SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PHOTOELECTRIC APPARATUS FOR TURBIDITY AND LIGHT PENETRATION MEASUREMENT[1]

DURING the past three years many thousands of turbidity and light penetration determinations have been made, both in the field and in the laboratory, by members of the research staff of the U. S. Bureau of Fisheries at the University of Missouri, using a photoelectric set-up, adapting the method of haemolysis measurement of Kesten and Zucker[2] to river water problems. Because of the simplicity of the apparatus, the rapidity with which measurements can be made and the accuracy of the results as shown by various checks on the data obtained, a description of the apparatus is presented below.

A General Electric nitrogen-filled caesium cell, Type P.J. 14, was mounted in a small light-tight black box having a circular opening 40 mm in diameter in line with the target of the cell. This cell box was placed in one end of a second black wooden box $60 \times 30 \times 30$ cms, and the photoelectric cell connected with a portable Ralston micro-ammeter of 30 to 300 range, sensitive to one tenth of a micro-ampere. In the opposite end of the box a Mazda tungsten bulb (25 to 100 watts, depending upon the needs of the work) was mounted behind a partition, in a parabolic reflector so that the reflector projected parallel rays through an opening in this partition 100 mm in diameter, onto the target of the photoelectric cell. The light bulb, which was operated by a heavy duty storage battery to insure uniformity of current (in the field the current can be drawn from battery of car or launch), was placed 30 cms from the target of the photoelectric cell. On the side of the partition in front of the light a carrier, into which glass screens could be mounted when monochromatic light was desired, held a glass-sided container filled with the water to be examined, in the line of parallel rays between the reflector and the target of the cell. For rapid routine turbidity examinations a 300 cc pyrex flask with flat, polished, parallel sides (Kolle flask type), having an inside measurement between the two, flat, polished sides of 25 mm, was used as water container, differences of 0.1 U. S. G. S. units of turbidity being easily detected. For determinations requiring higher accuracy, as sedimentation rates, erosion silt volumes and light penetration limits, a smaller, flat-sided container was constructed by cementing two thin plates of polished glass onto opposite sides of "U"-shaped frame of heavy brass.

Using a distilled water standard, which was considered as 100 per cent. for each combination of bulb and container, the per cent. of light screened out by any sample could be computed, and employing a standard suspension of Fuller's earth[3] for the measurement of water turbidity, calibration curves were readily prepared so that the deflections of the ammeter could be read directly in U. S. G. S. turbidity units.

In the light transmission and color selectivity studies the apparatus was standardized by photographs of the spectra of the light from each bulb and of the light transmitted by each container and Corning glass color screen, made against the helium spectrum.[4] For the interpretation of the data on light penetration the per cent. of light screened out by any given sample was transformed into a penetration-depth value by the following formula:

$$y = \frac{\log\ (1-x)}{\log\ (1-p)} \tag{1}$$

in which x = total per cent. of light screened out;
p = per cent. of light screened out by sample as measured by photo-electric cell; and
y = number of times the thickness of the sample in mm (inside measurement of container used) is contained in the depth at which any desired per cent. of light is screened out by the water under consideration.

The curves of light penetration as determined by this apparatus, using distilled water and various monochromatic lights, were found to agree very closely with data published by Pietenpol[5] and the curves given by Shelford.[6] As an additional check on the accuracy of light penetration measurement photographs of the spectra of the light transmitted by various samples of water were compared with the light transmission curves for different wave-lengths obtained from the photoelectric cell readings of monochromatic lights transmitted through these same water samples. The agreement of the spectra with the curves was very satisfactory both in the extent and the selectivity of the transmission.

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[1] Published by permission of the U. S. Commissioner of Fisheries.

[2] H. D. Kesten and T. F. Zucker, "The Determination of Rate of Haemolysis by the Measurement of Light Transmission," *Amer. Jour. Physiol.*, 87: 263–273, 1928.

[3] "Standard Methods of Water Analysis." 6th ed., Amer. Pub. Health Association, New York. 1925.

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[5] W. B. Pietenpol, "Selective Absorption in the Visible Spectrum of Wisconsin Lake Waters," *Trans. Wisc. Acad. Sci., Arts and Let.*, 19: 562–593, 1918.

[6] V. E. Shelford, "Laboratory and Field Ecology," Williams and Wilkins Company, Baltimore. 1929.