Solubility of Iron in Submerged Soils

J. B. HESTER and F. A. SHELTON

Riverton, New Jersey

While studying the water-soluble ions in the Brookston and similar soils from the vicinity of Chatham, Canada, an interesting phenomenon was observed that undoubtedly has a bearing upon the growth of certain crops in some seasons. On August 25, 1947, 24 samples of Brookston silty clay loam soil, A_p and B horizons, were used in the study of the water-soluble ions. The procedure (Fig. 1) consisted of placing 50 grams of soil inside a collodion bag in a 150-ml. extraction flask. Then 50 ml. of distilled water was added to the soil inside the bag, and another 50 ml. was placed on the outside of the bag. The bag was lifted slightly and held in suspension by stoppering the flask.

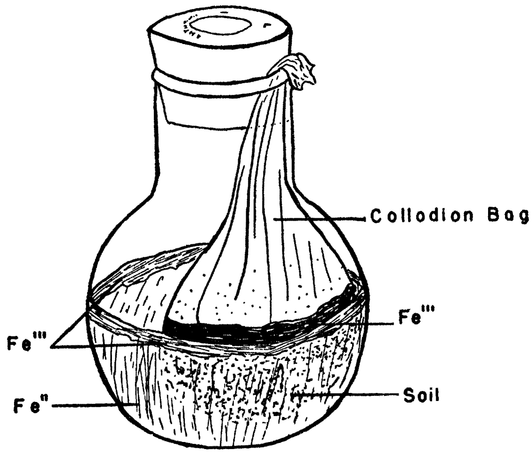

Fig. 1. Dialysis of soil in collodion bags.

TABLE 1

WATER-SOLUBLE IRON* IN BROOKSTON CLAY LOAMS

Soil horizon	Ferric iron	Ferrous iron
A_p	12 ± 5	24 ± 9
B	6 ± 1	21 ± 9

* Parts per million in the soil (mean of 24 samples, pH 6.7–7.2).

After the first analyses of the solution outside of the bag were made, the flasks were allowed to remain stoppered tightly, undoubtedly creating anaerobic conditions. After about one week a brown iron stain began to accumulate on the surface of the soil. On September 6, analyses of the water outside of the bag were made for ferrous and ferric iron.

The results in Table 1 show that considerable ferric iron was in solution, and an even larger amount of ferrous iron. Since the top soil had more soluble iron than the subsoil, undoubtedly the breakdown of the organic matter was influencing the solubility of iron. The pH value of the soils was near 7.0. By October 11 all of the ferrous iron had been oxidized to ferric iron, had collected on the flask and bag at the water level, and had precipitated in a gelatinous mass in the bottom of the flask.

Phosphates were not found in solution. Iron phosphates are of low availability to tomatoes (*1*) and other vegetable crops, particularly at a pH value near neutral. In at least two of the last 10 years, phosphorus deficiency on tomatoes has been exceptionally noticeable in the Chatham area in Canada and in the Toledo, Ohio, area. This occurred after a cold, wet spring. It is believed that the above phenomenon offers an explanation of the extreme phosphorus deficiency. In other words, once these heavy soils are packed down and water remains on them for several days, a suboxidation condition similar to that described above is set up. When wet, cold springs occur, early, deep, and thorough cultivation should help to prevent the purpling (phosphorus deficiency) of the tomato crop.

Reference

1. HESTER, J. B., BLUME, J. M., and SHELTON, F. A. *Va. truck exp. Sta Bull. 95*, 1937.

A Simple Calculator for Certain Types of Instrumental Data[1]

DANIEL A. BRODY and J. P. QUIGLEY

Department of Pharmacology, University of Tennessee, Memphis

Employing the nomographic principle of similar triangles, we have produced a simply constructed device which is of considerable value in converting the deflections recorded by optical manometers into their equivalent pressure measurements. Extensions of the underlying principle permit ready application of this apparatus to a number of other types of instrumental data.

In many situations, an instrumental reading, y, bears the following relation to the quantity, x, being measured:

$$y = k \cdot f(x), \qquad (1)$$

k being a proportionality factor. In some instruments, such as optical manometers, k may vary with the age and the con-

[1] The work described in this paper was supported by U. S. Public Health Service Grant No. 101.

ditions of membrane and mirror mounting, and in other types of instruments k may be altered at will.

Graphic representation of the relations between x, y, and k may be obtained as follows: Two parallel scales are constructed. One of them, a linear scale, will be the y scale; the other will be plotted as an f(x) scale. The plots for successive values, y and f(x), are placed to run in opposite directions on the two scales. A proportionality (k) scale may be laid out on a line joining the origins of the y and f(x) scales. If both parallel scales are plotted in identical units of linear measure and b is the distance between the two origins, the proportionalities represented by a point at the distance "a" from the origin of y scale will be

$$k = \frac{a}{b - a}. \quad (2)$$

Solving Equation 2 for a, the positions of points for a proportionality scale may be computed from

$$a = \frac{kb}{k + 1}. \quad (3)$$

Inspection of Equation 3 indicates that a full range of proportions from zero to infinity is included in the k scale.

For the sake of compactness and ease of reading, we construct the y and f(x) scales on the vertical sides of a square and the k scale on the appropriate diagonal. In some cases it might be preferable to treat the quantity being measured as y and the instrument reading as x.

A straight line joining an instrument reading on the y scale to the corresponding known quantity measurement on the f(x) scale will cross the k scale at a point determined by Equation 3. Straight lines passing through this point and various values of instrument readings on the y scale will intersect the f(x) scale at values corresponding, respectively, to the quantities being measured.

Since the deflection of an optical manometer beam is almost directly proportional to the applied pressure, we have made the f(x) or pressure scale of our calculator linear (Fig. 1). For the sake of simplicity we plot no values on our k scale but employ it merely as an index line.

To use the calculator, we join a known value on the pressure scale with its corresponding value on the deflection scale by means of a straight hairline inscribed on a thin, transparent strip of cellulose acetate. The strip is then shifted along its long axis until one of a number of regularly spaced small holes drilled along the straight line exactly overlies the index line. A push pin pressed through this hole into the wooden base underneath serves as a pivot for further settings. To calculate other pressures registered by the same manometer, the cellulose acetate strip is rotated so that the hairline intersects the deflection scale at points determined by measurement of the manometer record. The readings of the hairline on the pressure scale will then yield the corresponding pressure values.

Although proportionality factors are readily set up on a slide rule, our calculator appears to possess certain advantages not obtainable in a slide rule: (1) The scales are large, uniform, and easily read. (2) The scales are "tailored" to fit the ranges of values in which we are interested. Thus, in passing from values of less than 10 to greater than 10, as frequently occurs in our records, it is not necessary to change the setting of the calculator as it would be when using the ordinary C and D scales of a slide rule. (3) The mechanical manipulation of our calculator, once a point on the index line has been established, is considerably simpler than with a slide rule. The advantages of this feature become apparent in the analysis of lengthy records. (4) Because there are no sliding scales in apposition, the scales of our calculator are easier to read than those of a slide rule. (5) The scales of our calculator are labeled specifically as to type and units of measurement. Thus, the tyro is able to grasp the significance of the scales almost immediately and can learn to use the calculator satisfactorily with a few minutes of instruction and practice.

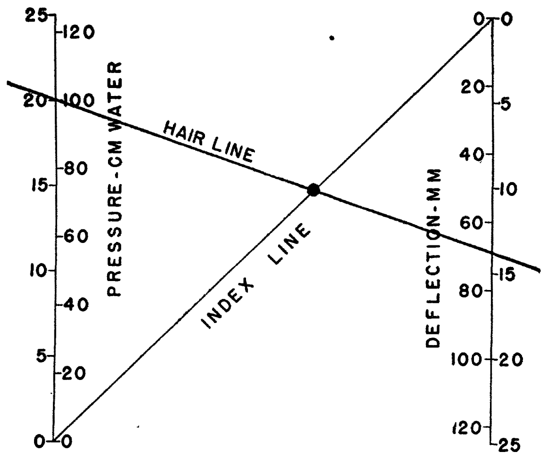

FIG. 1. Scheme of pressure calculator. Scales, plotted on millimeter paper, are 25 cm. long and 25 cm. apart. Usually the two outer or two inner scales are employed, and an index line setting for one pair of scales will serve for the other pair. Outer scales may be paired with inner scales, but individual index line settings must be determined for each of such combinations. Remainder of description is in text.

Other possible uses of this type of calculator are readily apparent. For instance, a linear f(x) scale would be useful for devices employing the strain-gauge principle. A quadratic f(x) scale should prove quite valuable in connection with flowmeters such as the orifice meter described by Gregg and Green (*1*). In other devices, such as the variable capacitator described by Lilly (*2*), f(x) cannot be expressed in simple mathematical terms, but suitable values for plotting the f(x) scale could be obtained from calibration of the instrument. Another form of this type of nomograph possesses linear y and f(x) scales, but the magnitude assigned to various points on the proportionality scale are k^2 rather than k (cf. Eq. 2). This constitutes a graphic representation of the law of inverse squares which we have found useful in calculating the correct photographic exposure for a given distance from a known exposure at another distance.

References

1. GREGG, DONALD E., and GREEN, HAROLD D. *Amer. J. Physiol.*, 1940, **130**, 114.
2. LILLY, JOHN C., LEGALLAIS, VICTOR, and CHERRY, RUTH. *J. appl. Phys.*, 1947, **18**, 613.