A Method for Measuring Sediment Oxygen Demand Using a Bench Model Benthic Respirometer

by

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Introduction

The apparatus described has been in use at the New England Regional Laboratory since 1973 and was designed and constructed to facilitate the measurement of Sediment Oxygen Demand (SOD) in the laboratory without the expense and time required for *in situ* techniques which involve the careful placement of large chambers on the bottom sediment using SCUBA or other techniques for positioning the equipment from a boat. Advantages of the "bench" technique include the ability to conduct several rate measurements for a given sample for prolonged periods of time, samples taken from environments with low dissolved oxygen can be measured, and a variety of substrate types can be used.

Design

The bench model SOD chamber is constructed of clear 1/4 inch acrylic plastic and has uniform inside dimensions of 30.5 cm. The top is larger (33.0 cm square) and is fitted with a rubber gasket. Water tightness is perfected using a lock down arrangement constructed from wing nuts, and threaded rod connected in two places on each side of the chamber with 2.5 cm thickness blocks of acrylic plastic.

A hole is drilled centrally in the top to accommodate a dissolved oxygen probe. A small reservoir 5 cm h X 10 cm l X 10 cm w is built on the top around the hole so that when the probe is in place a water seal is achieved and air leakage prevented. Large rubber O rings to

fit the probe on either side of the top gives added protection against air leakage.

Two holes are drilled, one each on opposite sides of the chamber and threaded to accommodate a 5/8" pipe thread. The influent port is centrally located 7.5 cm from the bottom. The effluent port is centrally located 7.5 cm from the top.

All seams are "glued" using butt joints where the ends to be joined are soaked in a mixture of 70% Methylene chloride - 30% Ethylene dichloride until slightly softened and then joined under pressure. A bead of silicon rubber cement run along the inside seams adds strength and water tightness to the chamber. Figure I is a schematic of system design.

Operation

The basic principle of operation of the bench model respirometer is to circulate a confined volume of water at a controlled rate within a chamber into which an environmental sediment sample has been placed to a uniform depth and area. Oxygen depletion in the water is monitored for a specified period of time in order to estimate the sediment oxygen demand which is the sum total of processes in the sediment utilizing oxygen.

In the field, replicate sediment samples are collected by grab - placed in plastic bags with a minimal amount of disturbance - iced and returned to the laboratory for analysis. The sediment is carefully

placed in the chamber to a uniform depth of 2.5 cm. Aerated aged tap water or water from the sample source (min D.O. 70% saturation) is gently layered over the sediment to prevent roiling. A flat acrylic plastic paddle or stainless steel spatula works well to disburse water over the sediment and with experience a minimum amount of disturbance can be achieved. Before a run, any suspended sediments are allowed to settle.

Circulation in the chamber is maintained at a constant rate with a variable speed peristaltic pump using a closed loop principle. The entry port is split into two diffusion nozzles so that mixing is rapid and total. The exit port is a single fitting. Both ports are connected to the pump by one continuous piece of tygon or equivalent pump tubing.

Tests can be conducted at ambient room temperature $20\pm2^{o}C$ or at environmental temperatures found at the sample source providing temperatures can be held constant.

Dissolved oxygen is monitored by probe calibrated daily (more often if required) for periods of time usually ranging from 4-24 hours depending on the rate of uptake. This normally includes a stabilization period of 15-60 minutes. If possible, the D.O. information should be continuously recorded.

Light and Dark bottles should be set using incubation water from the chamber to determine if respiration or photosynthesis attributable

to the water has a significant influence on the rate.

Given the change in dissolved oxygen, time, water volume, sediment surface area, and correction for respiration or production if any, SOD results are derived from the following equation:

$$\text{SOD gm } O_2/m^2/\text{day} = \frac{\left[(O_i - O_f) - (B_i - B_f)\right] \quad V}{(SA) \qquad (t)}$$

O_i = DO initial mg/l

O_f = DO final mg/l

B_i = DO bottle initial mg/l

B_f = DO dark bottle final mg/l

V = Volume confined water (.0255 m^3)

SA = Sediment area (.093 m^2)

t = time/days

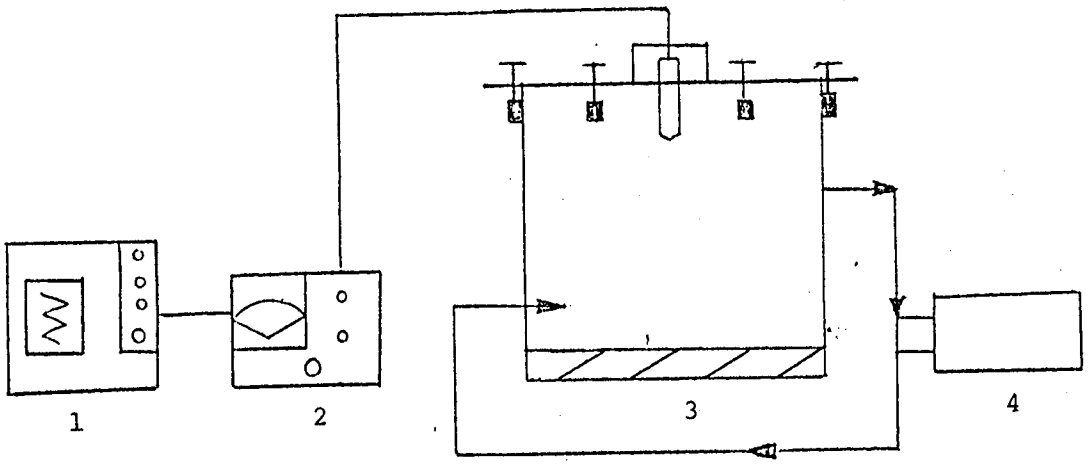
For the final determination of SOD, a rate is obtained by plotting time vs. oxygen depletion. The portion of each rate, where oxygen consumption versus time is constant is used in calculation of the rate. Appropriate corrections are made if respiration or production is significant in the light and dark bottles.

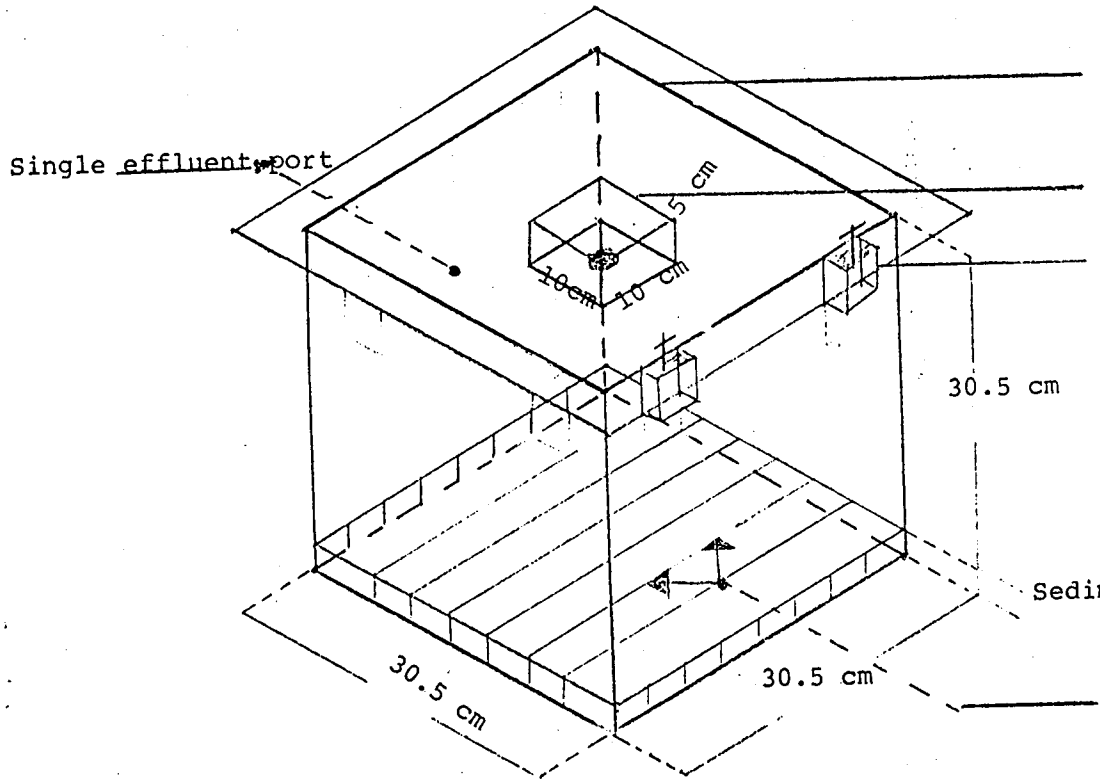
Whenever possible, analysis on a minimum of three sample replicates should be conducted for use statistically and as a means to determine natural variability among the sediments tested.

FIGURE I

Schematic and Design of Bench Model Sediment Oxygen Demand Apparatus

1. Recorder
2. Dissolved Oxygen Meter & Probe
3. Bench Model Respirometer
4. Variable Speed Peristaltic Pump with Closed Loop and Tubing





Not To Scale