. For example the equation becomes for Chicago:

$$T = 48 + 25\cos t + 7\cos\theta.$$

Neither of the two marches exactly follow the cosine law. The minimum temperature does not occur exactly half way between the two maximums. As an average condition for the United States it is but 9 hours from the minimum (6 A.M.) to the maximum (3 P.M.), but 15 hours from the maximum to the following minimum through the evening. This discrepancy can be almost entirely eliminated by correcting the time from the nearest maximum on the curve in the process of changing the days and hours into degrees, *i. e.*, in the winter time consider the coldest day of the year 180° (about January 15) and February 15 would be 180 + 31° rather than counting all the way from the maximum (about August 1), 7 A.M. would be 180 +20° and 5 A.M. 180—12°, 2P.M. 360°—20°. Thus the normal temperature at Chicago February 15 at 2 P.M. would be

$$T = 48 + 25\cos 211^\circ + 7\cos 340^\circ.$$

This formula applied to the various parts of the United States for various days of the year and hours of the day gave a mean error of 2½° F. This error was due largely to the variable time of sunrise and could be corrected if one knew even approximately the time of sunrise on the day in question.

In the arid west the daily range in temperature is not constant but is a periodic function of the time, being a maximum in the summer time and a minimum in the winter time. The reason for this is that in the summer time heat is being received fast and thus the maximum temperature attained would be larger for the same time interval than in the winter when the rate of absorption of heat is slow. In this dry area the daily range is very approximately 15° in winter and 25° in summer. Assuming this range to vary as a cosine function, which it does very approximately, the equation for the arid west becomes through the addition of one more term

$$T = Ma + \frac{Ra}{2}\cos t + \frac{Rd}{2}\cos\theta + \frac{Vv}{4}\cos\theta\cos t. \qquad (2)$$

The mean difference between the actual normal hourly temperatures and those obtained through using this equation was 2.75° F.

A careful distinction should be made between the determination of the normal temperature and the determination of the actual temperature. The above formula gives normal hourly temperature and the errors are almost always less than 5° F. and the mean error only 2.5° F.

Temperatures vary quite badly from the normals. One year differs from another by about .5° F. One January differs from another by about 2° F. and one January 4 from the January 4 of another year by an average of 4° F. These departures are caused mainly by the passage of storms with their alternate warming or cooling effects. In the arid west where irrigation and dry-farming are practised (one fourth of the earth's land area is equally dry) 80 per cent. of the days are free from rain, the sky is clear most of the time and the humidity is only 50 per cent. The departures from normal are, therefore, slight. Equation No. 2 will therefore give actual temperatures aproximately for this large area.

These actual hourly temperatures differ from the normals by from 0° F. to occasionally as much as 15 or 20° F. The normal calculated from equation two differs from the actual temperatures in the arid west by 5° F. It should be remembered, however, that the same equations gave the normal temperatures correct to 2½° F.

The U. S. Weather Bureau has continuous temperature records for several hundred cities for several decades and daily maximum and minimum temperature records for several thousand more cities. The equation submitted states approximately the law of this change in temperature with the time. Its simplicity and its generality are striking.

It has practical value in such cases as the determination of early morning temperatures where heating to protect crops from frost is practised, in calculating hourly values where thermograph records have not been taken and for engineers engaged in laying concrete, in determining the normal time in the spring and fall when freezing temperatures are experienced during working hours.

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THE AMERICAN CHEMICAL SOCIETY

(*Continued*)

The dynamics of the catalase reaction: Sergius Morgulis and Victor E. Levine. Many of the recent investigations on catalase are of little value because of incorrect technique and lack of appreciation of the dynamics involved. To draw proper deductions from experimental data it is necessary to select the proper method for the preparation of the enzyme and the proper preservative, and to regulate the hydrogen ion concentration of the enzyme as well as of the substrate. The shaking must be uniform and must begin almost as soon as the substrate comes in contact with the enzyme. The determination of the rate of evolution of oxygen is of greater importance than that of the amount of oxygen yielded within a given time. A ratio between the enzyme and substrate must be established such that the amount of oxygen liberated is directly proportional to the catalase concentration. For every catalase concentration there is an optimum amount of hydrogen peroxide. Increasing the peroxide beyond this amount results in a considerable progressive showing up of the reaction. The decomposition of hydrogen peroxide is a monomolecular reaction under the conditions of a constant substrate: enzyme ratio. With a constant quantity of enzyme the relation between hydrogen peroxide and the reaction velocity becomes inverse and logarithmic as soon as the concentration of hydrogen peroxide exceeds a certain limit. With a constant quantity of substrate the relation between the catalase concentration and the reaction velocity is direct and either logarithmic or linear, depending upon the presence or absence of an excess of peroxide. With a constant ratio between catalase and hydrogen peroxide the reaction velocities tend to approximate each other. Three types of curves are obtained when the reaction velocity is plotted against time: first, of rare occurrence, a curve showing a temporary increase in the value of K followed after one or two minutes by a slow falling off; second, a curve showing a continuous falling off, which is the most common and the one obtained when the catalase is in excess of the peroxide; third, a curve represented by a straight line, as is required by the monomolecular reaction, when the hydrogen peroxide is greatly in excess of the catalase.

The action of proteins on the phenol reagent of Folin and Dennis: Victor E. Levine. The phosphotungstic-phosphomolybdic reagent of Folin and Dennis is not specific for the phenolic group. The reagent can not serve as a test for proteins yielding tyrosine or hydrolysis, for all the proteins tested including gelatine give positive reactions.