Cheaper desalination

Current thinking

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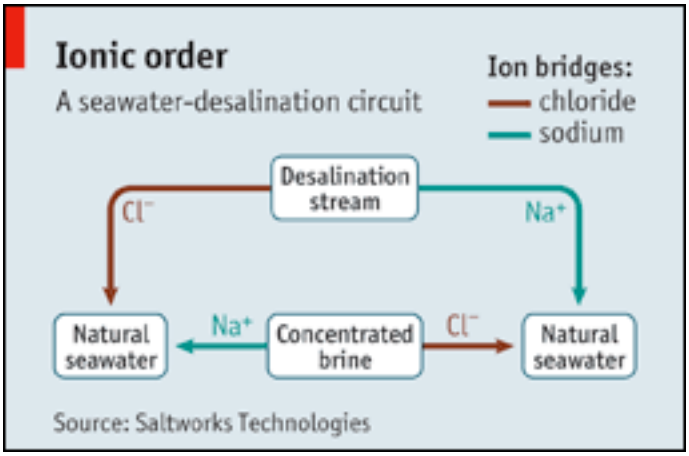
A fresh way to take the salt out of seawater

THERE is a lot of water on Earth, but more than 97% of it is salty and over half of the remainder is frozen at the poles or in glaciers. Meanwhile, around a fifth of the world's population suffers from a shortage of drinking water and that fraction is expected to grow. One answer is desalination—but it is an expensive answer because it requires a lot of energy. Now, though, a pair of Canadian engineers have come up with an ingenious way of using the heat of the sun to drive the process. Such heat, in many places that have a shortage of fresh water, is one thing that is in abundant supply.

Ben Sparrow and Joshua Zoshi met at Simon Fraser University in Vancouver, while completing their MBAs. Their company, Saltworks Technologies, has set up a test plant beside the sea in Vancouver and will open for business in November.

Existing desalination plants work in one of two ways. Some distil seawater by heating it up to evaporate part of it. They then condense the vapour—a process that requires electricity. The other plants use reverse osmosis. This employs high-pressure pumps to force the water from brine through a membrane that is impermeable to salt. That, too, needs electricity. Even the best reverse-osmosis plants require 3.7 kilowatt hours (kWh) of energy to produce 1,000 litres of drinking water.



Mr Sparrow and Mr Zoshi, by contrast, reckon they can produce that much fresh water with less than 1 kWh of electricity, and no other paid-for source of power is needed. Their process is fuelled by concentration gradients of salinity between

different vessels of brine. These different salinities are brought about by evaporation.

The process begins by spraying seawater into a shallow, black-bottomed pond, where it absorbs heat from the atmosphere. The resulting evaporation increases the concentration of salt in the water from its natural level of 3.5% to as much as 20%. Low-pressure pumps are then used to pipe this concentrated seawater, along with three other streams of untreated seawater, into the desalting unit. As the diagram explains, what Mr Sparrow and Mr Zoshi create by doing this is a type of electrical circuit. Instead of electrons carrying the current, though, it is carried by electrically charged atoms called ions.

Salt is made of two ions: positively charged sodium and negatively charged chloride. These flow in opposite directions around the circuit. Each of the four streams of water is connected to two neighbours by what are known as ion bridges. These are pathways made of polystyrene that has been treated so it will allow the passage of only one sort of ion—either sodium or chloride. Sodium and chloride ions pass out of the concentrated solution to the neighbouring weak ones by diffusion though these bridges (any chemical will diffuse from a high to a low concentration in this way). The trick is that as they do so, they make the low-concentration streams of water electrically charged. The one that is positive, because it has too much sodium, thus draws chloride ions from the stream that is to be purified. Meanwhile, the negative, chloride-rich stream draws in sodium ions. The result is that the fourth stream is stripped of its ions and emerges pure and fresh.

It is a simple idea that could be built equally well on a grand scale or as rooftop units the size of refrigerators. Of course, a lot of clever engineering is involved to make it work, but the low pressure of the pumps needed (in contradistinction to those employed in reverse osmosis) means the brine can be transported through plastic pipes rather than steel ones. Since brine is corrosive to steel, that is another advantage of Mr Sparrow’s and Mr Zoshi’s technology. Moreover, the only electricity needed is the small amount required to pump the streams of water through the apparatus. All the rest of the energy has come free, via the air, from the sun.