**A Simple, Overlooked Set of Parameters for Judging MSW Stabilization (2-29-12)**

**by**

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The simple set of parameters is total and soluble $BOD_5$ and COD for representative leachate samples. These values are easily obtained when the total suspended solids (TSS) tests is performed. The filtrate resulting from the TSS procedure is used to perform the soluble $BOD_5$ and COD tests. [Note that the filtrate can also be used to determine the total dissolved solids (TDS) value which is helpful in doing ion and material (ion and molecular) balances on the leachate.]

The total and soluble $BOD_5$ results are a measure of the oxygen demand of the leachate. In other words, the results indicate how much oxygen is necessary to convert the biodegradable organics in the leachate to carbon dioxide and water. Although a MSWLF operates typically anaerobically, the results are a measure of the organic content of the total and soluble organics in the leachate in terms of oxygen concentrations. The difference between the two values is a measure of the organic content of the leachate solids, which are TSS consisting of microbial and other entrained solids that have managed to infiltrate through and from the MSW mass to the leachate sump. **It is believed that they are mainly microbial solids.**

The total and soluble COD results are a measure of the oxygen demand of the leachate, but include both biodegradable and other COD oxidizable organics (non-biodegradables). This statement assumes that anything which is biodegradable is also COD oxidizable. Also, note that there will be some organic material which is non-COD oxidizable. Again, like the total and soluble $BOD_5$, the difference between the two COD values is a measure of the organic content of the leachate solids expressed in COD or oxygen units.

Since the total and soluble $BOD_5$ and COD results are in oxygen units, they can be compared directly. However, keep in mind that the $BOD_5$ is the five day BOD. The comparable BOD to the COD is the ultimate BOD which must be determined experimentally for the sample in question. In general, **$BOD_5$ is approximately 2/3 of the ultimate BOD**.

Concerning the comparison of $BOD_5$ and COD values, it is best to illustrate by using actual results for total and assumed results for the corresponding soluble $BOD_5$ and COD values. The total values are based on averages of Allen County's historical data (29 values) rather than a single set of individual values since it is assumed that the averaging will ameliorate possible analytical inconsistencies. These average values are: total $BOD_5$ and COD = 91 and 319 mg/L, respectively. If the ultimate total $BOD_5$ is 91/0.67 = 136 mg/L, then the portion of the BOD to COD is 136/319 = 0.43, or the leachate is about 43% biodegradable.

Another comparison example involves the use of the average TSS value corresponding to the previously selected total $BOD_5$ and COD values (omitting what appears to be an outlier) which is 60 mg/L. **If an oxygen equivalent value of 1.42 mg/L of oxygen per mg/L TSS is assumed** (i.e., the TSS is

assumed to be mainly microbial solids), the insoluble TSS has an oxygen equivalence or COD of 60 X 1.42 = 72 mg/L. This means that the soluble COD is approximately 319 - 72 = 247 mg/L, or the leachate COD is about (247 - 72)/247 = 0.71 or 71% soluble. **Assuming the BOD and COD have the same proportion of solubles**, the soluble ultimate BOD can be estimated to be 136 X 0.71 = 97 mg/L BOD.

It has been proposed that a benchmark for Final Storage Quality (FSQ) of leachate using total $BOD_5$ and COD results is a ratio of 0.1 (see Benchmarks document dated 9-16-11, page 3, Item 3. **Note that this value is for MSW instead of leachate, but a similar value can be assumed.** ). Obviously, the average values given above with a ratio of 91/319 = 0.28 is greater. The combined values of 91 mg/L and a ratio of 0.28 indicate that the MSW mass is still unstable based on the leachate quality emanating from the mass. An even better indicator is the ratio of the soluble $BOD_5$ and COD values **since the soluble degradable portion best represents the available food source for the microbes, i.e., the organics must be soluble before they can be taken into and utilized by the microbes.**[*] Using the numbers given above, the soluble BOD/COD ratio is 97/247 = 0.39 which is greater than 0.28 and which indicates that the MSW mass is even more unstable than using the total $BOD_5$ and COD values.

Recent Allen County data of 14, 110 and 26 mg/L $BOD_5$, COD and TSS, respectively, gives an ultimate BOD value of 21 mg/L and insoluble COD of 26(1.42) = 36.9 mg/L or a soluble COD of 110 – 36.9 = 73.1. Since the COD equivalence of the solids is greater than the ultimate BOD (21 versus 36.9), it is assumed that the soluble BOD is zero which suggests minimal MSW instability. The actual $BOD_5$ and COD ratio of 14/110 = 0.13 (versus 0.28 for the average values used previously) and the low $BOD_5$ value of 14 (versus 91 for the average values used previously) suggests a similar conclusion but not as conclusive.

In summary, total and soluble $BOD_5$ and COD values are more useful than just total $BOD_5$ and COD values because they are better indicators of FSQ. Also, the above examples would be more meaningful if actual soluble $BOD_5$ and COD values were available and did not have to be estimated.

[*]It could be argued that there are still biodegradable solids left in the insoluble $BOD_5$ and COD which will be released as solubles at a later time; however, the extra-cellular hydrolysis reactions are typically faster than the inter-cellular oxidation-reduction energy reactions. Also, the leachate solids are different than the MSW solids. This latter fact is not considered when using leachate (and LFG) emission values to determine PCC termination. It is a weakness of the emissions based methodology. However, if new organics are released from the MSW mass because of the introduction of moisture, then the leachate FSQ values will increase indicating that such a situation exists.