Lead, Salt, and Bacteria, Oh My!

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What happens to the body without water? First, nothing serious, just minor headaches and chills. Then thinking becomes harder and the body begins to waste away, but go fourteen days without it and the body will not survive. So, water is vital for life; however, 2.5 billion people do not have access to safe drinking water. Much of it is filled with salt or various strands of bacteria, particularly in oceans and bodies of water in developing countries. Harmful inorganic compounds also contaminate it, for example, the lead in Flint, Michigan's water. But, biochemists and engineers can innovate upon current options to create the solution to the shrinking amount. Filters are the answer, and with the widespread use of powerful deionization filters coupled with active carbon, much more of the water will be available for human consumption.

The key to solving the contamination conundrum lies within deionization filters, since they have the ability to remove most of the inorganic contaminates in water, which make up about ninety-five percent of all aqueous pollutants. Some of these pollutants are found naturally, for example the salt in ocean water, while some become contaminates because of people. Most that are introduced to water unnaturally, are extremely dangerous, like lead. Lead and other substances are most often introduced from agricultural runoff and improper disposal of industrial waste, which decreases the amount of drinkable water available. In order for these filters to remove the naturally occurring and unnaturally occurring wastes, they must rely on water's aptitude for causing compounds to dissociate into charged particles, or ions. The ions, along with elements that are not from the compounds, are attracted to resin beads within the filter. Resin beads, also called ion exchanges, are composed of "styrene cross-linked with divynalbenzene" and are soaked in one of two solutions, sulfuric acid or an ammonium salt solution, to make them attract the charged particles (Metal Finishing 1995). When contaminated water passes through the resins, the harmful compounds are drawn to the ion exchanges, leaving clean, drinkable water. Additionally, the resins can easily be reused once they are soaked in the solution and "do not require electricity" to run, thus making them efficient and somewhat cost effective (these filters, unfortunately, can be expensive) (Deionization by Ion Exchange 2010). Furthermore, engineers are experimenting with ways to make this filter even more efficient. They have discovered that when a flow of electrodes is introduced in the filter, it has a "removal efficiency rate of ninety-five percent" (Paulson 2013). Meaning that once it has passed through the deionization filter, more than ninety-eight percent of inorganic substances, like lead and sodium chloride, will be removed from the water.

Despite their capacity for removing inorganic pollutants, deionization filters prove to be ineffective at filtering organic contaminates; therefore, these filters should be paired with activated carbon to further clean the water. Organic compounds are just as harmful as inorganic compounds. They are usually microorganisms that are most common in underdeveloped countries. Thus, these countries often lack safe water. Activated carbon, also known as activated charcoal, can solve this. It is made from either coal or coconut shell which has been cooked until it is blackened and dry. This charcoal has the ability to separate organic matter, sediment, and chlorine, making it an excellent complement to deionization filters. These substances are removed "by simple mechanical filtration or by adsorption – meaning the contaminates adhere to the surface of the carbon" (Activated Carbon 2010). Adsorption is occurs more readily when the carbon has a larger surface area, which is increased through cracking or grinding the carbon block. Because of this, most activated carbon is in the form of powder to optimize the surface area to volume ratio. When paired with a deionization filter, water that is run though the tandem filters will be rid of not only inorganic compounds, but organic substances as well. But, activated carbon filters currently have more drawbacks than deionization filters. After a period of time, the "efficiency of the active carbon decreases… [and] part of the active carbon is destroyed" (Water Treatment Solutions 1998). This means that after several uses the carbon will cease to remove quite as many contaminates due to the pollutants blocking it up, and when it is wiped clean, some of the charcoal is lost in the process. Therefore, the filter will need to be replenished on a regular basis, somewhat negating any cost benefits of using carbon. However, as experiments with these filters progress, biochemists and engineers will work to improve the efficiency of the activated carbon filter, as well as find ways to prevent the activated carbon from being lost in the process of filtering water.

Using deionization filters and activated carbon filters together can help reduce the amount of people without clean drinking water. The deionization filters will give the most aid in areas affected by agriculture runoff and industrial waste. For example, Flint, Michigan currently is experiencing lead contamination in their water due to industrial waste. Since lead is toxic to people, and even ingesting small amounts can make a person very sick, these filters can serve as the answer to this dangerous situation. They have the ability to lower the lead concentration in water to the EPA's (Environmental Protection Agency) standards – no more than fifteen parts per billion (ppb). Additionally, this filter could help turn ocean water, which make up about ninety-seven percent of all of the water on Earth, into drinkable water. The deionization filter can purify the water because salt dissociates into ions when it is dissolved in water; therefore, it is attracted to the resins in the filter. By desalinating the water, much of the 2.5 billion people who do not have access to clean water would be able to get pure water. Furthermore, by adding activated carbon, the water would be made even safer due to its aptitude for removing organic compound. Organic compounds, like bacteria and other microorganisms, are also harmful. These compounds threaten many developing countries, often because there is a lack of funding for water cleansing. But, with activated carbon may of these countries would be able to have access to water free from microbes and bacteria due to activated carbon's efficiency as well as affordability. Currently, both of these filters have some problems, such as the deionization filter's cost and activated carbon's reusability, but engineers and biochemists can solve them. Engineers are searching for ways to improve upon the very effective deionization filter, and both will eventually figure out ways to beneficially change the activated carbon filter. These people are keys to using the two filters to decontaminate water and make it available to a larger percentage of the population.

Ultimately, the water crisis can be evaded with the use of deionization filters as well as with activated charcoal. Salt and lead can be effectively removed from water with deionization filters because of their ability to attract ions with their resins. And, activated carbon filters will separate the organic compounds that the resins cannot pick up. While neither of the filters works completely efficiently at the moment, biochemists and engineers can work to improve their performances, making them better suited to clean water and providing safe, life-essential water for everyone.

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