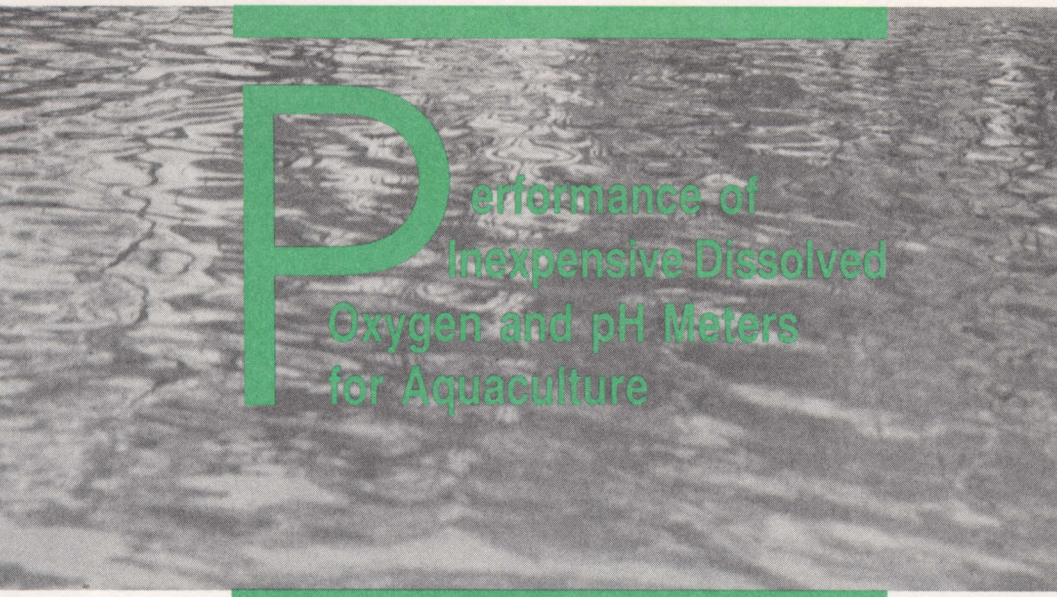

Performance of Inexpensive Dissolved Oxygen and pH Meters for Aquaculture

Leaflet 105 R. Wu and C.E. Boyd[1] December 1989

DISSOLVED OXYGEN (DO) is a critical variable in the management of aquaculture ponds, and fish farmers must have a reliable means of measuring its concentration. Inexpensive water analysis kits can be used to obtain accurate measurements of DO[2], but the procedure is time consuming and difficult to conduct at night when DO concentrations are most critical. Therefore, fish farmers with several ponds need a reliable instrument that permits rapid measurements of DO and which can be operated with ease in the dark. Portable DO meters appear to meet this need, provided they are accurate. Several brands of high quality DO meters are available at a cost of $750 to $1,250 each. Recently, a few companies have been offering less expensive DO meters ($250 to $350) for use in aquaculture.

Fish farmers sometimes need data on pH of water in hatcheries or ponds. Again, water analysis kits can be used, but color tests employed in kits usually provide pH readings 0.5 to 1.0 pH unit too high.[2] Conventional laboratory pH meters cost roughly the same as high quality DO meters. However, pocket pH meters are now available at low cost (less than $50) for use by fish farmers.

DESCRIPTION OF TEST

To determine the accuracy of DO meters, a study was conducted in 1987 and 1988 at the Alabama Agricultural Experiment Station. Comparisons were made of DO concentrations measured with two inexpensive DO meters (Digital Oxygen Analyzer, Engineered Systems and Designs, Wilmington, Delaware, and Sentry III

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[2] Boyd, C. E. 1976. An Evaluation of a Water Analysis Kit. Leaflet 92, Ala. Agr. Exp. Sta., Auburn Univ.

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Oxygen/Temperature Monitor, Barebo, Inc., Emmaus, Pennsylvania) and a pocket pH meter (Hach Company, Loveland, Colorado). Values obtained with these instruments were compared with values obtained with a conventional, portable DO meter and a standard, line-operated, laboratory pH meter.

During 1988, it was necessary to make DO measurements in a number of research ponds at the Fisheries Research Unit. Therefore, on several occasions between March and October 1988, probes of the three DO meters were tied together with a rubber band, and DO concentrations were measured at the same time and place with all three instruments. To compare pH measurements by the two meters, water samples were brought into the laboratory for pH analysis.

RESULTS

Concentrations of DO ranged from less than 1 p.p.m. (part per million) to 14 p.p.m. and water temperatures were from 50 to 86 °F. Over this broad temperature and DO range, DO estimates from the two inexpensive meters were highly correlated with concentrations determined with the conventional DO meter, figure 1. The conventional DO meter was found to repeatedly read the correct DO concentrations in prepared samples, so DO concentrations obtained by the conventional meter were considered true DO values. The regression equations, figure 1, were used to calculate the average DO concentration measured by the two meters at different true DO concentrations. Relative errors[3] and differences between measured and true values are provided below:

True DO, p.p.m.	*Difference*		*Relative error, pct.*	
	Digital	*Sentry III*	*Digital*	*Sentry III*
1	- 0.63	- 0.35	- 65.0	- 37.0
2	- .36	- .14	- 18.0	- 14.0
3	- .09	+ .07	- 3.0	+ 2.3
4	+ .18	+ .28	+ 4.5	+ 7.0
5	+ .45	+ .49	+ 9.0	+ 9.8
6	+ .72	+ .70	+12.0	+11.6
7	+ .99	+ .91	+14.1	+13.0
8	+1.12	+1.26	+15.8	+14.0
10	+1.80	+1.15	+11.8	+15.4
12	+2.34	+1.96	+19.5	+16.3

[3] Percent relative error = 100 x (true value - measured value) / true value

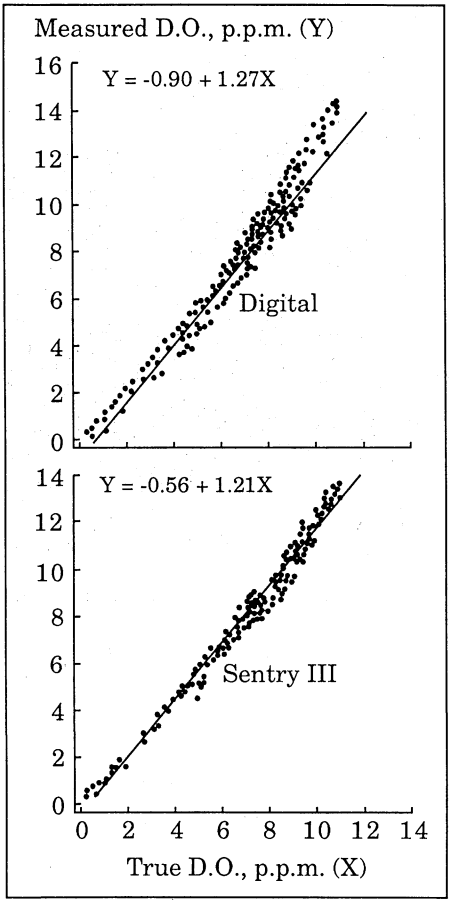

FIG. 1. Regressions between dissolved oxygen (DO) concentrations measured with a conventional DO meter (true values, X) and Digital or Sentry III DO meters (measured values, Y).

A negative sign before a difference or a relative error indicates that a DO meter gave a lower reading than the true value, while a positive sign indicates that a DO meter overestimated the true value. At low DO concentration, both the Digital and Sentry III meters underestimated true DO. When DO was 4 p.p.m. and above, the instruments overestimated true DO concentrations. Nevertheless, both meters provided a good approximation of DO concentration. When DO is low, management errors would not result from underestimations in DO of the magnitude found here. When DO concentra-

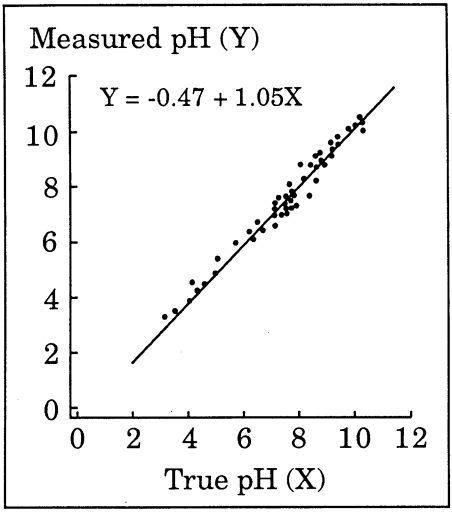

FIG. 2. Regression between pH values measured with a laboratory pH meter (true values, X) and an inexpensive, Hach pocket pH meter (measured value, Y).

tions are above 4 p.p.m., there is adequate DO for warmwater fish and overestimations of magnitudes observed would not be serious.

Durability of the two DO meters is largely unknown. The Digital meter was used for 2 months in 1987 and during the entire 1988 growing season with no malfunctions observed. The Sentry III meter was used during the 1988 growing season, and no malfunctions occurred. Conventional DO meters are more expensive and of better quality than the inexpensive meters tested. Several conventional DO meters have been used in water quality research by the Department of Fisheries and Allied Aquacultures. These meters have functioned properly for 3 to 6 years before repairs were necessary.

The pocket pH meter also provided pH values highly correlated with measurements made with the laboratory pH meter, figure 2. Using measurements made with the laboratory pH meter as true values, relative errors and differences between values measured with the pocket pH meter and true values were:

True pH	*Difference*	*Relative error, pct*
3	-0.32	-10.7
4	- .27	- 6.8
5	- .22	- 4.4
6	- .17	- 2.8
7	- .12	- 1.7
8	- .07	- .9
9	- .02	- .2
10	+ .03	+ .03

Agreement between measured and true values improved as pH increased. The pocket pH meter provided sufficiently accurate measurements for use in practical aquaculture. It is not known how long the meter will last, but it did not malfunction during the 1988 growing season.