EVE 290L
INTRODUCTION TO ENVIRONMENTAL ENGINEERING LABORATORY
EXPERIMENT #1

OXYGEN UTILIZATION RATE (OUR) TEST

BACKGROUND

This laboratory activity explores the Oxygen Utilization Rate or Oxygen Uptake Rate Analysis and its use in measuring the metabolic activity of organisms in aquatic systems. Introductory theory, procedure and application are covered.

Microorganisms use oxygen as they consume food in an aerobic aquatic system. The rate at which they use oxygen is an indicator of the biological activity of the system and is called the Oxygen Uptake Rate. High oxygen uptake rates indicate high biological activity; low oxygen uptake rates indicate low biological activity.

In biological waste treatment facilities, oxygen uptake rates are used to monitor performance of process units. The analysis is based on a series of dissolved oxygen (DO) measurements taken on a sample over a period of time. The test is most valuable for plant operations when combined with volatile suspended solids data. Combining oxygen uptake and volatile suspended solids data yields a value called the Specific Oxygen Uptake Rate (SOUR).

Specific Oxygen Uptake Rates (SOUR) describe the amount of oxygen used by the microorganisms to consume one gram of food and is reported as mg/l of oxygen used per gram of organic material per hour. The specific uptake rate is valuable when comparing one aquatic system with another or if a single system is to be charted over time. The performance of one aeration basin can be compared with another or the biological activity in a stream can be studied and compared both above and below a waste outfall. Furthermore, toxic or high organic loads can often be detected before severe deterioration of effluent quality occurs. Changes in the SOUR on effluent samples will indicate changes in loading.

INTRODUCTION

Biological waste treatment in the activated sludge process is based on the ability of the microorganisms to utilize dissolved oxygen in breaking down soluble organic substances.

The oxygen uptake test is a means of measuring the respiration rate of the organisms in the activated sludge process. Since it measures the oxygen used in the process, it is a useful tool in the evaluation of process performance, aeration equipment and biodegradability of the waste. So that comparisons can be made between various plants, it is usually expressed as the SOUR, i.e. the amount of oxygen in mg utilized by one gram of the volatile suspended solids in the activated sludge, in one hour.

EQUIPMENT

1. Dissolved Oxygen Meter with probe adapted to BOD bottle

2. 300 ml BOD bottle

3. Magnetic stirrer and magnetic stirring bar

4. Timer

PROCEDURE

1. Split into two (or three) groups.

2. Collect sample of mixed liquor suspended solid (MLSS) from local wastewater treatment facility (completed by instructor).

3. Continuously aerate sample prior to initiation of step 5 of experimental protocol (completed by instructor).

4. Calibrate the DO probes (completed by instructor).

5. Fill a 300-mL BOD bottle with an MLSS sample. Immediately after filling, place a glass stopper in the bottle.

6. Place the BOD bottle on stirrer with magnetic stir bar.

7. Place DO probe in the bottle making sure the stopper provides a good seal and switch on the magnetic stirrer.

8. Measure DO as quickly as possible; record the DO concentration in the bottle as a function of time. Continue to record the DO concentration in the bottle every 30 seconds for approximately 10-15 minutes (it may take longer). The actual time required depends on the rate of oxygen depletion. ~~Allow sufficient time to get at least 1 mg/L DO difference between start and finish of the test~~. **Be sure to record both the DO measurement and the time**. The meter reads the DO concentration in mg/L.

9. At the completion of the experiment, dump aqueous content from BOD bottle back into the appropriately marked container. Wash BOD bottle and repeat experiment with the other sample. Make sure all glassware is clean at the end of the lab period.

CALCULATIONS

1. Construct a plot of DO vs. time. You should have two curves, one for each sample.

2. Draw the best straight lines through points.

3. The slope can now be calculated: two points in time are selected through which the line passes. By subtracting the lower DO value from the higher and dividing the answer by the time interval selected, the slope is obtained.

4. Calculate Oxygen Uptake Rate for curves representing both bottles 1 and 2. The uptake rate is expressed normally in the units mg O_2/L/hr. Therefore, from the slope:

Oxygen Uptake Rate = mg O_2/L/min x 60 min/hr

5. Calculate the Specific Oxygen Uptake Rate. Assume the volatile suspended solids (VSS) concentration is 2400 mg/L (VSS is normally obtained from routine daily solids analysis).

   SOUR[(mg/g)/hr] = Uptake Rate x 1000 [mg/g]/VSS [mg/L]

   Discuss the following questions in your report:

   a. Both samples were taken recently from the Poplar Street WWTP. If your SOUR values calculated from the two samples differ, speculate why.

   b. Explain why oxygen uptake rates can be used in operational control of activated sludge systems.