Lab 4: Oxygen

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Contents

Introduction

Water engineering is heavily reliant on the amount of oxygen present within a sample of water. These oxygen levels are what allow environmental water to sustain organisms and wastewater treatment plants to manage their biomass growth for pollutant removal. Within a wastewater treatment plant the levels of dissolved oxygen (DO) are heavily monitored to keep the system at optimal conditions for the desired effluent. DO is not the only measure of oxygen that is used with water samples: biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are used as well [1]. These three measures look at the concentration of oxygen alongside the oxygen that is needed by the inhabitants of that sample, organism or pollutant.

The samples tested were both brought in from the Rio de Flag Wastewater Treatment Plant on October 1, 2018 by Shelby Carawan. The MLSS sample was gathered at 1303 with a VSS of 3.5 mg/L and the primary effluent sample was taken at 1259 [2]. This lab was assisted by S. Carawan and M. Stoll for clean-up and general questions that arose. For this procedure there was no HACH or SM method used.

Methodology

The equipment for this lab was easily attained and the workstations organized post completion. The BOD bottle used was disposable, and after a through rinsing, it was thrown away. All other equipment was cleaned and left to dry in the appropriate locations. The equipment is listed directly below [1].

- DO meter and probe
- BOD bottle
- Pipette
- Pipette bulb
- 300 mL Beaker
- Mixed liquor suspended solids (MLSS)
- 10 mL Primary effluent

The pipette was used to measure out the primary effluent and add it into the BOD bottle, immediately followed by the MLSS poured from container, to beaker, to bottle. This created slightly more waste of MLSS and cleaning, but the beaker prevented clogging of the pipette from how polluted the MLSS sample was. Once the BOD bottle was full, the probe was inserted and the timer was set for fifteen minutes. The data recording process was completed quickly and without any noticeable error as the process was completed by machine. The temperature was collected upon initially inserting the probe to analyze the relationship temperature and DO carry.

Once all the data was gathered, there were two equations that were considered. These equations look at the oxygen uptake rate (OUR) and specific oxygen uptake rate (SOUR) [3].

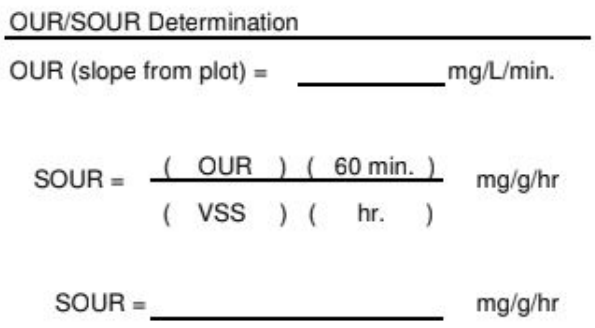

Figure 1. OUR and SOUR equations and respective units

The data gathered was inputted into Microsoft Excel to find the calculations for OUR and SOUR, as well as provide a visual representation of the data.

Results

The overall testing of the DO lasted for 15 minutes total and as Table 1 shows (below), the DO concentration reached 0.0 m/L before the testing was completed. This is only a small clip of the data available, the full table can be found in Appendix A, Table 3.

Table 1. Dissolved oxygen content upon reaching 0 mg/L

Time	**DO**
(min)	(mg/L)
13	0.04
13:20	0.00
14	0.00

The starting temperature of the MLSS and primary effluent mixture was recorded as 69.9˚F with an initial DO concentration of 6.69 mg/L. These values, and the values recorded on one minute intervals for a fifteen minute period, were graphically organized for ease of viewing. In this graph it is possible to see the recorded data as well as a matching linear trendline (equation listed).

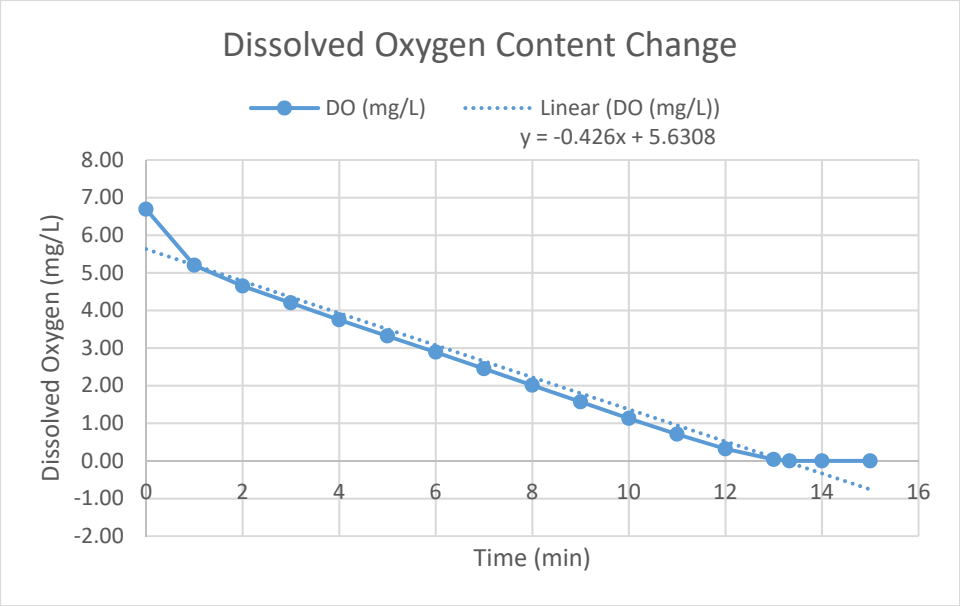

Figure 2. Dissolved oxygen concentrations over time, includes linear trendline

Utilizing the linear trendline produced from the data, the OUR and SOUR were calculated to analyze the difference in oxygen uptake rates utilizing the equations given in provided material [3]. These rates are listed below:

Table 2. Oxygen and specific oxygen uptake rates

OUR (mg/L/min)	-0.4268
SOUR (mg/g/hr)	-7.317

Discussion

Results

As depicted in Figure 2, the rate of decrease of dissolved oxygen is viewed in both an exponential and linear fashion. The DO showed an exponential decrease for the first three minutes before shifting to a nearly linear decrease. A linear trendline has been applied to gather the assumed slope and calculate both OUR and SOUR, these results can be viewed in Table 2 of the Results section. These values were both calculated to be negative due to the decreasing, not increasing, concentration of oxygen present in the sample.

As per the initial procedures, the lab called for a glucose solution to be utilized within the BOD bottle with the MLSS sample. During the lab time, a primary effluent was utilized as opposed to the glucose solution, however this change should not have affected the results of the testing.

Error

The largest error that could have affected the measured data was not immediately placing the DO probe into the testing bottle. The MLSS was transported to the work station via a beaker and then poured into

the BOD bottle. The first transport of water was not enough to properly fill the BOD bottle, thus another trip was made to the fume hood. Once the MLSS is removed from the aerated container, it immediately starts to lower in DO, and the extra travel time to gather more sample could have affected the measurement results upon beginning the testing. Additionally, the pipette could have caused human error of measurement when adding the primary effluent to the BOD bottle.

Conclusion

The dissolved oxygen content of the MLSS sample was tested with a DO probe over 15 minutes where the values were continuously decreasing. This data was in line with the initial prediction made prior to the testing and was still successful with older primary effluent and MLSS samples.

References

[1] Northern Arizona University, "Lab 4: Oxygen," [Online]. Available: https://s3.us-east-1.amazonaws.com/learn-us-east-1-prod-fleet01-xythos/5b6cbef360ea4/10478160?response-content-disposition=inline%3B%20filename%2A%3DUTF-8%27%27cene281L_fall2018_lab4%25281%2529.pdf&response-content-type=application%2Fpdf&X-Amz-Algorithm=A.

[2] S. Carawan, CENE 281L MLVSS.

[3] Northern Arizona University, "MLSS Oxygen Uptake Rate," [Online]. Available: https://s3.us-east-1.amazonaws.com/learn-us-east-1-prod-fleet01-xythos/5b6cbef360ea4/943467?response-content-disposition=inline%3B%20filename%2A%3DUTF-8%27%27cene281L_fall2018_lab4sample.pdf&response-content-type=application%2Fpdf&X-Amz-Algorithm=AWS4-HMA.

Appendix A

Table 3. Dissolved oxygen content test data

Run no.	1
Temperature (F)	69.9
VSS (g/L)	3.5
Time	**DO**
(min)	(mg/L)
0	6.69
1	5.20
2	4.65
3	4.20
4	3.75
5	3.32
6	2.89
7	2.45
8	2.01
9	1.57
10	1.13
11	0.71
12	0.32
13	0.04
13:20	0.00
14	0.00
15	0.00