



The University of Georgia

Cooperative Extension Service

College of Agricultural and Environmental Sciences / Athens, Georgia 30602-4356

MAY 2011

PROCESSING TIP . . .

BASICS OF THE BIOCHEMICAL OXYGEN DEMAND (BOD) WASTEWATER ANALYTICAL TEST

Since the implementation of the Clean Water Act and subsequent creation of the United States Environmental Protection Agency (USEPA) in the early 1970s, poultry processing plants have been required to continually improve the quality of their process wastewater effluent discharges. The determination of wastewater quality set forth in environmental permits has been established since the 1970s in a series of laboratory analytical tests focused in four (4) major categories: organics, solids, nutrients and physical properties.

For most poultry professionals a complete understanding of the standard methods required to accurately complete critical wastewater analytical tests is not necessary. However, a fundamental understanding of the theory behind and working knowledge of the basic procedures used to complete these wastewater tests, and the answers to commonly asked questions about each test can be a valuable tool for anyone involved in generating, monitoring, treating or discharging process wastewater.

Measuring the Organic ‘Strength’ of Wastewater

Analytical tests aimed at establishing the concentration (typically in mg/L or the equivalent unit of ppm) of organic (i.e., carbon based) matter have been traditionally used to determine the relative ‘strength’ of a wastewater sample. The laboratory test most widely used to establish and monitor environmental permit limits for the concentration of organic matter in wastewater samples (i.e., concentrations >1.0 mg/L) is biochemical oxygen demand (BOD).

The BOD test is based on the principle that if sufficient oxygen is dissolved and available in a wastewater sample, aerobic biological decomposition (i.e., stabilization of organic waste) by microorganisms will continue until all waste is consumed. The BOD test is also known as ‘BOD5’ since it is based on the accurate measure of dissolved oxygen (DO) at the beginning and end of a 5-day period in which a wastewater sample is held under dark incubated conditions at 20°C (i.e., 68°F). The change in DO concentration over 5-days represents the ‘oxygen demand’ for respiration by the aerobic biological microorganisms in the sample.

The 5-day completion window of the traditional BOD5 test has an inherent disadvantage in that it cannot be used by wastewater treatment system personnel to make real-time operational adjustments. Wastewater treatment plant operators now rely on the timelier chemical oxygen demand (COD) test that takes only ~3 hours to complete. However, since most environmental wastewater permits still contain a limit for BOD, the test remains highly relevant.

PUTTING KNOWLEDGE TO WORK

The University of Georgia and Ft. Valley State College, the U.S. Department of Agriculture and counties of the state cooperating.
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Basics of the BOD Test

To ensure proper biological activity during the BOD test, a poultry processing wastewater sample must be: [1] free of chlorine (if chlorine is present in the sample a dechlorination chemical such as sodium sulfite must be added prior to testing), [2] in the pH range of 6.5 -7.5 S.U., and [3] have an existing adequate microbiological population (if the microbial population is inadequate or unknown a 'seed' solution of bacteria is added).

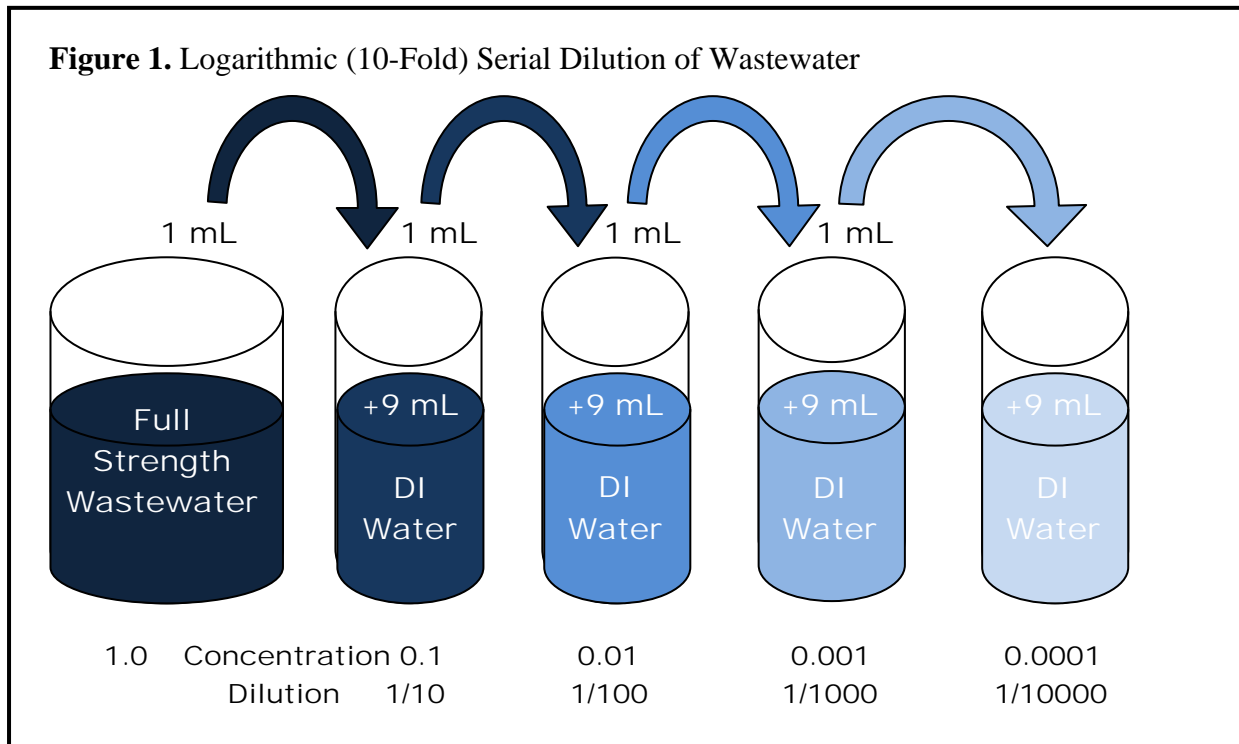
Specialized 300 mL BOD bottles that are designed to allow full filling with no air space and provide an airtight seal are used for the test. The bottles are filled with the sample to be tested and a DO meter is used to measure the initial DO concentration (mg/L) in each bottle which should be a least 8.0 mg/L. Each bottle is then placed into a dark incubator at 20°C for 5 days. After 5 days (\pm 3 hours) the DO meter is used again to measure a final DO concentration (mg/L) which ideally will be a reduction of at least 4.0 mg/L. The final DO reading is then subtracted from the initial DO reading and the result is the BOD concentration (mg/L).

Wastewater Sample Dilution

One of the most frequently ask questions concerning the BOD test is how can a laboratory report a BOD concentration for a wastewater sample of several thousand mg/L if the initial DO reading in BOD sample bottle is only 8.0 mg/L?

The answer is **serial dilution**. **Serial dilution** is a procedure that allows for the stepwise reduction in concentration (usually 10-fold) of full strength wastewater in DI (deionized) water as illustrated in Figure 1 below.

After dilution, the resulting difference in initial and final DO reading simply has to be multiplied by the dilution factor to determine the final BOD result. As an example: 1.0 mL of a full strength wastewater sample added to 9.0 mL of DI water results in a 0.1 dilution of the wastewater. The DO concentration (mg/L) reduction must then be multiplied by 10 to determine the final BOD concentration.



It is important to note that the serial dilution procedures for the BOD test, especially in the case of high-strength poultry processing wastewater samples that involves several dilutions in series, demand high precision to ensure accurate results. This is where experience really pays off in the laboratory. It is important that laboratories and laboratory technicians with extensive experience in running BOD tests be identified. Also, it is smart to periodically split samples (i.e., divide one sample into two) and have different laboratories run the BOD analysis and compare the results.

For more information or to have questions answered concerning BOD or any wastewater analytical test contact your local University of Georgia Cooperative Extension Agent.

A handwritten signature in cursive script, appearing to read "Brian Kiepper".

Brian Kiepper
Extension Poultry Scientist

Extension County Coordinator/Agent

“Your local County Extension Agent is a source of more information on this subject.”