Lab #2 HINTS

A note on reporting results in the lab: relate the calculated values to a standard! For instance, in lab 1 is the water soft, hard, very hard, etc.? In lab 2, are the BOD and fecal coliform counts acceptable for release into a river (look up the guidelines & reference them)? Conclusions should be addressed when answering questions.

Sewage Samples:

There were four sewage samples:
- Raw (before any treatment)
- Primary (after primary settling)
- Mixed liquor (recycled organisms from secondary settling) and
- Final (before leaving the treatment plant)

Each stage of the treatment plant should show a reduction in solids, oxygen demand, and bacteria (except for the mixed liquor, since it contains recycled organisms).

Biochemical Oxygen Demand (BOD):

The amount of oxygen required for bacteria to decompose organic matter in the solution. Occasionally, bacteria must be added to the sample (seeded) if there are not enough organisms present to decompose the organic matter. It is an indicator parameter of how much organic matter is in the sample.

Note: It does not tell you how many organisms are present! It tells you how much oxygen is needed for decomposition of organic matter.

Reasons for the BOD test:
(1) to determine the approximate amount of oxygen to biologically stabilize the organic matter in a system,
(2) to determine the size of waste treatment facility
(3) to measure the efficiency of some treatment processes
(4) to determine compliance with wastewater discharge permits.

It can be calculated theoretically, for example, a simple sugar (glucose):

$$C_6H_6O_2 + 6.5O_2 \xrightarrow{\text{bacterial decomposition}} 6CO_2 + 3H_2O$$

For every mole of glucose, 6.5 moles of oxygen are required. Therefore the BOD of 1 mole of glucose is 6.5 moles of oxygen.

You can only calculate the theoretical oxygen demand if you know the chemical formula of the organic matter – if you don't know it, you have to measure it!

The BOD (sometimes called BOD_{ult} for ultimate BOD) may take a long period of time to reach (long decomposition time) - so a shorter time period is used.

In your lab, you are measuring BOD_5 (or occasionally BOD_4 or BOD_6) at two dilutions. (Note: if you are measuring BOD_4 or BOD_6, be sure to calculate BOD_5 in your lab report!)

Equation:

$$BOD = \frac{(D_1 - D_2) - (B_1 - B_2)f}{P}$$

D1, D2 – dissolved oxygen in diluted sample at time 1 and time 2
B1, B2 – dissolved oxygen in blank at time 1 and time 2
f – ratio of seeding in sample and blank
P – ratio of sample size to bottle size (the bottles are 300 mL).

- The dilution water was NOT seeded. There were enough organisms in the sample already. Therefore, use f=1.

- There are some extra conditions for valid BOD tests:
  - $D_2 > 1$ mg/L (if it is less than 1 mg/L, the bacteria did not have enough oxygen for the 5 days)
  - $D_1 - D_2 > 2$ mg/L (if it is less than 2 mg/L, the bacteria were not decomposing the organic matter properly)
  - $B_2 << B_1$ (the dissolved oxygen in the blank samples should not change very much)

Bacterial Examination:

This is also an indicative parameter. Many kinds of bacteria exist, some of which are hazardous (e.g. disease causing organisms). Since testing for each organism is time-consuming and expensive, we use indicator tests.

In the lab, you did the bacterial examination on the final effluent only! This is the water that will be released into the environment.

The assumption in this lab is that each colony was formed from only ONE organism. (How good is this assumption?)

In your lab, you performed a Heterotrophic Plate Count and a Membrane Filter Technique. The first measures all bacteria, the second measures fecal coliforms only.

$$Total\ Coliform = Fecal + Non\ Fecal$$

Fecal coliforms are usually dangerous, Non-Fecal coliforms may be dangerous.

To get the number of cells in your sample, use the following equation:

$$\#cells = \frac{\#colonies \times dilution\ factor}{sample\ volume}$$

Solids:

This is also an indicative parameter. Solids indicate the strength of the wastewater.

You will calculate four values of solids: fixed dissolved, volatile dissolved, fixed suspended, volatile suspended.

Dissolved solids pass through the filter, suspended solids are caught on the filter.

$$Total = Dissolved + Suspended$$

Dissolved solids are calculated according to the above equation (you measured total and suspended)

Volatile solids can be ignited, fixed solids remain after ignition.

$$Total\ Dissolved = Volatile\ Dissolved + Fixed\ Dissolved$$

$$Total\ Suspended = Volatile\ Suspended + Fixed\ Suspended$$

The following equations may also be used (units are mass/volume):

$$Total\ Suspended\ Solids = \frac{(Dry\ wt. - Tare\ wt.)}{Sample\ Volume}$$

$$Volatile\ Suspended\ Solids = \frac{(Dry\ wt. - Ash\ wt.)}{Sample\ Volume}$$

$$Fixed\ Suspended\ Solids = \frac{(Ash\ wt. - Tare\ wt.)}{Sample\ Volume}$$

$$Total\ Solids = \frac{(Dry\ wt. - Tare\ wt.)}{Sample\ Volume}$$

$$Volatile\ Solids = \frac{(Dry\ wt. - Ash\ wt.)}{Sample\ Volume}$$

$$Fixed\ Solids = \frac{(Ash\ wt. - Tare\ wt.)}{Sample\ Volume}$$

The tare weight is the weight of the container, before the sample was added.
The dry weight is the weight of the dried container, all the liquid has been evaporated (contains both fixed and volatile solids).
The ash weight is the weight of the dried and ignited container (contains fixed solids only).