The pH Value as an Expression of the Acidity or Alkalinity of Soils

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In regard to soils, the use of the words "sour" (when one wishes to express a condition of acidity) and "sweet" (when one wishes to express the absence of acidity) is quite general. However, if one were to say that one soil had a pH value of 5.6 and another soil had a pH value of 7.5, one would be stating practically the same thing, namely that the former is sour and the latter is sweet, but would be employing a widely used technical term which expresses definitely the intensity or degree of acidity, just as a reading on the Fahrenheit or the centigrade scale may be said to express definitely a degree of heat. In brief, therefore, the pH or pH value is a number which expresses definitely the intensity or degree of acidity, and one which can be accurately determined. One should bear in mind the distinction between intensity of acidity and quantity of acid; the pH value is an expression of the intensity only, and not a measure of the quantity of acid or acid substances present nor the lime requirement as indicated by the Truog method or the Veitch method. For example, an aqueous solution of vinegar (acetic acid) and an aqueous solution of sulphuric acid may each contain the same quantity of acid and yet the intensity of acidity would be greater in the sulphuric acid solution. This is because a greater percentage of the total hydrogen in the sulphuric acid solution exists as hydrogen ions than in the case of the vinegar solution. The concentration of hydrogen ions represents the intensity of acidity, whereas the total hydrogen, including that as hydrogen ions, represents the quantity of acid.

The meaning of the pH value may be further simplified by discussing briefly the physico-chemical significance of acidity. From a chemical point of view, water may be considered as yielding to a very small degree two simpler component parts, one part (the hydrogen ion) characteristic of acids, and the other part (the hydroxyl ion) characteristic of alkalies. In pure water the concentrations of these two parts have been found to be equal and the resulting condition is one of neutrality, that is, the water is neither acid nor alkaline. At this neutral point the pH value is calculated to be approximately 7.0, and values below 7.0 indicate increasing acidity, and values above pH 7.0 indicate decreasing acidity or increasing alkalinity.

It should be mentioned at this point that there are factors which cause slight variations in the neutral point; however, pH 7.0 may be considered as a convenient point of reference for the differentiation of acid from alkaline solutions, except in those instances where great accuracy may be demanded. In any aqueous solution, soil extract, or suspension, there exists what may be termed a condition of balance or equilibrium between the part characteristic of acids (the hydrogen ion) and the part characteristic of alkalies (the hydroxyl ion). That is, if the concentration of the acid part (the hydrogen ion) is increased by the addition, for instance, of an acid or acid substance, then the concentration of the alkaline part (the hydroxyl ion) is decreased but never becomes zero. An example of this would be the application of sulphate of ammonia to a soil whereby a strongly acid reaction can be produced. And likewise, if the concentration of the

alkaline part (the hydroxyl ion) is increased by the addition of an alkali, then the concentration of the acid part (the hydrogen ion) is decreased but never becomes zero. In this regard the use of carbonate of lime, a saturated solution of which has a pH value of about 8.4, would decrease the acidity or increase the alkalinity. It is known from physico-chemical laws that the product of the concentration of the acid part (the hydrogen ion) and the alkaline part (the hydroxyl ion) is equal to a constant value, so consequently the concentration of neither part can ever become zero regardless of the increase in the concentration of either part. It is evident, therefore, that there are always present in any aqueous solution, whether acid, neutral, or alkaline, both the acid and the alkaline parts. The final reaction, therefore, depends upon the relative concentrations of the acid (the hydrogen ion) and the alkaline (the hydroxyl ion) parts. There are available methods for determining directly the concentration of the acid part (the hydrogen ion) and it is this concentration which is expressed in a form called the pH value. Having determined the concentration of the acid part (the hydrogen ion), the concentration of the alkaline part (the hydroxyl ion) may be easily calculated. The pH scale is, therefore, a continuous acidity scale in that it is an expression of the concentration of the acid part (the hydrogen ion) in acid, neutral, or alkaline solutions.

It is quite apparent, therefore, why one can speak of the acidity or the pH value of a neutral or alkaline solution, meaning by this that when the concentration of the acid part (the hydrogen ion) is equal to the concentration of the alkaline part (the hydroxyl ion), the reaction is neutral; and when the concentration of the acid part (the hydrogen ion) is less than the concentration of the alkaline part (the hydroxyl ion), the reaction is alkaline. Instead of stating the acidity in terms of the concentration of the acid part (the hydrogen ion), which would necessitate the use of unwieldy values, this is more conveniently done by converting these concentrations over to pH values. As a result of this change it so happens that as the pH value increases, the intensity of acidity decreases, and vice versa. Values below pH 7.0 therefore represent acid conditions; that is, as the pH value decreases below 7.0, the intensity of acidity increases and the concentration of the acid part (the hydrogen ion) becomes greater than the concentration of the alkaline part (the hydroxyl ion). The intensity of acidity of a soil at a pH value say of 4.5 is therefore greater than that at a pH 5.0, that at pH 5.0 is greater than at pH 6.2, and that at pH 6.2 greater than at pH 7.0, the neutral point. The neutral point, pH 7.0, is merely that point at which the acid and alkaline parts are present in equal concentrations. As the pH value increases above 7.0 a soil or aqueous solution becomes alkaline, that is, the concentration of the acid part (the hydrogen ion) becomes less than the concentration of the alkaline part (the hydroxyl ion). The intensity of acidity at pH 8.2, for instance, is less than at pH 7.0, the neutral point, and the reaction is alkaline; that at pH 8.8 is less than at pH 8.2, and the reaction is more alkaline; that at 9.0 is less than at pH 8.8, etc. Stated in other words, the alkalinity at pH 8.2 is greater than at pH 7.0, the neutral point; that at 8.8 greater than at pH 8.2; that at pH 9.0 greater than at pH 8.8, etc.

Two general methods which are widely used for the determination of the pH value of soils are the electrometric and the colorimetric.

The determination of the pH value by the electrometric method necessitates the use of complicated electrical apparatus, whereas the colorimetric method, the simpler of the two, and sufficiently accurate for practical purposes, employs substances known as indicators, the colors of which exhibit distinct changes with small variations in the pH value of the substance being tested. Comparison is then made against color standards of known pH values, which have been standardized by the electrometric method. Because of its ease of manipulation, as well as the simplicity of the apparatus it requires, the colorimetric method, of which there are many adaptations, has found wide use not only in the laboratory but in the field and among florists, nurserymen, and others, or wherever a laboratory may not be available.

The determination of the pH value has also found extensive application among greenkeepers and in the field of fine turf investigations. Oftentimes what is called "sourness" of soils, without a knowledge of the pH value, does consist of an injurious acidity; but sometimes when assumed on the basis of poor drainage there is involved another factor. It is quite probable that this other property of badly drained soils may be their reducing power. In such instances the application of lime may not be called for so much as proper drainage. In the June, 1929, issue of the Bulletin attention was called to the fact that certain injuries to turf, including some fungous diseases, are more serious when the soil is extremely acid, and that applications of lime under such conditions give beneficial results not obtained from fertilizers or fungicides.

To the investigator in almost any field of research, an accurate knowledge of the intensity of acidity, the pH value, alone or in connection with other factors, is of considerable importance.

Grasses play an important part in the building up of land. Beach grass is the means of constructing extensive dunes along the Atlantic coast as far south as Maryland. Extensive mud flats and tidal estuaries on the Atlantic coast are occupied by species of grass called Spartina, which thrive in the soft mud submerged at high tide. Their stout underground stems form dense lateral networks, ever pushing outward, assisting in the formation of good dry land. The building of land on a large scale has recently taken place in England, France, and Holland by a species of Spartina, the only plant found capable of gaining a foothold on the bottomless areas of mud along those coasts. Spartina planted outside of the dikes of Holland is building up land at a rapid rate.

Not all mice are bad mice. The grasshopper mouse, which is found over a wide range in the western United States, has a fondness for grasshoppers and other injurious insects which stamps it with real value. In appearance it resembles the white-footed mouse, but is shorter and of a heavier build. It utters a bark like that of a tiny terrier, and at times a howl like that of a miniature wolf. It is credited with being able to rid kitchens, basements, cellars, and greenhouses of cockroaches and other insect pests. The mice are easily handled for this purpose if kept in cages and allowed to run loose at night.