Centrifugal Separation & Chemical Analysis

A Science Paper Presented By:
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April 2007
Abstract

Water is essential for life. Humans play a large role in the quality of water available. The purpose of the project was to determine if there was more sediment and dissolved oxygen, before or after a water treatment plant. Water treatment plants have the duty to return quality water for environments down stream.

A Hanna test kit was used to determine the oxygen concentrations. A centrifuge was used to separate the water and sediment. The mass of the sediment for each sample was obtained with digital balance with a sensitivity of ± 0.000 grams. The results revealed that there were larger amounts of sediment and dissolved oxygen before the water treatment plant.

The hypothesis was accepted. A statistical analysis of unpaired $t$ tests showed $p < 0.0001$ for all comparisons.
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Statement of the Problem:

Do different locations along the Missouri River affect the amount of sediment (grams) and dissolved oxygen (ppm) in water samples collected before and after the local water treatment plant?

Purpose of the Study:

Water is essential for life. Humans play a role in the quality of water that is available. The purpose of this project is to determine if a water treatment plant changes the amount of sediment and dissolved oxygen in the water before it is returned to the environment and available to those living downstream. The idea for this project came from the book, 100 Award Winning Science Projects. The information in this project may possibly help the community, as well as others.

Review of Literature:

Understanding the basic materials that may exist in freshwater and studying the sources from which these particles are placed in the water helps humans become more educated in maintaining the availability of freshwater. Water is essential for life. Numerous people monitor the freshwater available on a daily basis. This is a crucial task and very important to human health.

Centrifugal Separation is an important process used to separate a solid or a particulate from the liquid itself by rotating them in a tube in a horizontal circle. As the dense particles move along the length of the tube to a greater radius of rotation, they displace the lighter particles to the other end. This is done by a machine called a centrifuge. The centrifuge forces the particulates from a suspension according to density (www.ktf-split.com, 2004-05).
A centrifuge can separate anything from milk or juice, to lake or river water. The reason it separates river water is so we can see how much sediment is in the water. To reduce the amount of sediment and bacteria in the water, water treatment plants filter them out. The process includes coagulation, sedimentation, filtration, disinfection, and then storage (www.mayfieldews.com, 2000). All of these steps have a very important role in the process of filtering water. Water treatment plants also add in chloramines to kill any leftover bacteria.

Of course there are different ways to treat and clean water. The most popular and most efficient way to do it is by filtering it. The filters remove the impurities in the water by filtering them out and capturing them before the water is used. The other way is called reverse osmosis technology. It is quite an advanced way to treat water because unlike the filtering process, the water is treated at the molecular level. Reverse osmosis uses the water treatment equipment; too, so let it will be true that all impurities in the water are removed also. This includes microorganisms, excessive salts and other things left behind by chemical and disinfection products as well (www.Water-Treatment-Equipment.com, 2006).

Bacteria are one-celled organisms that are so small that they cannot be seen with the human eye. They are separated into three different groups, round or spherical, rod shaped, and spirally curved. They reproduce by splitting into two bacteria and then each cell grows then splits into two daughter cells. This is called simple fission (The World Book Encyclopedia, 17). They are often associated to the causes of human and animal diseases. The average life span of any type of bacteria is usually a few minutes to a few
hours long. The bacteria survive by inhabiting an environment favorable to its need like any other organism (Bacteria, 2004).

A watershed is an area of land where all of the water drains to a central location. For example, the Missouri River watershed contains more sediment than any other river shed because all of the rivers up North draining down and eventually flowing out of the Gulf of Mexico. Soil is the number one pollutant in the water, then nitrate, followed by Atrazine. In the spring when crops are planted, there is always a higher level of sediment in the water because planting stirs up the dust and the dirt. Nitrate is a chemical from fertilizer or animal/human wastes that can cause a disease called Methemoglobinemia or “Blue Baby Syndrome”. They call it “Blue Baby Syndrome” because it reduces the ability of the blood to carry oxygen of some babies if the mother came in contact with it while pregnant. The baby’s face then turns blue because of lack of oxygen. Atrazine is a herbicide that is picked up by the flow of the water and is carried away.

Another important thing to look at in the water is the dissolved oxygen level. It tends to have a higher level in colder water than in warmer water (Maltsberger). Dissolved oxygen levels can be easily tested with reagents in a test kit. Dissolved oxygen is vital to many aquatic organisms.

Water is important to life. Maintaining quality freshwater will always be an issue of discussion and concern. Numerous people work daily to monitor and maintain quality water. Everyday we turn on faucets and believe that they are doing their jobs and they are doing it well. However, humans often neglect to think about individual activities and choices that may be changing the water we so desperately need.
Hypotheses:

The null hypothesis is that there will be no difference when testing the amount of sediment and dissolved oxygen in the water before and then after the water treatment plant.

The alternative hypothesis is that there will be more sediment and dissolved oxygen in the water before water treatment plants than after them. Water treatment plants are supposed to filter out the sediment so that the water will be cleaner and safer for communities down stream.

Experimental Design:

Independent Variable- the collection site of water samples on the Missouri River

Dependent Variable- the amount of dissolved oxygen and sediment in the samples

Control Group- none defined, true comparison

Constants- same locations of water samples, same days of getting samples, same river, same depth of getting samples from, same day of testing, same centrifuge, same temperature of water, same amount of water in test tubes while experimenting

Retests- 20 retests with dissolved oxygen (10 at each location)
   20 retests with amount of sediment (10 at each location)

Quantitative Measure- amount of sediment (grams)
   dissolved oxygen (parts per million)

Materials Needed:

1 Dissolved Oxygen Kit- Hanna Instruments
1 Economy Water Sampler Kit- Science Kit and Boreal Laboratories
20 Test Tubes (10 standard size; 10- 15 ml.)
Pencil and Paper
2- 473.2 ml. water samples (samples collected before and after water treatment plant)
1 Centrifuge with conical tubes
2 plastic pipettes
1 stop watch/sports timer
1 digital scale (that weighs in grams)
Procedures:

Testing for Dissolved Oxygen: Basic Steps for Hanna Dissolved Oxygen Test Kit

1. Obtain water samples at location along the Missouri River before the water treatment plant and after the plant by completely submerging the container to create an overflow and then capping.
2. Obtain samples on the same day and test as soon as possible.
3. Invert the collection bottle before testing.
4. Add 5 drops of the number 1 reagent (from dissolved oxygen kit) to 15 milliliters of the water sample.
5. Add 5 drops of number 2 reagent.
6. Mix well.
7. Add 10 drops of number 3 reagent.
8. Pour 5 milliliters of solution into next vial.
9. Add 1 drop of number 4 reagent.
10. Use a syringe to obtain number 5 reagent to zero mark.
11. Add drops slowly with syringe till clear.
12. Take the amount added times 10 to obtain parts per million.
13. Repeat for 10 retests on samples before water treatment plant and 10 retests for samples obtained downstream from the plant.

Testing for Sediment:

1. Plug in centrifuge.
2. Clean all test tubes (rinse and dry).
3. Mass the empty tubes and record according to number.
4. Invert collection bottle several times.
5. Add samples to the test tubes to balance the centrifuge machine.
6. Centrifuge for 10 minutes.
7. Remove all water from the top of the tubes and mass again to obtain the sediment remaining.
8. Repeat to obtain 10 retests for each location.
Discussion of the Data:

Data Table of the Amount of Dissolved Oxygen (ppm) & Sediment (grams) Before And After a Water Treatment Plant Along the Missouri River

<table>
<thead>
<tr>
<th>Retests</th>
<th>Sediment Before (g)</th>
<th>Sediment After (g)</th>
<th>Dissolved Oxygen Before (ppm)</th>
<th>Dissolved Oxygen After (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.030</td>
<td>.007</td>
<td>3.5</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>.031</td>
<td>.001</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>3</td>
<td>.034</td>
<td>.008</td>
<td>3.0</td>
<td>1.0</td>
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<tr>
<td>4</td>
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<td>3.0</td>
<td>1.0</td>
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<td>5</td>
<td>.049</td>
<td>.003</td>
<td>3.5</td>
<td>1.5</td>
</tr>
<tr>
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<td>.066</td>
<td>.004</td>
<td>4.0</td>
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<td>.004</td>
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<td>.007</td>
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<td>.008</td>
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<td>1.0</td>
</tr>
<tr>
<td>Mean</td>
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<td>.005</td>
<td>3.05</td>
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<td>Median</td>
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<td>.0045</td>
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</tr>
<tr>
<td>Mode</td>
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<td>.007, .004</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>.0169</td>
<td>.00254</td>
<td>.75</td>
<td>.35</td>
</tr>
</tbody>
</table>

Results & Observations:

There were 40 test samples tested; 20 for samples before the water treatment plant and 20 after the plant. Ten retests for the water collected before the treatment plant were tested for grams of sediment and ten retests were completed for dissolved oxygen. Likewise, the same number and type of retests were completed for the water collected downstream for the treatment plant. The ten that were tested from water samples collected before the water treatment plant, for dissolved oxygen, had a mean of 3.05 ppm, while the samples collected after the treatment had a mean of 1.25 ppm. The mean sediment in grams for the samples collected before the treatment plant was 0.044 and the
mean sediment for the samples after the plant was 0.005 grams for the 15 millimeter of water tested for each. It was observed that the water collected before the treatment plant was murkier in appearance.

Graphs:

Graph 1: Scatter Graph for Sediment

Graph 2: Scatter Graph for Dissolved Oxygen
The null hypothesis is that there would be no difference when testing the level of sediment and dissolved oxygen for water samples collected before and after a water treatment plant. The alternative hypothesis is that there would be more sediment and dissolved oxygen in the water samples collected before the water treatment plant. The hypothesis is accepted, because there was a greater amount of sediment and dissolved oxygen for the samples collected before the water treatment plant as compared to the other group. A statistical analysis of unpaired $t$ tests showed $p<0.0001$ for both test comparisons. This is very important to know, because water treatment plants are supposed to help maintain healthy water for the communities downstream.
Future Study and Application:

To continue the project one could:

1. Test different rivers.
2. Test areas near and far from cities.
3. Test to determine the type of bacteria present.

This is very important to understanding the quality of freshwater available. Water is crucial to life! Water treatment plants and the people that are responsible for maintaining quality water have great responsibilities. Also, the general public needs to be informed and educated concerning methods to sustain quality drinking water.

Acknowledgements:

I would, first of all, like to thank Mrs. Freeman for all of her help and knowledge. I could not have completed this project without her. I would also like to thank my parents for being there for me, and answering any questions I had throughout the whole project. They also helped me get my water samples and let me use a lot of ink and paper. The last person I would like to thank is Beverly Maltsberger for sharing her time during a very educational interview. Thank You!!!!!!

Literature Cited:


www.ktf-split.hr/glossary/image/centrifuge.com.


Maltsberger, Beverly. Personal Interview. 18 September, 2006.
