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THE GREAT SHAKE

WORKBOOK

Napa Sanitation District

2/16/2018

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COVER SHEET

The Napa "Great Shake" Coversheet

Introduction: The following lessons introduce students to algebra equations in order to determine hydraulic detention time, conversion of a flow and concentration into pound and mathematic ratios.

Materials:

- Projector connected to a computer with internet to play video of incident
- Copies of each of the following:
    - Warm-Up and Exit Ticket
    - The Napa Shake up Worksheet
    - Applied Wastewater Math Formula Sheet and Conversion Factors
    - Student Surveys

Estimated Timeframe:

- 45 minutes to an hour, depending on how you spread and imbed your think time

Prior Knowledge/Skills Needed:

Before this application lesson, students must be able to:

- Calculate the result of an algebra equation using multiplication
- Calculate the result of one equation divided into another
- Calculate the ratio of one equation over another
- Conversion of a percentage to a decimal

Common Core State Standards:

CCSS.MATH.HS.A-CED.2: Create equations in two or more variables to represent relationships between quantities;

CCSS.MATH.HS.A-REI.3: Solve linear equations and inequalities in one variable, including equations with coefficient represented by letters.

Additional Common Core State Standards:

CCSS.MATH.HS.N-1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas;

CCSS.MATH.HS.A-CED.3: Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Implementation Suggestions:

- Ask students to think/write/pair/share often so students can verbalize and communicate their mathematics
- Students should do work on the board in groups or pairs

Accommodations/Modifications:

- For English Language Learners:
    - Be sure to have precise definitions of content vocabulary ready ahead of time.
    - Be sure to include think time when appropriate
    - Ask students to Think/Write/Share between for each question
- SPED/504:
    - Allow students to use a calculator for calculations
    - Allow students to use applied math formula sheet
    - Focus on having students verbalize the process in their own words
    - While students are finding solutions you may ask students for estimated solutions first, this helps students see if they are headed in the right direction with their answers

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WARM-UP EXERCISE

The Napa "Great Shake" WARM-UP

Calculating hydraulic detention time and organic loading are two important factors treatment plant operators have to understand in order to operate a wastewater treatment plant.

Hydraulic detention time (HDT) also known as hydraulic retention time (HRT) is a measure of the average length of time that a compound (in this case wastewater) remains in a treatment tank or unit. Simply stated if you started to fill a tank with wastewater the detention time is the average amount of a time that a drop of that water will remain in the treatment tank before the tank fills and that drop of water flows out of it. This is important because as wastewater passes through a treatment tank it must stay in the tank for the necessary period of time in order to be adequately treated. For example, in most aeration treatment systems, 4 to 8 hours of detention time is necessary in order for the microorganisms in the aeration system to absorb, adsorb and remove the contaminants (bacteria food) in the wastewater.

Like humans, animals and other organisms, the microorganisms used to treat wastewater need the right amount of food in order to survive and thrive. Organic loading in wastewater is measured as BOD (Biochemical Oxygen Demand) which is a test run in a lab which measures the concentration or strength of the organic loading of a volume of wastewater. Think of the BOD or organic load as wastewater contamination which serves as bacteria food that the microorganisms in the treatment system consume and remove from the wastewater. Treatment plant operators must understand the relationship between the contaminant (organic load) in the wastewater relative to the amount of microorganisms in the treatment system that are available to remove that organic load. Therefore, operators must calculate the pounds of organic load contained in a volume of wastewater then calculate the pounds of microorganisms that are in the treatment system which is available to consume and remove the organic load. The operator then compares the pounds of organic loading to the pounds of microorganisms. This comparison is referred to as the Food to Microorganism (F/M) ratio. Most treatment plants operate at an F/M ratio of 0.2 to 0.5. This means for every 2 to 5 pounds of organic load in a volume of wastewater the treatment system must contain 10 pounds of microorganisms in order to stabilize and remove that organic load.

1. **Hydraulic Detention Time**

A. Calculate the Hydraulic Detention Time in a treatment tank given the following:

Flow to a rectangular aeration basin is 3.0 million gallons per day. The clarifier is 100 ft in length, 50 ft wide, and 15 ft deep. Calculate the aeration basin's hydraulic detention time.

$$\text{Volume of Rectangular or circular tank of uniform depth, } \{ft^3\} = \text{area, } \{ft\}^2 \text{ x depth, } \{ft\}$$

$$\text{Detention time, } \{hr\} = \left[\frac{\text{tank volume, } \{ft^3\} \text{ X } 7.5 \left\{\frac{\text{gallons}}{ft^3}\right\} \text{ X } 24\left\{\frac{\text{hrs}}{\text{day}}\right\}}{Q, \ \{\text{gallons/day}\}}\right]$$

B. Is this an adequate amount of treatment time?

2. **Organic Loading**

   a. Convert a concentration of wastewater contaminants to pounds.
      i. A wastewater flow rate is 6 MGD (million gallons/day) has an organic loading concentration of 250 mg/l BOD (Biochemical Oxygen Demand).

$$\underline{\text{BOD or SS}},\ \{\text{lbs/day}\} = 8.34\ \{\text{lbs}\cdot\text{L/MG}\cdot\text{mg}\} \times Q,\{\text{MGD}\} \times \text{conc},\{\text{mg/L}\}$$

   b. Determine microorganism population in pounds.
      i. A wastewater treatment tank has a volume of 3.0 (MG) million gallons and has a solids concentration of 2500 mg/l (parts per million) which is 81% volatile (microorganisms).

Bacteria under Aeration (lbs) = 8.34 (lbs*L/MG*mg) x Vol,(MG) x Conc. (mg/l) x Volatile %

   c. Comparing pounds of wastewater contamination (bacteria food) to pounds of bacteria in the treatment system what is the Food to Microorganism Ratio?

$$F/M = \frac{\text{CBOD applied}}{\text{Organic solids under aeration}}$$

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VIDEO

"The Great Shake" Contextualized Learning video

April 19, 2016

Levi Fuller, Operations Supervisor and Chief Plant Operator, Dublin San Ramon Services District

June 17, 2016

Details

File Type:

Author:

Organization:

Signatory:

Organizational Processes:

Tara McClinton, Wastewater Laboratory Technician, Napa Sanitation District

October 12, 2016

Andrew Jellison, Operator-in-Training, Napa Sanitation District

June 16, 2016

Sinzee Tran, Wastewater Treatment Operator 1, Dublin San Ramon Services District

May 26, 2016

Rodrigo Montanez, Lab Tech at Napa Sanitation District

October 12, 2016


Rodrigo Montanez, Lab Tech at Napa Sanitation District ...
EXIT
Rodrigo Montanez, Lab Technician
Napa Sanitation District
MORE VIDEOS
0:05 / 3:16
YouTube

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WORKSHEET

The Napa “Great Shake” Worksheet

Wastewater treatment plant operators have to make numerous calculations in order to make adjustments to treatment processes in order to produce well treated water that can be safely placed back into the environment. Two of those calculations are hydraulic detention time which is a measure of the average amount of time a volume of wastewater is in a treatment unit. Wastewater treatment plants use microorganisms in the treatment process. These microorganisms consume contaminants in the wastewater using that contamination as their food source. Operators most insure that there is the proper amount of microorganisms to remove the contaminants in the incoming wastewater. Therefore, wastewater operators must calculate the food to microorganism (F/M) ratio. F/M ratio is a calculation that compares pounds of contamination in volume of wastewater to the pounds of microorganisms in a wastewater treatment tank that are available to consume and remove that contamination.

The City of Napa Wastewater Treatment Plant operates well with a determined hydraulic detention time and organic loading rate (Food/Microorganism Ratio). As a result of the Napa Earthquake staff estimates that approximately 360,000 gallons of wine spilled and made its way into the wastewater treatment plant. This 360,000 gallons increased both the detention and organic loading (Food to Microorganisms ratio).

If we assume the following:

Normal Flow: 6 million gallons per day

Normal Flow BOD: 250 mg/l

Aeration Total Volume: 3 million gallons

Aeration Mixed Liquor Suspended Solids: 2500 mg/l

Volatile Content: 81% (% of material in the treatment unit that is organic. i.e. bacteria)

Normal Detention Time: 4.5 hours

Normal Food/Microorganism Ratio: 0.24

Refer to the warm-up exercise where the normal detention time and food to microorganism ratio was determined for the City of Napa's Wastewater Treatment Plant. August 24, 2014 the *South Napa Earthquake* resulted in a spill of 360,000 of wine making its wat into the City of Napa's sewer and eventually that wine along with the normal wastewater flowed into the Napa Wastewater Treatment Plant.

If 360,000 gallons of wine with a BOD content of 11,500 mg/l flows into the treatment plant along with the normal wastewater flow:

1. What is the impact on treatment detention time in the aeration system? Normal Range is 4 to 8 hours.

2. What do you think the operator may have to do in order to adapt to this change?

3. What is the impact on treatment food to microorganism ratio? Normal Range is 0.2 to 0.5.

4. What do you suspect the operators at Napa needed to do in order to adapt to this change in food to microorganism ratio?

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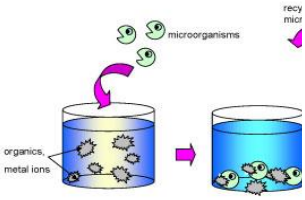
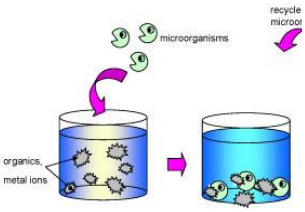
EXIT TICKET

Exit Ticket



1. What is the importance of detention time in a treatment tank?
2. What is the significance or meaning of organic loading in a biological treatment process like one might find in a wastewater treatment plant?
3. What is food to microorganism ratio?
4. Why is food to microorganism ratio important?
5. How could a spill of wine impact the biological treatment process like one might find in a wastewater treatment plant?

Exit Ticket



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STUDENTS FEEDBACK FORM

Feedback Form for Students (Online)

Go here for the Online Version of Feedback Form:
https://goo.gl/forms/3vSjzMuzFDuxY1y73

Feedback Form for Students

Please rate each of the following aspects of this lesson:

	Excellent	Very Good	Good	Fair	Poor	Very Poor
1. Video						
2. Lesson Presentation						
3. Worksheet						
4. Time Allotted						

5. What aspect or part of this lesson do you believe was the most effective at helping you reach the learning goal?

6. Where would you have wanted more training or help on this?

7. Did this curriculum increase your awareness of the water/wastewater industry?

8. Additional Comments/Suggestions: