pH – pH Without Tears Part 2 by Barry Moore from tank Talk Volume 13 No. 1 1988

pH WITHOUT TEARS -- Part 2: Measurement

by Barry Moore

In Part 1 of this series (TANK TALK 12 (4): 143), we learned that pH is an inverse logarithmic measure of the hydrogen ion (H^+) concentration in an aqueous solution. The pH of neutral water is 7; values below this, such as 6, 5, etc. indicate increasing acidity, whereas values above, 8, 9, etc. indicate increasing alkalinity. A change in pH of one unit corresponds with a 10-fold change in H^+ concentration.

Now the adequate control of pH is an important facet of aquaristics for fish and plants are both more or less strictly adapted to waters of particular characteristics and many will not thrive under artificial conditions, if wide variations are allowed to occur. However, we first need to measure the pH, before we can consider its control, and the means for doing this are the subject of this second Part.

papers. In use, a single drop of tank water is placed on a strip of the paper and the immediate colour change is noted and compared with the chart. Quick colour appreciation is needed here for any delay will result in colour drift due to the action of carbon dioxide from the atmosphere.

Aquarists with large numbers of tanks and marine enthusiasts (who need to monitor their tanks frequently) may find the indicator methods too tedious in continuous use and people (like myself) who have defective colour vision will have difficulty in using them effectively. For such enthusiasts the electronic pH meter is probably a must, though it will set them back a tidy sum in initial outlay and will likely show a rather greedy appetite for expensive mercury-based batteries.

Such meters are based upon the principle of the so-called glass electrode. This consists of a glass tube, ending in a thin (and therefore easily broken) bulb, filled with an electrolyte (an electrically conducting solution), and provided with an internal wire as a conductor. When placed in a test solution, this electrode develops an electrical potential that varies regularly with the pH. All that is necessary to complete the instrument is therefore an electronic means of balancing the generate potential against a standard one (often provided by dry ba teries) and some indicator of the result, either a needl traversing a dial or a digital output.

Although laboratory-style, mains-powered pH meters are bot bulky and expensive and are hardly appropriate for the averag aquarist, there are fortunately small pocket-sized prob available that admirably suit our purposes. These show digit output directly in pH, utilise small mercury-based batteries : their reference source, and cost about $150. In use, the botto cover is removed and the exposed (but more or less protecte electrode is dipped into the sample or directly into the tan The switch is thrown and the pH may then be read direct from the screen, once the value has become stable.

A simple method of pH measurement, and one that is adequate for the needs of most aquarists uses certain dyes or 'indicators' that change in colour with shifts in pH value. The best known of these indicators is litmus--a natural colouring matter present in certain lichens, that changes from red in acidic solutions to blue in alkaline ones, the change occurring over a narrow range of pH centred about the neutral point (7). Although litmus is still used to some extent, it is now largely superseded by modern synthetic dyes that show varied and more dramatic colour changes and cover a wide range of shifts in pH. By cleverly combining several of these dyes, it has been possible to develop the so-called 'universal indicators', which run through the natural spectrum of colours from red to violet, as the pH shifts from 1 to 10 (strongly acidic to strongly alkaline).

However, such indicators are of little interest to the aquarist since most of the range covered is well beyond that at which any biological activity can occur and the accuracy attainable by shade-matching, even by the most discerning eye, is probably no better than 0.5 of a pH. We are solely concerned with the range of natural waters, namely pH 4 to 9, and need an accuracy of 0.2 of a unit. Fortunately, these needs are covered by special, narrow-range, indicators that can be purchased as specific kits from aquarists shops.

In making the test, one places a specified small volume of the tank water in a test-tube and adds a drop or two of the indicator solution, as instructed. Then it is merely a question of observing the colour change and matching the shade produced against a printed and calibrated chart provided in the kit. For most people there is little difficulty in this, provided the test sample is itself not too highly tinted--and that's a good argument for adding some activated charcoal to one's aquarium filter!

Indicator papers, impregnated with the same dyes, are also available. These are normally bound into small narrow booklets, with the colour-matching charts provided on the end-papers. In use, a single drop of tank water is placed on a strip of the paper and the immediate colour change is noted and compared with the chart. Quick colour appreciation is needed here for any delay will result in colour drift due to the action of carbon dioxide from the atmosphere.

Aquarists with large numbers of tanks and marine enthusiasts (who need to monitor their tanks frequently) may find the indicator methods too tedious in continuous use and people (like myself) who have defective colour vision will have difficulty in using them effectively. For such enthusiasts the electronic pH meter is probably a must, though it will set them back a tidy sum in initial outlay and will likely show a rather greedy appetite for expensive mercury-based batteries.

Such meters are based upon the principle of the so-called glass electrode. This consists of a glass tube, ending in a thin (and therefore easily broken) bulb, filled with an electrolyte (an electrically conducting solution), and provided with an internal wire as a conductor. When placed in a test solution, this electrode develops an electrical potential that varies regularly with the pH. All that is necessary to complete the instrument is therefore an electronic means of balancing the generated potential against a standard one (often provided by dry batteries) and some indicator of the result, either a needle traversing a dial or a digital output.

Although laboratory-style, mains-powered pH meters are both bulky and expensive and are hardly appropriate for the average aquarist, there are fortunately small pocket-sized probes available that admirably suit our purposes. These show digital output directly in pH, utilise small mercury-based batteries as their reference source, and cost about $150. In use, the bottom cover is removed and the exposed (but more or less protected) electrode is dipped into the sample or directly into the tank. The switch is thrown and the pH may then be read directly from the screen, once the value has become stable.

Such pocket-sized meters thus provide a quick and easy means of monitoring the pH of one's tanks but they are not entirely without their idiosyncrasies and they need to be handled accordingly. In particular, it is essential to ensure that the electrode is equilibriated with the test sample, as indicated by a more-or-less stable reading, before a pH value is accepted. Otherwise, and particularly if a series of samples is being tested in turn, wildly varying results will be forthcoming. ------ Another must is to ensure that the electrode is free from contamination or carry-over from earlier use: frequent rinsing in clean water is desirable and indeed, essential, if marine samples are being tested. Some owners who use their meters intermittently but more or less continuously keep the electrodes permanently immersed in a shallow container of distilled water.

Finally, one must be careful to ensure that only the bottom portion of the meter is wetted by the sample: total immersion, leading to flooding of the electronic section, would be fatal. Thus, provision of a wrist-strap is a wise precaution, if the meter is intended for use directly in one's aquariums. Otherwise, there is a very real risk of seeing 150 dollars' worth of electronic wizardry lying dead at the bottom of a tank!

In the third and final part of this series, we shall look at the aspect that concerns us most, namely, the importance of pH in aquaristics and the rationale of its control.

* *