April 2021

Water Filter Student Design Plan

Center for Urban Resilience

Name: _____ Date: _____ Class/Period:_____

Water Filter Design Plan

Filter Design Rules

1. Your team must come up with a team name
2. Your team's filter must produce a minimum of 200 ml of "potable" water
3. You must design, construct and produce the final quantity of water in the time limit of 2 classes
4. Your team must supply a detailed, labeled drawing of your filter
5. Your team may use some or all of the materials given, but cannot use anything not listed or any additional materials.
6. The water sample can be passed through the team's filter as many times as the team chooses.

Filter Material List

- One mortar and pestle
- One plastic pipette
- 250 ml graduated cylinder
- 250 ml of coarse sand
- 250 ml of fine sand
- 250 ml of activated charcoal
- 250 ml of "contaminated" water
- 1 foot of one inch PVC pipe
- 1 sq. foot of cheesecloth
- 2 small coffee filters
- 3 rubber bands
- 1 sq. foot of nylon netting
- 2 large cotton balls
- 2 iodine tablets or drops
- 1 funnel
- 1 storage container

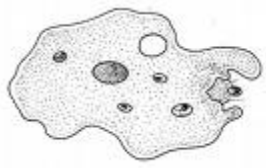
Water Tests

- Temperature (° Celsius)
- Turbidity
- pH
- Dissolved O_2
- Nitrates
- Phosphates
- Coliform Bacteria
- Biochemical Oxygen Demand (BOD)

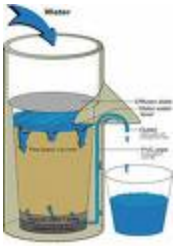
Water Treatment 411

Potable water is water that is fit for human consumption, also known as drinking water. Water, in its purest form, is naturally potable, but most likely the water that we have access to requires a multi-step water treatment to be considered safe for drinking. Wherever the source of the water is, the safety of water is decided by a series of tests that look for contamination. Your team has been given the task of learning all that you can about the treatment of water in an effort to produce drinkable water by creating a point-of-use (POU) water treatment method. In order to be successful, use this Brief as a primary source of information about water contaminants and some of the most common water treatments.

Examples of Water Contaminants

Bacteria 	Bacteria are small organisms that can cause an infection that can feel like food poisoning. *E.coli* and *salmonella* are two common bacteria found in contaminated water throughout the world. *Vibrio cholerae*, the bacteria that can cause cholera, is also found in some developing countries.
Protozoan Cysts 	Protozoa found in water are single-celled parasites that are in its' cystic form (meaning a parasite is in a form that can survive outside of its' host's body). The most common protozoan parasite found in water is Giardia, which causes an infection in the small intestine. Amoebas are other protozoa that can cause havoc, leading to amoebic dysentery. Another common protozoan is Cryptosporidium.
Chemicals/Toxins 	Chemicals can come from any run-off, whether from an industrial source or from fertilizer that people are using on their crops. The most common contaminants include pesticides, herbicides and fertilizer (phosphates and nitrates) and the occasional heavy metal. Aside from the direct contamination of these chemicals, phosphates and nitrates can also create the right environment for toxic bacteria to grow in the form of algal blooms.
Particulates 	Particulates are any solid object that is found in the water that cannot be dissolved in water. This could be a large item like little pieces of leaves, roots, and pebbles and could be smaller items like silt and sediment, heavy metals, etc. Particulates in water can be benign and only make the drinking process unpleasant, or can actually be objects that should not be ingested by humans and can cause health issues over time.

Common Water Treatments

Boiling 	This is the best, and easiest, method to use. Boiling will neutralize most bacteria and protozoan cysts. The water needs to be at a full boil for 4-5 minutes to be effective. Boiling does not treat particulates, heavy metals and some chemicals and toxins. Boiling can be ineffective if the person who is in charge of the process does not have a way of keeping time, a commonplace issue in developing countries. This process should be followed by filtering to remove larger particulates from the water.
Chlorine (halogen) 	Chlorine (bleach) will kill bacteria and most times will treat protozoan cysts. It is not 100% foolproof in treating Giardia and Amoebas. Most people complain about the taste of adding chlorine to their drinking water, which can sometimes deter people from using this method or for not using a sufficient amount of chlorine in the process.
Iodine (halogen) 	Iodine functions in the same manner as chlorine, but has the reputation of having a better taste than the chlorine. There have been questions about its safety on the long-term use of iodine, but it is fine for short-term usage. Iodine cannot be used by people who suffer from thyroid issues or pregnant women. Iodine comes in tablet form or in liquid form.
Solar and Ultraviolet Purification 	Ultraviolet (UV) light destroys the DNA of bacteria, viruses and protozoa. UV light can be used naturally, by the sun, or through special UV light bulbs. To use the sun, the contaminated water is placed in a transparent bottle and oxygenated by shaking up the bottle. The bottle is then placed in the hot sun for a minimum of six hours, raising the temperature and exposing the water to UV light rays. Water can be exposed directly to UV light bulbs for a treatment as well. This process requires the water to be filtered for particulates before being used.
Solar Distillation 	This method uses the sun as well, but in this treatment, the sun's heat is used to evaporate the water and there is a contraption set up to capture the condensation. The water condensate is pure water and removes all bacteria and particulates.
Filtration 	Filters work by physically removing contaminates from the water. A simple filter can work like a coffee filter, removing solids from a liquid. More advanced filters can remove microscopic objects, including bacteria and protozoan cysts. A filter works only as good as the extent of the physical size of the actual filter material. Filters can also be treated with chemicals, like iodine that allows for multiple forms of disinfection to take place. Larger filters usually contain sand, gravel and active carbon in different grades, or sizes. Smaller filters, such as the filters used in many homes in the United States, have **activated carbon**, which is very porous and can absorb chemicals in the water.

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Team:_____