Toxicity in BOD Testing[1]

Standard Methods 5210B says to report the average of all BOD (or cBOD) bottles that meet the criteria of 2.0 or more mg/L of dissolved oxygen (DO) depleted with at least 1 mg/L DO retained, if ***there is no evidence of toxicity.*** But other than stating that toxicity would occur at ***higher sample concentrations,*** the method doesn't give the analyst much of a clue about what toxicity is, what causes it, or what to do about it.

Toxicity in BOD testing is the characteristic of a sample that causes it to interfere with biochemical oxidation of organic materials during incubation. When present in sufficient quantities, these toxic materials might even upset the biochemical process in a waste-water treatment process, as any small treatment plant that has had a local micro brewery "dump" a significant amount of beer might know. ***In addition to beer (alcohol), other toxicants are high alkalinity or acidity, chlorine, trace metals such as copper, lead, chromium, mercury, and arsenic, or compounds such as cyanide.*** Sample pretreatment required by the method, such as neutralization and dechlorination, eliminates some of those toxicants, but others remain and can cause gross errors in results if not addressed.

It is highly unlikely that a toxicant could survive the wastewater treatment process in sufficient strength to interfere with BOD results for an **effluent** sample. Accordingly, a wastewater treatment plant (WWTP) need be concerned about toxicity only in its **influent**. Septage, waste from electroplating operations, wasted adhesives from some wood product manufacturers, brewery discharges, as well as many other industrial wastes are likely to cause toxicity in WWTP influents.

Toxicity is indicated by increased BOD values as the sample becomes more dilute. For example, in a three-bottle dilution series of 20, 10, and 5 milliliters of sample where the depletions were 4.00, 3.50, and 2.50 mg/L DO, the calculated BOD would be 60.0, 105, and 150 mg/L, respectively (average of 158 mg/L). The increasing values might, or might not be caused by toxicity. To prove toxicity, several more bottles at even higher dilutions must be run.

In a hypothetical but realistic case of toxicity, the dilution series might be 10, 5, 2, 1, 0.1, 0.05, 0.02, 0.01 milliliters of sample. Since accurate measurement of influent less than 1.0 milliliter is problematic, it would be necessary to pre-dilute the entire sample, in this case by a factor of 10, to get the four most dilute bottles in this example. If the respective depletions were, say, 3.50, 2.50, 2.67, 2.17, 3.50, 2.83,

[1] Extracted from *A Bug's-Eye-View of the BOD Test* by Perry Brake, January 2007.

3.47, and 2.00 mg/L, the calculated BODs would be 105, 150, 400, 650, 1050, 1700, 5200, and 6000 mg/L. Results from this 8-bottle dilution series would be defensible proof of toxicity. When reporting results for such a case, report the result for the single bottle that gave the highest BOD while meeting the criteria of depleting at least 2.0 mg/L DO and retaining at least 1.0 mg/L. In this case, 6000 mg/L would be reported.

Why should a WWTP worry about toxicity if it generally doesn't affect the effluent? Industries discharging to a WWTP are usually billed according to BOD loading. The difference in billing for 158 mg/L, versus 6000 mg/L BOD if a dilution series had been run, could lead to a significant billing change for the industry whose discharge caused the toxicity in the case.