Monzeglio, Hope, NMENV

From: Chavez, Carl J, EMNRD
Sent: Wednesday, May 10, 2006 12:16 PM
To: Price, Wayne, EMNRD; Foust, Denny, EMNRD; Cobrain, Dave, NMENV; Monzeglio, Hope, NMENV
Subject: FW: Dissolved Oxygen Uptake Test

FYI, some more info. from Jim Lieb of Giant on the DOUR to consider. Thanks.

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(Pollution Prevention Guidance is under "Publications")

From: Jim Lieb [mailto:jlieb@giant.com]
Sent: Wednesday, May 10, 2006 12:00 PM
To: Chavez, Carl J, EMNRD
Cc: Ed Riege; Cote Edward L.
Subject: FW: Dissolved Oxygen Uptake Test

Carl

Here is some more information on the Dissolved Oxygen Uptake Rate method we would like to use in the treatability study at the aeration and evaporation ponds. For various reasons better explained in the attached email, the DOUR method has greater reliability than the BOD method.

Let me know if you have any questions.

Regards,

Jim Lieb

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From: Cote Edward L. [mailto:ECote@hrc-engr.com]
Sent: Tuesday, May 09, 2006 1:43 PM
To: Jim Lieb
Subject: Dissolved Oxygen Uptake Test

Jim:

The Dissolved Oxygen Uptake Test (DOUR) is a direct measurement of the health of a biological wastewater treatment system. The test simply measures how much oxygen Giant's microorganisms consume over a short period of time, typically 10-30 minutes. Microorganisms consume oxygen while they are consuming contaminants and their fellow dead microorganisms. The test is run with an actual grab sample from the aeration basin and the results are immediate. The State of New Mexico may wish to consider this test in lieu of influent/effluent BOD testing since it tells them that you are removing contaminants biologically, and not by some other means.

This test allows the operator a chance to quickly change operations if the DOUR reading goes down. We often add nutrients or freeze dried microorganism, especially acclimated to the particular industrial waste. The BOD test requires 5-6 days of waiting to learn of your results, then another 5-6 days when you make a process change.

BOD test results are often suspect and hence, disputable, for two reasons:

a. The test starts by adding a "seed" of microorganisms. The seed should be specific to the waste, but labs are not consistent on this. It is common for labs to get different results.
b. The results of the BOD test vary with the dilution ratio because of toxicity effects. Influent BOD values are generally high and require dilutions of 1:100 or greater, otherwise all of the oxygen before the end of the 5 days. This dilution reduces the microorganism's inhibition by diluting toxins and gives a false sense of how biodegradable a sample is.

I faxed along the test method from a Water Environment Federation book, "Basic Activated Sludge Process Control". I spent two days last fall with the author, Dave Flowers, troubleshooting an automotive plant. This plant likes the test because it allows the operators to develop a "feel" for their bugs health and immediately respond with a remedy.

Please feel free to contact me if you need further info.

Regards

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"water bear" (an aquatic animal), the waste was weak and the mixed liquor was 800 mg/L, but the effluent was of good quality.

What can be interpreted of abnormal conditions is the following:

- If an abnormal microorganism predominates in a given system, it is because an environment that is favorable to the organism exists.
- If the abnormal microorganism is subjected to a change in environment, it may dissipate in favor of another indicator organism that thrives in the new environment.
- If the change in environment occurs gradually, a smooth transition can be observed through routine microscopic examination.
- An operator's role is to change and maintain conditions favorable to those organisms that result in a desired effluent quality when they predominate.

OXYGEN UPTAKE RATE TEST AND RESPIRATION RATE

The oxygen uptake rate (OUR) test and resulting respiration rate (RR) measure and show how active organisms are in the activated sludge process. The activity of the organisms is related to the amount of oxygen the organisms consume. The OUR test measures how much oxygen a sample of activated sludge consumes over a specific time period. The RR relates the OUR test results to the concentration of organisms in the activated sludge sample. The results from the OUR test are used to calculate RR. Another term for RR is specific oxygen uptake rate (SOUR).

Refer to *Operating Activated Sludge Using Oxygen Uptake* (Water Pollution Control Federation, 1989, Problem-Related Operations-Based Education, Alexandria, Va.) for more detailed information on the OUR test and RR and their relationships to the activated sludge process.

Equipment

- Calibrated and fully charged DO meter and a means of constantly stirring the sample. A self-stirring BOD bottle probe or separate magnetic stirring device may be used.
- Stopwatch or other timing device.

Other Data Required

- Volatile suspended solids in grams per litre (ounces per gallon) of the activated sludge sample from which the OUR test was performed. Refer to "Volatile and Fixed Residue in Wastewater" in *Simplified Laboratory Procedures for Wastewater Examination* (Water Pollution Control Federation, 1985, Special Publication, Washington, D.C.).

Procedure

1. Collect a fresh sample of activated sludge.
2. In the laboratory, immediately after sample collection, transfer approximately 750 mL (46 cu in.) of the well-mixed activated sludge to a 1-L (0.035-cu ft) bottle.

3. Cap the 1-L (0.035-cu ft) bottle and thoroughly shake or aerate the sample to bring the DO level above 5 mg/L.
4. Pour a well-mixed portion of the aerated sample into a BOD bottle and fill to overflowing. Some bubbles will gather at the top. Tilt the bottle and/or tap on the sides of the bottle with a spatula to work the bubbles out of the sample. NOTE: The activated sludge sample that remains after filling the BOD bottle can be used to perform a volatile suspended solids (VSS) test in step 11.
5. Insert DO meter probe into BOD bottle and begin stirring. Turn DO meter to 0 to 10 scale.
6. Wait approximately 30 to 60 seconds for DO meter reading to stabilize. (Note: The indicator needle or readout should be dropping constantly during this procedure.)
7. Beginning at any given time, record the DO level of the sample in 30-second or 1-minute intervals. Do not record DO levels less than 1.0 mg/L.
8. Graph the results by plotting DO (in milligrams per litre) on the vertical axis and time (in minutes) on the horizontal axis.
9. Draw a straight line connecting the majority of the points. Extend the line so that it crosses the horizontal and vertical axes. Note: The operator may discover that the line is not straight at the beginning and end of the test (Figure 2.3, from *Operating Activated Sludge Using Oxygen Uptake* [1989]. Problem-Related Operations-Based Education, Water Pollution Control Federation, Alexandria, Va.). The straight line is drawn to negate the effects of these curves. At the

beginning, false values (undissolved bubbles, for example) cause interference. At the end, the curve flattens because of limitations of the DO meter. There is no advantage in continuing to graph values of 1 mg/L O_2 or less.

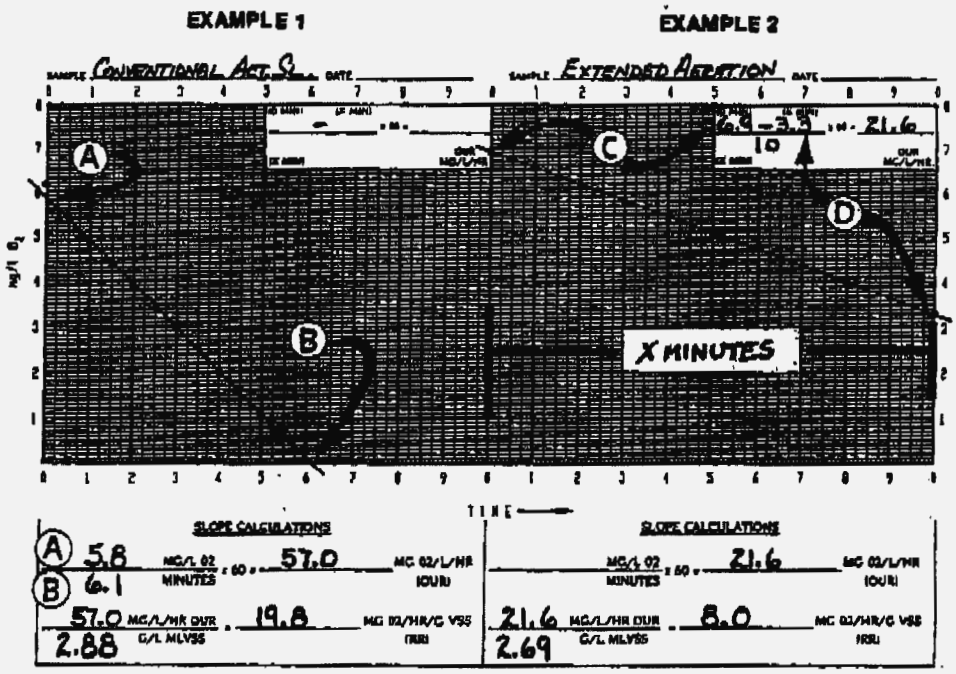

Figure 2.3 Graph of OUR test.

10. Determine the slope of the line, in milligrams per litre of oxygen per minute. (The easiest way to determine the slope is to use the points at which the line crosses the axes. Divide the milligrams per litre of oxygen crossing point A by the time in minutes crossing point B.)
11. Determine the VSS content of the activated sludge sample. Express VSS concentration in grams per litre (ounces per gallon). This is done by dividing the milligrams per litre of VSS by 1 000.

12. Enter values in the equation and calculate the respiration rate. The RR is expressed as milligrams of oxygen per hour per gram of VSS. Note: The U.S. Environmental Protection Agency permits the use of SOUR as a means of evaluating compliance with biosolids vector attraction reduction for aerobic digesters. As stated previously, RR and SOUR are the same. If the RR is being performed on an aerobic digester sample to determine compliance with vector attraction reduction requirements for beneficial use of biosolids, total solids is used to calculate RR, not VSS. Refer to "Total Solids, Volatile Matter and Fixed Matter in Sludge" in *Simplified Laboratory Procedures for Wastewater Examination* (Water Pollution Control Federation, 1985, Special Publication, Washington, D.C.).

Calculation

The calculations and equations for OUR and RR are described separately below.

Oxygen Uptake Rate

There are two commonly used methods for calculating OUR. Both methods arrive at the same numerical result. In both cases, the respiration rate worksheet/graph will be used.

The first method as stated in the procedure above requires drawing a straight line through the greatest number of points graphed. The line will cross both the horizontal (time) and vertical (milligrams per litre) axes of the graph. The values at these two points are used in the OUR calculation (refer to Figure 2.3). The milligrams per litre of

oxygen value, *A*, is divided by the minutes value, *B*, and multiplied by 60 minutes per hour to derive milligrams per litre per hour.

The second method (refer to Figure 2.3) is applicable when using the second, or right hand, side of the graph to do an OUR on an aerobic digester or extended aeration system. These usually flat lines may not conveniently cross the horizontal axis. The straight line through the majority of points should still be drawn. Pick a point on the line as time zero (*C*) and enter the milligrams per litre of oxygen value in the calculation box on the upper part of the graph. Pick a second point (*D*) on the line as the end time and enter it. The points should be at least 5 minutes apart. Divide by the time span between the two points, and multiply by 60 minutes per hour to derive the milligrams per litre per hour OUR.

$$\text{OUR (mg/L·h)} = \frac{\text{DO concentration at 0 min (mg/L)} - \text{DO concentration at } x \text{ min (mg/L)} \times 60 \text{ min/h}}{x \text{ min}}$$

Respiration Rate

The RR is the OUR divided by the VSS in grams per litre (ounces per gallon). The abbreviation MLVSS stands for mixed liquor volatile suspended solids.

$$\text{RR (mg } O_2\text{/g·h VSS)} = \frac{\text{OUR (mg/L·h)}}{\text{MLVSS (g)}}$$

The respiration rate worksheet/graph (Figure 2.4, from *Operating Activated Sludge Using Oxygen Uptake* [1989]. Problem-Related Operations-Based Education, Water Pollution Control

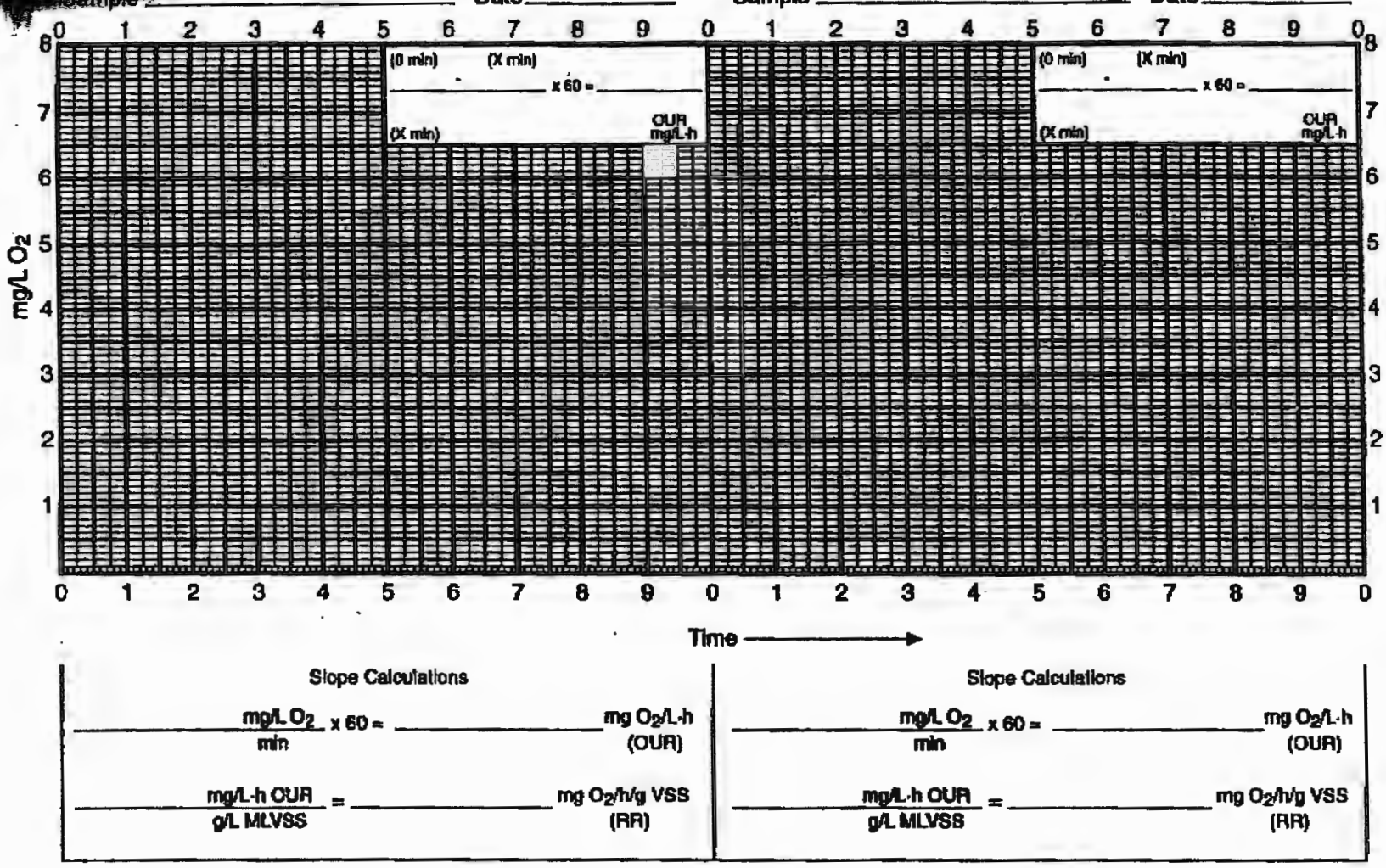

Figure 2.4 Respiration rate worksheet/graph.

Federation, Alexandria, Va.) can be used to perform the RR and OUR calculations.

Sample Problem

An OUR test on an activated sludge sample with a TSS concentration of 1 750 mg/L and VSS concentration of 1 400 mg/L yields the readings shown in Table 2.2. Plot these readings on the respiration rate worksheet/graph (see Figure 2.4). What is the OUR, using the first method of OUR calculation? Verify this using the second method of OUR calculation.

Calculate the respiration rate on the worksheet. The respiration rate worksheet/graph shown in Figure 2.5 illustrates the solution to the example problem.

Table 2.2 Results from SOUR test on an activated sludge sample.

Time	O_2, mg/L	Time	O_2, mg/L
0	4.8	3 min	3.1
15 sec	4.5	4 min	2.7
30 sec	4.3	5 min	2.2
45 sec	4.1	6 min	1.8
1 min	4.1	7 min	1.3
1.5 min	3.8	8 min	0.9
2 min	3.6	9 min	0.7
2.5 min	3.4	10 min	0.5

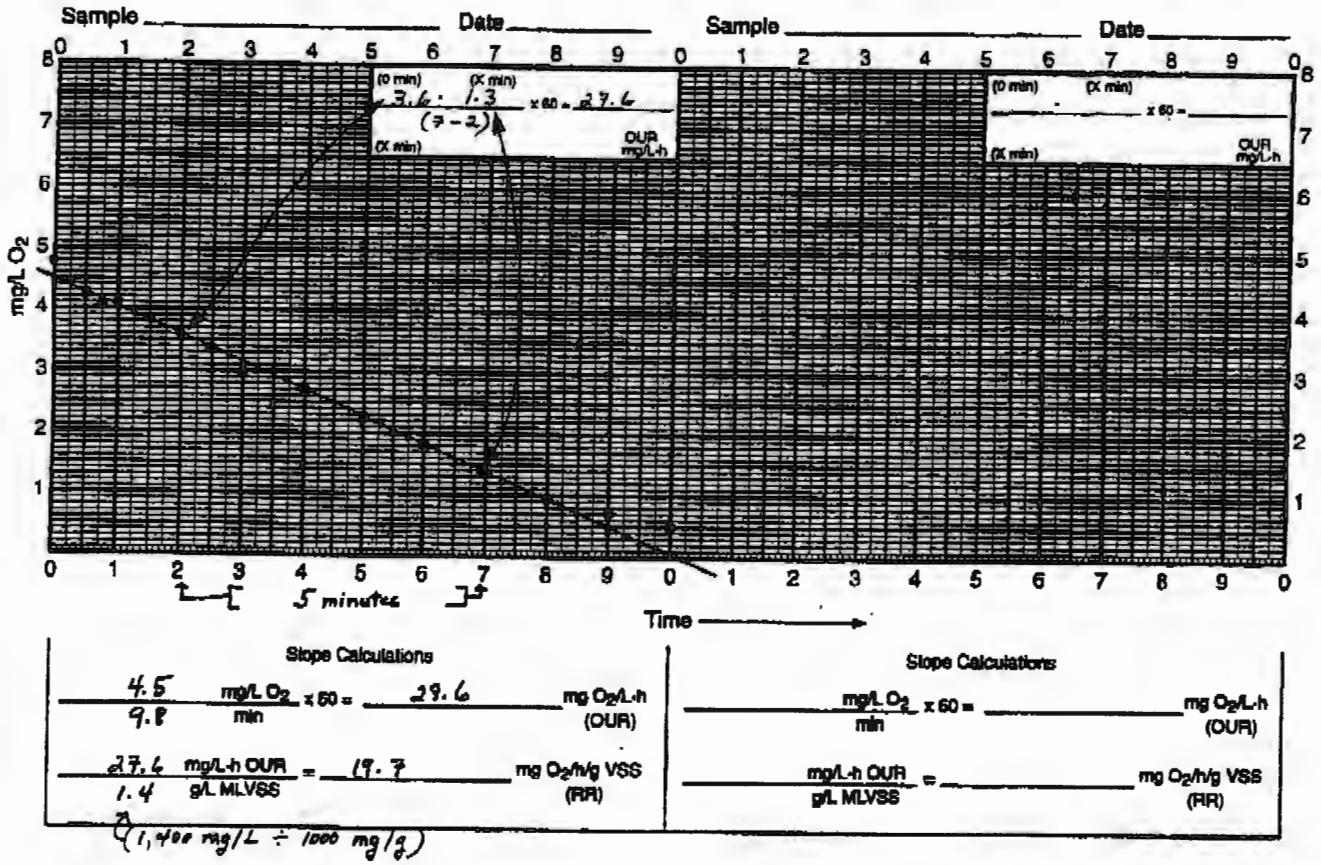

Figure 2.5 Solution to respiration rate sample problem.

SLUDGE VOLUME INDEX

Sludge volume index (SVI) is defined as the volume of sludge in millilitres (cubic inches) occupied by 1 g (0.04 oz) of activated sludge after settling for 30 minutes. This index relates the 30-minute settling volume from the settleometer process control test to the concentration of solids in the sample on which the settleometer test was performed. The SVI will help the operator evaluate the settling characteristics of the activated sludge as the concentration of the solids in the system change.