Desalinating water: the obvious solution to many of humanity's dilemmas

Environment

Water is critical to life as we know it. Our planet is roughly 70% covered in water, we are roughly 60% water, and without it, we would all be dead (" Saline Water"). The trouble with our planet is that all that sweet, sweet water is not available to us. Fresh water, the water that we humans use for drinking, cooking, farming, manufacturing, and so much more, makes up only 2. 5% of Earth's water. Even more troubling, not all of that water is available. Some of it is trapped deep underground where we cannot reach it, more is frozen and locked away by nature, and for some humans, it just so happens that where they live has no water. Ultimately, only . 007% of the planet's water supply can be used (" The Water in You"). Even with our limited supply, we use too much today for our water to naturally replenish, while polluting other sources. We will use up all available freshwater if we do not change anything. What will we do then? It turns out, we already have a solution, called " desalination." While still not in widespread use, desalination will become our most dependable source of clean water, thanks to our ever-growing knowledge of physical and chemical processes.

Desalination is exactly what it sounds like, the process of removing the salt from saltwater, such as ocean water, so that humans can do useful things with it, like not die. On a small scale, desalination is simple. Just boil some saltwater, and once it's evaporated, you've desalinated the water! As a bonus, you even get some nice salt to season your food with. The problem is, this takes a lot of energy and money. To produce enough freshwater to provide for the needs of thousands of people, large desalination plants must be constructed at optimal locations, with different technology needed for different levels of salinity (Younos 40). Even the amount of pre-treatment of the water changes depending on the location, meaning that the places that most need water will have to pay the most for it.

Today, there is very little choice for millions of people around the world when it comes to water. Many nations like Saudi Arabia, Israel, and other Middle Eastern countries, located near the salty coast yet without abundant freshwater, depend on this technology to survive. And the U. S. is not as safe as you think it may be. The nation depends on California for most of its crops, including 90% of our lemons, 60% of our fresh-market vegetables, and a third of our melons (“ Californian Drought”). However, California has been affected by terrible droughts. Almost all Californian crops require outsourced irrigation. This means water that could be going towards not only Californians, but also citizens of neighboring states, is being used up at alarming rates. While this is happening, rising sea levels puts huge numbers of coastal aquifers at risk. The salty coast water is able to seep into the groundwater in a process called saltwater infiltration, turning previously pure water into mouth-twisting saltiness (Barlow introduction). So, dear reader, you can see that this is a big deal. Now, how do desalination plants work in the first place?

Today, most plants use reverse osmosis. This is a process where saltwater is pumped at high pressures through a semipermeable membrane. The membrane is made with tiny holes, big enough to let water flow through, but small enough to trap the salt on one side. When the pressure is really high, the water can be forced through even smaller holes, which filters out even the smallest of salt particles. Reverse osmosis is a simple, but prohibitively expensive solution to our problem (Bienkowski 2015). Most reverse osmosis plants require three to ten kilowatt-hours (kWh) of energy to produce one cubic meter of fresh water, compared to under one kWh of energy for traditional water purification plants. This drives the cost of water up to five dollars for a thousand gallons of freshwater from desalination plants (“ Water Desalination Using Renewable Energy 30). The question is, how do we do better?

Our quest for complete aquatic domination begins with changing as little as we can. Instead of working to revolutionize the industry, scientists have worked on improving the already present and working technologies. Today, that means better membranes for filtration. The trouble with our membranes today is that they are not sturdy enough to achieve maximum efficiency. When engineers make them with too many small holes, the membranes become weaker and the high pressure water destroys them. By using better materials like carbon nanotubes, membranes could have many more smaller holes that do not weaken the membrane. This makes reverse osmosis more efficient, which means less energy and money for the same amount of water (Fravel AMTA). Others support changing the structure of the membranes to increase the surface area that meets the water. This, unlike improving the actual membrane material, lets the membrane take in and desalinate more water, which achieves the same goal. Unfortunately, both approaches would take decades to implement. Working with such small and precise objects requires a lot of testing to make sure the membranes will not accidentally tear while working. And even after engineers manage to make them, there is also the slight problem of replacing existing membranes with these new, better ones. After all, building new plants does not save money (Bienkowski 2015).

Others support the use of renewable energy sources, such as solar and wind power, and recapturing energy from the actual process of desalination. As explained in an IRENA technology brief, renewables could efficiently power the plants, while turbines could be placed within the plants. By putting turbines inside, the desalination plant is turned into a hydroelectric generator. These turbines would be turned by the high pressure water being pumped through. This in turn would provide energy to allow more water to be pumped, resulting in a self-supporting beneficial cycle, where power enables the creation of more power. The whole idea of renewables becomes even better when two things are considered. First, the cost of renewables, especially solar, has gone done dramatically in the past twenty years, and continues to drop. Secondly, almost every location that needs desalination plants is located near the ocean, in an arid and sunny climate. The ocean provides some of the most consistent winds for wind power, and sunny weather is great for solar power.

And besides, we are not limited to improving and implementing what we have today. Scientists and engineers have figured out ways to use chemical processes to do the same work. Electrodialysis is the most viable chemical technology we can use today. It works by moving the salt ions present in saltwater. This is possible because of the how water molecules and salt molecules interact. Salt is normally a neutral solid, with no positive or negative charge. Water, however, is polar, which means each water molecule has a slight negative charge on one side and a slight positive charge on the other. When salt is put in water, the charge from the water breaks salt into positive charge sodium and negative charge chlorine. Electrodialysis uses an electric current to push the negative ions to one side of the water, and the positive ions to the opposite side. This makes three streams of water, one with negative ions, one with positive ions, and clean freshwater in between. Placing a barrier along where the water is separated pushes the freshwater onto a completely different path from the ionized water. The remaining water can then be simply run through the process again and again, purifying it further each time (Ondrey 12).

Is there anything that makes desalination not worth it? Currently, desalination is incredibly expensive, and usually not worth its cost. Per the US Geological Survey, in 2002, 12, 500 plants produced 14 million cubic meters of water every day. This accounted for less than 1% of total worldwide water use (“ Saline water: Desalination”). This seems pretty convincing for not pursuing desalination. After all, why waste millions of dollars on such a small amount of water? And there are environmental effects too. Like any construction project, desalination plants destroy the nearby environment. However, the arguments for desalination seem more convincing. The actual desalination process has almost no effect on the environment. Desalination plants are basically humans imitating nature’s water cycle, which filters water too. Even if it did have some effect, the oceans have 1, 338, 000, 000, 000, 000, 000 cubic meters of water. That is 1, 338, with 15 zeroes behind it. Increasing our current desalination efforts 1000 times would still be negligible in the grand scheme of our planet’s water. Finally, desalination is important because every day, more people need it to survive. Water supplies shrink daily, as climate change takes its toll and humans draw more and more of it for so many different needs. Estimates for future water use vary wildly depending on which of the many changing variables researchers considered. However, as water becomes more important, we cannot continue to blindly stumble forward with no precautions. Desalination works, and it improves steadily. It will not be a question of whether to use it, but of where and how soon.