**Memorandum**

Date: 1/21/2010

To: Dr. Urban

From:

Re: Wastewater Treatment: MLSS and MLVS

CC: Bo Zhang

The objective of the lab exercise was to measure mixed liquor suspended solid (MLSS) and mixed liquor volatile solid (MLVS) concentrations in wastewater and a clay suspension, as is practiced in activated sludge wastewater treatment plants. Environmental engineers are concerned with particles suspended in water and proper operation of wastewater treatment plants and therefore measure the total mass of suspended particles as well as the mass of organic matter suspended in the activated sludge unit. These measurements allow engineers to adjust the flow rate of return sludge from the secondary clarifier into the secondary treatment reactor to ensure that influent organic matter will be treated with an adequate concentration of microorganisms. /Good. It would be appropriate to mention the statistical goals as well./

Measurements of MLSS and MLVS were recorded after filtering wastewater samples and suspended clay solution samples. Measurements of this nature are recorded every day in wastewater treatment plants so that environmental engineers can properly set the flow rate of return sludge. See the enclosed "Table 1: MLSS Values" for measurements of suspended solids in the clay solutions and the wastewater solutions. Group 4's measurements of the MLSS in the suspended clay solution gave a mean value of 0.8122 g/L, which is lower than the true value of 1.000 g/L. See enclosed "Table 2: MLVS Values" for the measurements of volatile solids in the clay solutions and the wastewater solutions. Our group's measurement of the MLVS in the suspended clay solution gave a mean MLVS value of 0.0256 g/L, relatively close to the true value of 0.000 g/L, as clay is inorganic and should not contain any volatile solids. /Your conclusions section does address the objective that you stated in your Introduction. Had you also mentioned the quality assurance goals in the Introduction, you could have mentioned the conclusions pertaining to accuracy and precision in this section.

Also enclosed is "Figure 1: Clay MLSS Values", which shows box and whisker plots displaying the mean, $25^{th}$ and $75^{th}$ percentile values, as well as all data points of clay suspension MLSS values for both Group 4 and the entire class. The enclosed "Figure 2: Clay MLVS Values" shows the mean MLVS value of our individual group as a point with error bars extended to plus and minus one standard deviation along with a second point with error bars that represents the results of all three groups who filtered the suspended clay solution and a line representing the true value./Are you stating Conclusions in this paragraph? It sounds more like results to me./

During this experiment one pure water sample and six 30-mL samples of our suspended clay solution were filtered using the vacuum apparatus. Filters had previously been placed in the muffle furnace to eliminate their organic content. The water control sample and three of the 30-mL filtered samples were placed in the drying oven at 110°C overnight. The remaining three were placed in the muffle furnace for 3 hours at 550°C. Data were recorded to determine the mass of the filtered materials after drying. /Cite the lab handout because it provides more details about the methods./

This is where it would be good to present your tables and figures of results.

The precision of individual groups is better than the precision of the whole class. The standard deviations of individual groups are lower than that of the entire class (Fig. 1). The compiled class measurements of MLVS were more precise than individual groups', as seen in the lower measured standard deviation for these values. However, six of the MLSS filters stuck to trays during the drying process; which may have contributed to the lower precision in the individual groups' MLSS samples.

The water blank sample results were similar for each group, which indicates that all groups had a pure water sample and similar technique. The ratio of volatile solids is lower for the clay samples, because natural clay has no organic matter and therefore no volatile solids. Before any filtering was completed, all filters were placed in the furnace to combust any organic matter found in or settled upon the filters. Some groups measured a change in mass in the water blank filter; this result can be attributed to prior incomplete combustion of organic matter when the filter was placed in the furnace the first time.

The bias for our group was determined by subtracting the true value from our calculated values. Our bias could have by affected by tears on the edges of the filter papers caused by forceps during removal, and to excess time in between pouring samples. Also, as the walls of the vacuum head attachment were not cleaned during each run, sample could have remained on the walls and contributed to a low measured MLSS. In considering the F/M calculation, if one were to mistakenly use the MLSS a lower than accurate ratio would result, which would give the false indication that there were enough microorganisms to digest the BOD. However, in this case the error resulting from mistakenly using MLSS would not be significant, as the MLSS and MLVS values overlap within one standard deviation.

**See Encl.: (Table 1: MLSS Values, Table 2: MLVS Values, Figure 1: Clay MLSS Values, Figure 2: Clay MLVS Values)**

| MLSS Values | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Tray #** | **Weight Residue (g)** | **MLSS (g/L)** | **Mean** | **Std Dev** | **RSD/COV** |
| **Group 4** | 2 | 0.0256 | 0.853333333 | 0.8122222 | 0.0356423 | 4.3882394 |
| | 3 | 0.0238 | 0.793333333 | | | |
| | 4 | 0.0237 | 0.79 | | | |
| **Group 1** | | | | 2.3633 | | |
| **Group 2** | | | | 1.1156 | | |
| **Group 3** | | | | 2.1658 | | |
| **Group 4** | | | | 0.8122 | | |
| **Group 5** | | | | 1.3917 | | |
| **Group 6** | | | | 1.6742 | | |
| **Group 7** | | | | 2.1733 | | |
| **Group 8** | | | | 0.9122 | | |
| **Group 9** | | | | 1.9167 | | |
| **Group 10** | | | | 2.1283 | | |
| **Group 11** | | | | 1.3375 | | |
| **Group 12** | | | | 0.9600 | | |
| **Class Average WW** | | | | 1.8074 | 0.6524277 | 36.097953 |
| **Class Average Clay** | | | | 0.8948 | 0.0816686 | 9.1268668 |

Table 1: MLSS Values

Significant digits?

| MLVS Values | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Group** | **Tray #** | **Weight Residue (g)** | **Mean MLSS** | **MLVS (g/L)** | **Mean** | **Std Dev** | **RSD/COV** |
| **Group 4** | 5 | 0.0221 | 0.812222222 | 0.0755556 | 0.0255556 | 0.0578312 | 226.29589 |
| | 6 | 0.0255 | | -0.037778 | | | |
| | 7 | 0.0232 | | 0.0388889 | | | |
| **Group 1** | | | | | 1.8189 | | |
| **Group 2** | | | | | 0.6069 | | |
| **Group 3** | | | | | 1.6303 | | |
| **Group 4** | | | | | 0.0256 | | |
| **Group 5** | | | | | 1.0561 | | |
| **Group 6** | | | | | 1.1250 | | |
| **Group 7** | | | | | 1.6333 | | |
| **Group 8** | | | | | 0.0844 | | |
| **Group 9** | | | | | 1.4378 | | |
| **Group 10** | | | | | 1.6458 | | |
| **Group 11** | | | | | 0.9075 | | |
| **Group 12** | | | | | 0.1000 | | |
| **Class Average WW** | | | | | 1.3180 | 0.4018959 | 30.493744 |
| **Class Average Clay** | | | | | 0.0700 | 0.0531159 | 75.879823 |

Table 2: MLVS Values/This goes above the table.

Significant digits?

Units should be indicated for all columns.

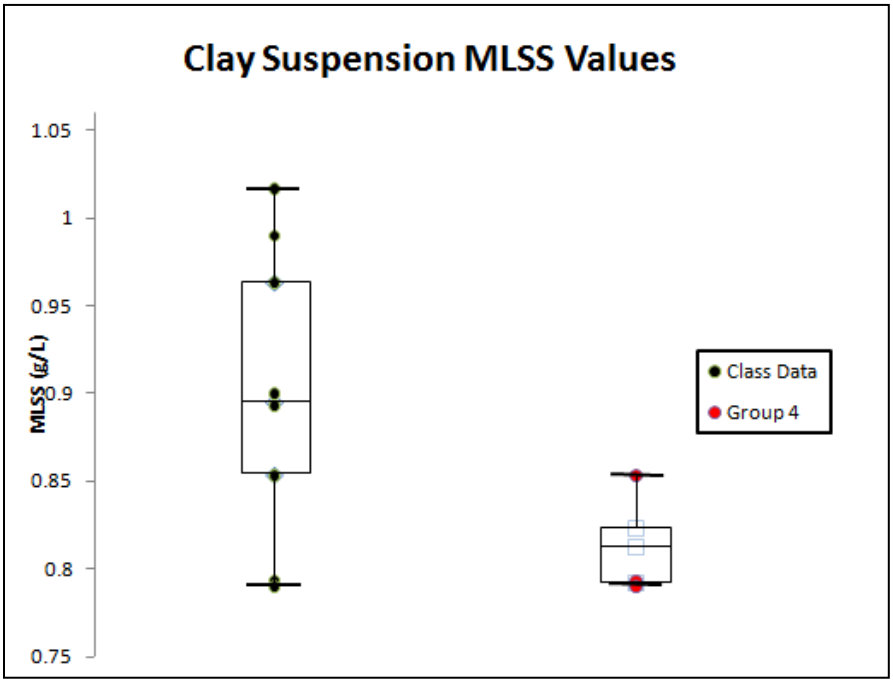


Figure 1: Clay MLSS Values

Good figure.

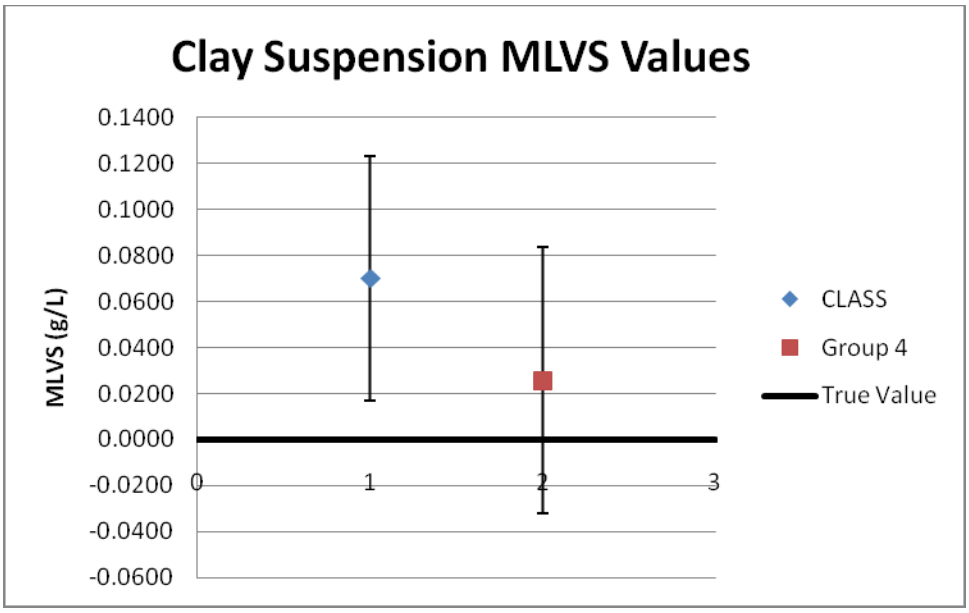

Figure 2: Clay MLVS Values

Good figure.  There is no need (indeed, it is undesirable) to include a chart title within the Excel chart.