First Steps to Treating Surface Water

Subject Area(s) **Environmental Science, Chemistry**

Associated Unit **Drinking Water Treatment Process**

Associated Lesson **Drinking Water Treatment: Coagulation, Flocculation and Sedimentation**

Activity Title **First Steps to Treating Surface Water**

Header

Image 1

Image file: water_droplet_Activity1.jpg

ADA Description: Water droplet falls into a pool of water creating ripples.

Caption: Water must be treated before it can be considered safe to drink.

Grade Level 10 (9-12)

Activity Dependency

Lessons:

- Introduction into Drinking Water Treatment

Activities:

- The Clean-up Crew: Filtration

Time Required 1 day

Group Size 2-3 students

Expendable Cost per Group

Cost will depend on material availability. If groups are responsible for supplying materials the cost is approximately 5 dollars per group.

Summary

In this activity, students observe how coagulation works by adding Alum powder to a sample of bayou water. After vigorously shaking the solution of Alum Powder and water for approximately two minutes the students simulate flocculation by gently agitating the solution for the next 10-15 minutes. The students allow their mixture to sit still in the classroom overnight to allow sedimentation to occur. Participation in this activity gives each student tangible, hands on experience observing and learning about each of the first three steps of the conventional drinking water treatment process; coagulation, flocculation, and sedimentation.

Engineering Connection

The current technologies and methods used to provide clean drinking water is a testimony to many years of research and exploration by scientist and engineers. In this activity students repeat the same procedures designed by engineers to treat drinking water in large scale facilities on a small scale. They have the opportunity to use their knowledge of chemistry and interactions between different substances to produce viable solutions for treating water for

drinking. Additionally, engineering technologies that have been developed by engineers for the purpose of drinking water treatment are introduced and briefly discussed.

Engineering Category = #2
Choose the category that best describes this activity's amount/depth of engineering content:
1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords
coagulation, drinking water treatment, flocculation, sedimentation, surface water treatment

Educational Standards

National and State

Texas,science, 2009, Environmental Systems 5(B): Identify source, use, quality, management, and conservation of water.

Texas, science, 2009, Chemistry 10(F): Investigate factors that influence solubilities and rates of dissolution such as temperature, agitation, and surface area.

ITEEA Educational Standard(s)

ITEEA, Standard 9, Grades 9-12, K. A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

ITEEA, Standard 15, Grades 9-12, M. Conservation is the process of controlling soil erosion, reducing sediment in waterways, conserving water, and improving water quality.

Pre-Requisite Knowledge

Learning Objectives

After this activity, students should be able to:
- Identify the sources of our drinking water.
- Explain the drinking water treatment process from source to sedimentation.
- Describe factors that affect the rate of interaction between the coagulant and dissolved particles during flocculation.
- Evaluate the effectiveness and importance of the conventional drinking water treatment process.

Materials List

Each group needs:
- Masking tape
- Marker/Pen
- 2-Liter Bottle w/ cap
- 1.5 Liter's Bayou water or water with a high turbidity
- 1/8 tsp. Alum
- pH test strip
- Safety Equipment: Goggles, Apron (optional)
- Notes and Activity Guide (attached)

Teacher needs:
- 1 Balloon
- Measuring spoon (1/8 teaspoon) for the Alum

- Container that can hold and dispense 1.5 liters of test water to each group (groups of 2-3)
- Spetrometer (for measuring turbidity)
- Kim wipes
- Spectrometer Test Tubes

Introduction / Motivation

(Have Drinking Water Treatment Process PowerPoint Presentation ready: Start at slide 18- Drinking Water Treatment Processes: Coagulation, Flocculation, and Sedimentation)

(Teacher holds up a bottle of the un-treated bayou water) Who thinks it would be safe to drink this water? What observations lead you to decide if it was safe to drink the water in the bottle? Have you ever given any thought to where the clean, drinkable water that flows from your tap originates? Does it look anything like this water? In truth, the water that readily pours from your tap could look identical to the water in this bottle but it is not clean, clear and safe to drink until it goes through a treatment process. There are many water treatment plants around the world which purify millions of gallons of water a day from lakes, rivers, and reservoirs to be used for drinking and other purposes.

How can these treatment plants take dirty water and make it safe enough to drink? Scientists and engineers have developed a method for treating water that we will call the conventional drinking water treatment process because it's the most common and widely accepted process. It consists of six main steps: coagulation, flocculation, sedimentation, filtration, disinfection, and finally storage. In today's activity we will be focusing on the first three steps of the process.

(Teacher follows the Drinking Water Treatment Process PowerPoint to introduce the first three stages of water treatment and the activity procedure.)

What is static electricity? (Teacher statically charges a balloon and sticks it to the wall) What does this have to do with water treatment? The first stage of water treatment is called coagulation in which a chemical is added to destabilize the particles in water. Water particles naturally have a negative charge which creates a repulsive force between them. If Aluminum or Iron is introduced the repulsive forces between particles is eliminated and they stick together; much like the balloon sticks to the wall. After coagulation the water is slowly mixed to allow for flocculation. Flocculation is the second stage of the treatment process and is designed to maximize collisions between the destabilized particles to form flocs or clumps of particles. The water will spend about 30 minutes to an hour in the flocculation basin before it is moved along to the third stage of the treatment process known as sedimentation. During sedimentation the water is slowed down to allow the flocs to settle to the bottom before the supernatant is passed on to the filtration, disinfection, and storage stages. By the end of today's activity we will be able to repeat and explain the purpose of each of the first three stages of the drinking water treatment process.

Vocabulary / Definitions

Word	Definition

coagulation	adding chemical agents to destabilize the particles in water
flocs	groups of particles that collide and stick together during flocculation
flocculation	mixing the water to allow the particles to collide and form flocs
sedimentation	keep the water calm and allow the flocs to settle to the bottom
turbidity	measure of the amount of light scattering particles in solution

Procedure

Before the Activity

- Gather bayou water or water from a source with high turbidity
- Make sure the water is easily transferrable from the storage container to 2-Liter bottle during the activity
- Gather all other materials: balloon, 2-Liter bottles w/ cap, Alum Powder, measuring spoon, markers, masking tape, spectrometer, kim wipes, pH test strips, and spectrometer tubes.
- Make copies of the Drinking Water Treatment Notes and Activity Guide (one per person)

With the Students

1. Teacher starts with challenge question: Who thinks it would be safe to drink this water?
2. Teacher presents the section of the PowerPoint entitled Drinking Water Treatment Processes: Coagulation, Flocculation, and Sedimentation – Slides 18 to 30.
   - Student's complete fill - in notes (Notes and Activity Guide WKS) as teacher presents (20 min).
3. Teacher explains how the spectrometer works and tests a sample of the untreated water. (Depending on the number of spectrometers and time available, it is best for the teacher to operate the spectrometer).
4. Teacher divides the class into groups of 2-3 (material availability may determine group size)
5. Students record the transmittance.
6. Teacher advances PowerPoint to slide 31.
7. Students follow directions on slide 31 and record observations on the Notes and Activity Guide.
8. Teacher continues advancing the slides and students continue to follow step-by-step instructions. Stop at slide 34.
9. Make sure students labeled their water sample and put their bottles in the pre-designated area as well as return all safety equipment.

Figure 1

Image file: unsafe_drinking_water_Activity1.jpg

ADA Description: A young girl holding a bottle of unsafe, untreated water.

Source/Rights: By © Pierre Holtz - UNICEF, hdptcar from Bangui, Central African Republic (Unsafe drinking water 04) [CC-BY-SA-2.0 (http://creativecommons.org/licenses/by-sa/2.0)], via Wikimedia Commons

Url:http://commons.wikimedia.org/wiki/File:Unsafe_drinking_water_04.jpg

Caption: Why is drinking water treatment so important? Water that is untreated, like the water in the picture, can contain multiple contaminants from many different sources.

Attachments

Lesson2_guided_notes_and_Activity1.docx

Safety Issues

- Make sure students do not drink the water. At no point in the activity will the water be clean enough to safely drink.
- Water spills on the floor can create slipping hazard.
- Goggles and Apron are recommended.

Troubleshooting Tips

Investigating Questions

Assessment

Pre-Activity Assessment

Brainstorming: Challenge Question: Who thinks it would be safe to drink this water?

- The challenge question can first be open for class discussion but allow the students to discuss their answers to the class with more detail in their small groups.

Activity Embedded Assessment

Lab Notation: As the students participate in the activity they should be recording every step of the procedure with enough detail that it can be reproducible by another scientist.

- Students should record enough detail and accuracy in their lab documentation to submit a lab write-up at the end of the activity.

Lab Write-up: This activity and assessment corresponds to the TeachEngineering Activity titled: The Clean-up Crew: Filtration. This lab write-up assessment can be completed separately or in conjunction with The Clean-up Crew: Filtration Activity but the student's methodology section should reflect both activities if completed in conjunction with each other. Following the activity the students will be asked to create an official lab write up including a background, methodology, and conclusion section.

Write up Requirements:

General Requirements:

- Each section of the paper needs to be at least one paragraph in length (Each paragraph should be minimum 5 sentences).
- Grammar and spelling should be correct.
- Typed or hand written in pen.
- (Optional) No use of personal pronouns.

Background Suggestions:

- What percentage of Earth's water is usable for drinking water treatment and where does it come from?
- What are the pros and cons of using ground and surface water?
- What are the main types of water contaminants?
- What are some different techniques engineers and scientists have developed for treating water?
- Why is water treatment important?

Methodology Suggestions:

- Use vocabulary when describing each step of the water treatment process.
- Include enough detail in each step of the procedure so that the reader could repeat the each step of the experiment exactly as the original.

Conclusion Suggestions:

- Restate the hypothesis and describe whether or not it was supported or refuted.
- Discuss results (transmittance after completion of water treatment activity) and any limitations or successes that led to the irregular or expected outcome.

Post-Activity Assessment

Summative Assessment: Following the completion of the TeachEngineering Unit: Drinking Water Treatment Processes the students will be given the attached summative assessment, Drinking Water Treatment Quiz.

Activity Extensions

Activity Scaling

- For lower grades, ___?
- For upper grades, ___?

Additional Multimedia Support

References

Other

Redirect URL

Contributors

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Acknowledgements

Classroom Testing Information

The testing for this curriculum was conducted individually on a paper test at the end of the unit. The test was given in May at Galena Park High School to 183 juniors and seniors.

Name:_____ Date:_____ Per:____

Drinking Water Treatment Processes: Part 2

Conventional Drinking Water Process

-(1.)_____ - Adding chemicals to destabilize the particles in water.
-(2.)_____ - Mixing the water to allow the particles to collide and form flocs.
-(3.)_____ - Keep the water calm and allow the flocs to settle on the bottom.
-(4.)_____ -Remove the remaining _____ by passing the water through a _____.
-(5.)_____ - Adding a chemical agent (_____) that kills any remaining microorganisms.

Filtration

What are filters made of?

-Filters are most often made of _____ and possibly a _____.
-The size of the sand is designed to create _____.
-_____ are removed throughout the media filter and not just the _____.
-The _____ in the filters is called _____.

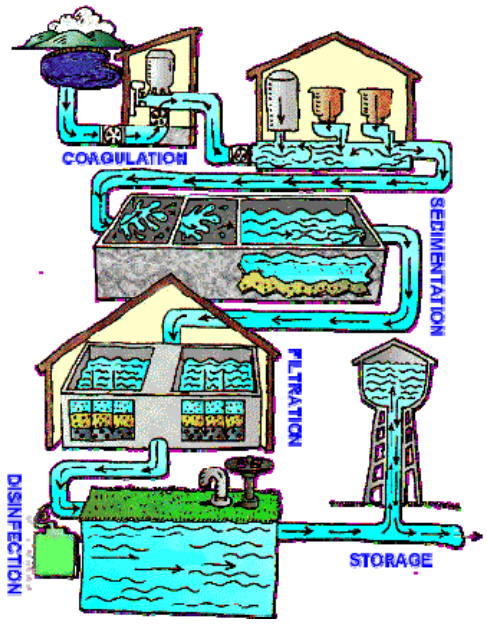
Three Mechanisms of Floc Removal

-The three mechanisms of floc removal are _____, _____, _____.

Stages of Filtration

-(1.)_____ - Filter-to-waste:_____.
-(2.)_____ - Optimum floc removal:_____.
-(3.)_____ - Cleaning the filter media:_____.

Conventional Drinking Water Process (Review)



Identify and describe each step in the process:

1. _____
   _____
   _____
2. _____
   _____
   _____
3. _____
   _____
   _____
4. _____
   _____
   _____
5. _____
   _____
   _____

Name:_____ Date:_____ Per:____

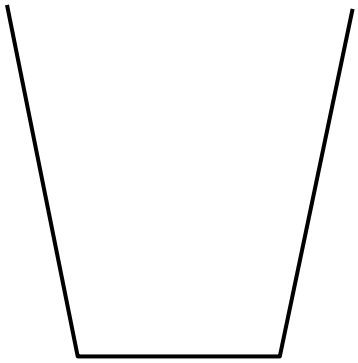
Drinking Water Treatment Lab (Cont).

Materials:

1. Sand
2. Activated Carbon
3. Small pebbles
4. 1 Filtration Cup
5. 1 Collection Cup
6. Treated Bayou Water
7. Catchment Container

Day 2: Filtration

1. Discuss as a group how you want to design your filter
2. Draw a diagram of your filter with the different types of media labeled



Lab Procedure:

1. Follow the instructions on the board for building your filter.
2. Make a few observations of your water sample before filtration and after filtration.

Before Filtration: After Filtration:

Notes:

Conclusion:

1. Write a paragraph (5 sentences min.) to report the results of your experiment.
   - -Make sure to restate your hypothesis and explain whether it was supported or refuted.
   - -Report results of the experiment showing evidence to support or refute hypothesis.
     - -Use observations you made before and after treatment and transmittance results.
   - -What worked well and what needs to be changed for the next experiment?