The Effects of Filtration on Pond Water

By: Carter J. Alves, 6th Grade
Zionsville Middle School

Question

How well do different filter materials remove contaminants from pond water?

Hypothesis

If I run pond water through carbon and sand filters, I think the carbon filter will remove the most contaminants because I know that home water purification systems often use carbon filtration.

Abstract

- **2.1 Billion people globally do not have access to clean drinking water, that is 26% of the world population.**
- This experiment was done to find effective ways to purify water with simple materials that are easily obtainable.
- In this experiment I created homemade filters using simple materials (carbon vs sand).
- I used a spectrophotometer to visualize the contaminants in the water that would be harmful to drink.
- In total, the carbon filter had less contaminants in the water than the sand filter, and the absorbance followed a trend similar to high purity reverse osmosis water and ultra-pure lab-grade water.

Variables

Independent

- Filter medium material

Dependent

- Electric conductivity (EC)
- Total dissolved solids (TDS)
- Potential of Hydrogen (pH)
- Spectral Absorbance (AU)
- Filter run time

Constants

- Filter hole size
- Amount of filter material
- Amount of water ran through
- Same filling technique
- Temperature of water
- Amount of water sample in the plate reader

Materials

Materials

- Jumbo cotton balls **(Unraveled, cut to 3cm squares)**
- 25x 50ml plastic conical tubes
- Positive displacement pipettor
- 180g (120mL) 125µm (120 US mesh) silica sand
- 76g (240mL) granular activated carbon
- Ring stand
- 0.0-13.0 pH test strips
- 6.0-8.0 pH test strips
- 3x medium bowls (for filter preparation)
- Bucket attached to pole (See fig. 3)
- Large bucket

Equipment

- Stopwatch
- Total Dissolved Solids (TDS) & Electric Conductivity (EC) meter
  - Measures total dissolved solids with a mathematical formula based on electric conductivity.
- Spectrophotometer (Microplate reader) (See fig. 5)
  - Measures spectral absorbance (200-800nm), which can show different contaminants because they absorb different wavelengths.

Procedures

1) Label 50mL conical tubes (2 runs per filter, 3 of each filter, 2 controls).
2) Drill one 7/64” (2.8mm) hole in the tip of both tubes.
3) Unravel and cut cotton balls to 3cm squares.
4) Soak cotton square in clean water and drop damp cotton square into the filter and press it into the tip with a long stick (e.g., straw).
5) Pour filter material into the tube (30mL sand, completely fill or 60mL carbon) Tap on a hard surface to pack the material.
6) Fill pipettor with 50mL pond water and put the filter in the ring stand with the corresponding collection tube below.
7) Start stopwatch and *gently* drop pond water into filter (it might not all go in at once, so keep it filled until all 50mL is inside). (See fig. 1)
8) When the filter is finished stop the stopwatch and do step seven, then discard material and rinse filter, repeat step 4-7 (three times per filter, with duplicates).
9) Run control filters (one of each filter, two runs per filter) with clean water the same way as steps 4-7 just with clean water.

Spectrophotometer

1) Prepare an empty clear bottom plate.
2) Put 300µL of each sample into the corresponding well. (See fig. 2)
3) Run the absorbance test from 200-800nm.

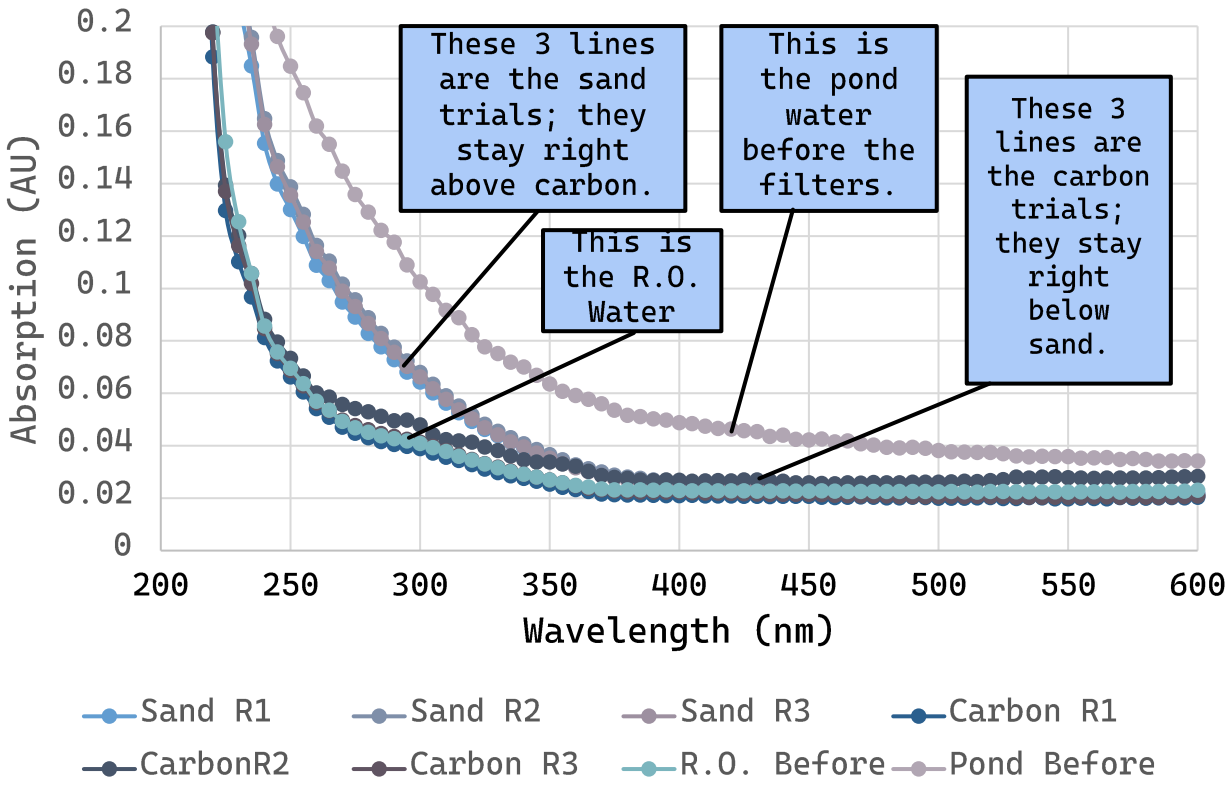
TDS, EC, pH

1) Fill a beaker with 30mL of the sample.
2) Dip TDS probe in and dunk pH strip, record data.

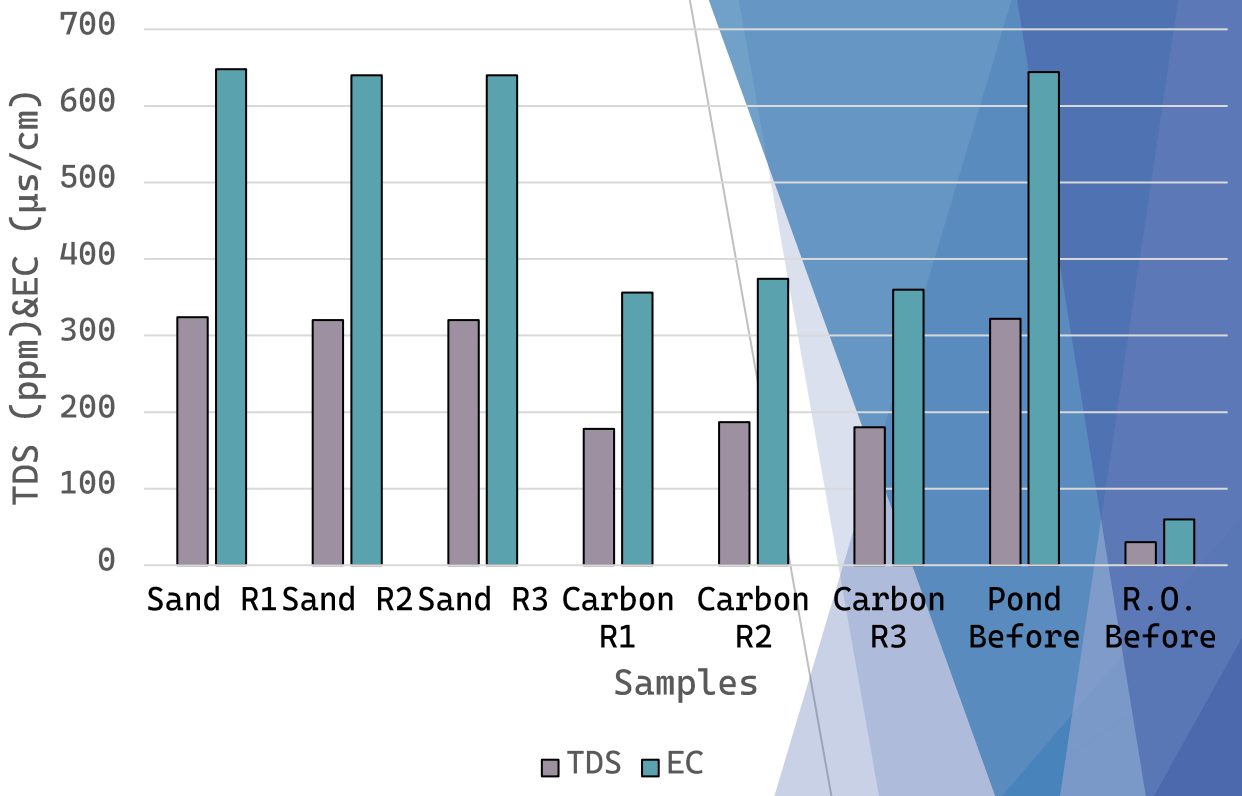
Conclusion

- In conclusion, I learned that different filter types absolutely influences the effectiveness and quality of filtration.
- In this case the carbon filter always removed more contaminants than sand.
- The sand filter control had shown to add some sediment to the water and did not affect pH, and the carbon did not affect the amount of sediment but did raise the ph.
- If possible, carbon filters should be used to clean dirty water over sand.

Spectral Absorbance In Filtered Pond Water Samples



TDS & EC In Filtered Pond Water Samples



This graph shows that the carbon filters always stayed below sand this means that there is less contaminants in the water. All the lines follow a reverse-plateau trend as the lines converge. The “Pond Before” sample always was above all the other samples, meaning that both filters worked.

This graph shows that each run was very similar and concise. The sand runs were all higher than carbon in TDS and EC, the sand and pond samples were very similar, this means that the sand filter was not effective at lowering TDS. The carbon stayed in between sand and R.O. water.

Next Steps

In the future, there should be more research and experimentation on the topic of filtering dirty water for people in need.

This topic is a very real and very urgent problem that needs to be solved to help people in communities without clean water.

This experiment shows that homemade carbon filtration is possibly a viable option, but it needs to be tested further in fields like bacteria and parasites.

Photos

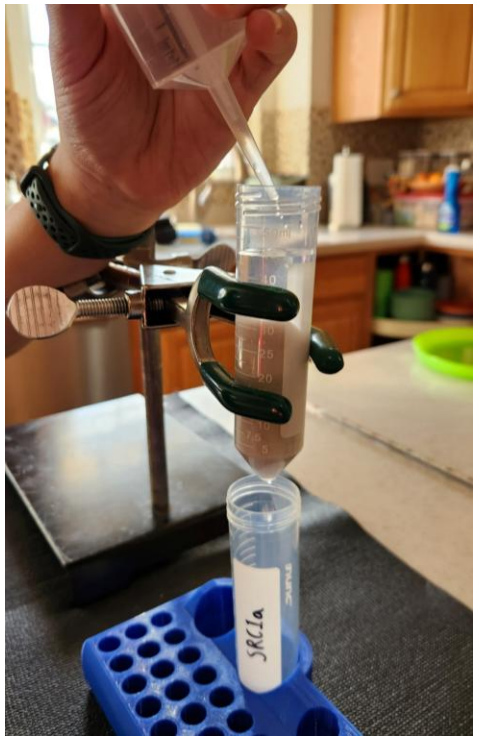


Fig. 1: Running the filters

Fig. 2: Filling the plate reader

Fig. 3: Collecting the pond water

Fig. 4: My setup for testing

Fig. 5: Running the spectrophotometer