# Water Treatment

Driving Question

* What are some processes used in water treatment, and what contaminants are they effective in removing from water?

Materials and Equipment

|  |  |
| --- | --- |
| * Turbidity sensor
 | * Soda bottle, empty, 500-mL
 |
| * Water quality sensor
 | * Water, 500 mL
 |
| * Conductivity sensor w/3 cuvettes
* Test tube, 18-mm × 150-mm
 | * Wash bottle containing water
* Wastewater" sample, 500 mL
 |
| * Beaker (4), 150-mL
* Beaker (5), 50-mL
* Activated charcoal, 2 g
* Paper napkins (9), dinner, white, smooth
* Lint-free lab tissue
 | * Waste container
* Buffer solution pH 4, 25 mL
* Buffer solution pH 10, 25 mL
* Paper napkins (9), dinner, white, smooth
* Stirring rod
 |
| * Wastewater" sample, 500 mL
 |  |

Background

Water treatment concerns facing Agriculture are complex due to many demands for irrigation, higher standards for water quality, more governmental regulations and declining access. Water sources for the industry include, ground and surface water, treated water from cities and industry. Major issues such as wastewater storage on swine and diaries as well as vegetable/fruit wastewater recycling are being carefully analyzed. Wastewater management is key in being success in today’s Agriculture operations. Treatment technologies that are used in the Agricultural industry are: filtration, biological treatment, aeration, mixing, reverse osmosis and disinfection.

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

* Wear safety goggles at all times for all wet labs.

Procedure

1. Pour 100 mL of the a well stirred "wastewater" sample into each of four 150-mL beakers.

2. Label the beakers as follows:

* Beaker 1 “Untreated”
* Beaker 2 “Activated Charcoal”
* Beaker 3 “Sedimentation”
* Beaker 4 “Agglutination”
* 3. Set the beaker labeled “Sedimentation” aside for approximately 30 minutes. Why is it important to ensure that the beaker labeled “Sedimentation” is not touched or moved during these 30 minutes?
* 4. Put 2 mL of the 4% swimming pool clarifier solution in the beaker labeled “Agglutination" and use the stirring rod to thoroughly mix the pool clarifier into the wastewater.
* 5. Predict whether or not each water treatment method will cause a change in the perimeters of the wastewater. Use words such as increase, decrease, lighter, darker, clearer, cloudier, stronger smell or less odor. Record your predictions in Table 1.

Table 1 : Predictions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water treatment method | pH | Conductivity | Turbidity | Odor | Appearance(color, transparency) |
| Filtration |  |  |  |  |  |
| Activated charcoal filtration |  |  |  |  |  |
| Agglutination |  |  |  |  |  |
| Agglutination followed by filtration |  |  |  |  |  |
| Sedimentation |  |  |  |  |  |

6. Make a filter as follows:

 a. Cut off the top half of a 500-mL soda bottle to use as a funnel.

 b. Fold a paper towel in half, and then fold it in half again. Separate the layers to make a funnel-shaped filter.

 c. Stack 3 paper napkins together and shape them into a shallow bowl. Tuck these into the paper funnel and push the entire membrane construction into the funnel, forming a bowl to hold the filtrate.

7. Open the Water Treatment lab form the experiments menu in the SPARKvue.

8. Connect to the turbidity sensor with interface and water quality sensors with interface.

8. Calibrate all the sensors using the directions that came with the equipment or go to <https://www.youtube.com/user/pascoscientific> to view calibration methods.

10. Set the range of the conductivity on the air link enabled water quality sensor to its lowest setting (0 to 1,000 µS/cm) by pressing the green button.

Table 2: Water treatment process results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water treatment type | pH | Conductivity(µS/cm) | Turbidity(NTU) | Odor | Appearance(color, transparency, other observations) |
| Untreated "wastewater" |  |  |  |  |  |

11. Examine the beaker labeled “untreated” and record its odor, color and general appearance in Table 2.

12. Place the pH and conductivity sensors in the wastewater labeled “Untreated” and allow the readings to stabilize and then record the values in Table 2. Remove the sensors from the sample and thoroughly clean them with distilled water.

13. To determine the turbidity of the wastewater read the instructions that are inside of the turbidity box or see the demonstration, <https://www.youtube.com/watch?v=BAyY0UrJrLI> . Record the turbidity in Table 2. What is turbidity?

Table 3: Water treatment process results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water treatment type | pH | Conductivity(µS/cm) | Turbidity(NTU) | Odor | Appearance(color, transparency, other observations) |
| Filtration |  |  |  |  |  |

14. Test the effect of filtration on the untreated wastewater sample.

 a. Arrange the filter you created earlier over a 50-mL beaker

 b. Pour 10 mL of the wastewater from the beaker labeled “Untreated” into the filter, inside the paper napkin "bowl".

 c. Filter the wastewater until you have 15 to 20 mL of filtrate in the 50-mL beaker.

15. Record the odor, color and general appearance in Table 3.

16. Transfer the filtrate into the test tube and determine the pH and conductivity of the filtrate and record in Table 3. Use an aliquot (sample portion) of the filtrate to record the turbidity and record the data in Table 3.

17. Discard the paper towels and napkins from the filter and clean the bottle so that another filter can be made. Clean the beaker, test tube and sensors by thoroughly rinsing them with distilled water.

Table 4: Water treatment process results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water treatment type | pH | Conductivity(µS/cm) | Turbidity(NTU) | Odor | Appearance(color, transparency, other observations) |
| Activated charcoal filtration |  |  |  |  |  |

18. Make another filter as described in step 6.

 a. Measure and add 1 gram of activated charcoal to 100mL of water and stir.

 b. Pour this slurry into the filter.

 c. After that slurry has drained, slowly pour another 100mL of water into the filter.

 d. The paper filter should be coated with a layer of activated charcoal. If the water is not clear add 100ml of water.

19. Arrange the activated charcoal filter over a 50mL beaker.

 a. Pour 10 mL of wastewater into the beaker labeled “Activated Charcoal” into the filter paper napkin bowl.

 b. Filter the waste water until you have 30mL of filtrate in the 50mL beaker.

 c. Pour the wastewater from the “Activated Charcoal” beaker into the filter in 10 mL portions stop at 20mL.

20. Determine the odor, color, and general appearance of the activated charcoal filtrate, and record these in Table 4.

21. Transfer the activated charcoal filtrate to the test tube. Determine the pH and conductivity of the activated charcoal filtrate and record them in Table 4.

22. Use an aliquot of this filtrate to determine the turbidity and record in Table 4. See the instructions given in the Untreated Wastewater section if you need to review the process. What effects did adding activated charcoal to membrane filtration have on the results of the filtration?

Table 5: Water treatment process results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water treatment type | pH | Conductivity(µS/cm) | Turbidity(NTU) | Odor | Appearance(color, transparency, other observations) |
| Agglutination |  |  |  |  |  |
| Agglutination followed by filtration |  |  |  |  |  |

23. Test the effect of agglutination by returning to the beaker labeled “Agglutination” that you have been stirring over the last 30 minutes. Determine the odor, color, and general appearance of this water, and record these observations in Table 5.

24. Determine the pH and conductivity of this water and record them in Table 5.

25. Use an aliquot of the water in the beaker labeled “Agglutination” to determine the turbidity and record in Table 5

26. Make another paper membrane filter as described in the Set Up. Follow the directions in step 19 to complete the new filter using the beaker labeled “Agglutination”.

27. Determine the odor, color, and general appearance of the agglutination filtrate, and record these in Table 5. Transfer the agglutination filtrate to the test tube.

28. Determine the pH and conductivity of the agglutination filtrate and record them in Table 5.

29. Use an aliquot of this filtrate to determine the turbidity and record it in Table5. See the instructions given in the Untreated Wastewater section if you need to review the process. Clean the beaker, test tube, and sensors by thoroughly rinsing them with water.

Table 6: Water treatment process results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water treatment type | pH | Conductivity(µS/cm) | Turbidity(NTU) | Odor | Appearance(color, transparency, other observations) |
| Sedimentation |  |  |  |  |  |

30. Test the effect of sedimentation by returning to the beaker labeled “Sedimentation” that has sat undisturbed for approximately 30 minutes.

31. Use a pipette to transfer a 30-mL sample from the top of the beaker into the test tube, being careful not to disturb the sediment.

32. Determine the odor, color, and general appearance of the water in the test tube, and record these observations in Table 6.

33. Determine the pH and conductivity of this water and record them in Table 6..

 34. Use an aliquot of the water in the test tube to determine the turbidity and record it in Table 6. See the instructions given in the Untreated Wastewater section if you need to review the process.

Table 7: Designed water treatment system results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water Treatment Data Set | pH | Conductivity(µS/cm) | Turbidity(NTU) | Odor | Appearance(color, transparency, other observations) |
| My Designed Treatment System |  |  |  |  |  |

35. Design a filter that will treat the wastewater using two or more of the techniques that you have tested and collect data to compare them with other filters your classmates have assembled. Record the data in table 7.

* **Analysis**

Compare the data obtained from your designed water treatment system with the data collected in Part One by filling in “My Designed Treatment System” data and the "Best Individual Test System" in Table 4. Share the data with your classmates. Use Table 4.

Table 4: Designed water treatment system results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water Treatment Data Set | pH | Conductivity(µS/cm) | Turbidity(NTU) | Odor | Appearance(Color, Transparency, Other Observations) |
| My Designed Treatment System |  |  |  |  |  |
| Best Individual Test System (from Part One)  |  |  |  |  |  |
| Best Designed System in the Class  |  |  |  |  |  |

* **Questions**
1. What was the effect of filtration using a simple paper filter?
2. What was the effect of treatment with the activated charcoal filter?
3. What was the effect of treatment with an agglutinating agent? What was the effect of agglutination followed by filtration?
4. What was the effect of treatment with sedimentation?
5. Which treatment method worked best for odors?
6. Which treatment method worked best for lowering turbidity? Which was least effective?
7. What was the effect of treatment on pH?
8. Compare the results obtained with your custom-designed filtration process to those from the individual filter media. Be sure to make comparisons regarding the rate of filtration. (Why might this be important?)
9. Based on your results and those of your classmates, which combination of treatment processes produced the best results? Explain, using your data to support.
10. Suppose you had to design a system to treat for human consumption a large amount of the type of wastewater used in this activity. What treatment methods would you include? Explain.?