technology today

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Water Everywhere—But Not a Drop You Want to Drink

In 1797, Samuel Taylor Coleridge, a British poet, published his poem "The Rime of the Ancient Mariner." A very famous line from this poem is "Water, water, every where, nor any drop to drink." Coleridge's title alone provides you with enough information to deduce that his mariner was surrounded by sea water and probably had run out of fresh drinking water during the voyage described in the poem.

The mariner could have had plenty of water to drink if his technology skills matched those of Julius Caesar, who used solar energy to distill sea water to meet the drinking needs of his troops in 49 B.C.E.

When a clean water supply doesn't exist, people turn to technology to provide fresh water. The energy costs associated with all water purification processes have kept these technologies from providing cheap water for the masses of people who need it.

A United Nations (U.N.) World Study of the Environment is one of many different studies that indicate that "20 percent of the world's population [still] lacks access to safe drinking water" (www.unep.org/geo2000/english/0046.htm). You might think this U.N. report refers only to third-world countries, but a recent Duke University report indicates that 16 percent of Americans use bottled water as their primary source of drinking water.

A May 18, 2006, news release from Lawrence Livermore National Laboratory (LLNL) describes a nanotube membrane breakthrough that might soon provide an inexpensive technology for producing fresh water from sea water. To understand the LLNL breakthrough, you need some insight into the methods currently used to turn sea water into drinking water.

Distillation basically heats the water until it evaporates. The next step in the process chills the steam to catch what is now distilled water. This process has been used for centuries.

Electrodialysis passes electricity between electrodes in a tank of sea water. This causes electrically charged salt ions to pass through a semipermeable membrane, leaving the desalinated water behind in the main tank.

Reverse osmosis uses high pressure to separate salt or other contaminants from water through the use of a semipermeable membrane. The openings in the membrane are small enough to keep salt molecules and other organic materials (including viruses and bacteria) from passing through the membrane. To learn more about each of these processes, you only need to put their names into your favorite search engine.

The Lawrence Livermore National Laboratory breakthrough combines *a nanotube membrane with a silicon chip.* The nanotube part of the equation contains billions of aligned hollow carbon atom tubes. These tubes are so thin that it would take almost 50,000 of them to equal the thickness of a single strand of human hair. The silicon chip gives the nanotubes structure at the same time that the nanotubes give the silicon its porosity.

Each hollow tube in the silicon chip stands ready to block salt and other organic molecules that you don't want in your drinking water. The nanotube holes are so small that they can only pass a few gas molecules and only six water molecules at a time. Figure 1 shows individual methane molecules flowing through a nanotube.

The goal is to eventually use these new nanotube membranes in reverse osmosis water treatment plants. Each membrane would require much less pressure to cleanse water of salt and other impurities. Current testing shows the possibility of improving fresh water flow in a reverse osmosis plant to the point where fresh water flow would increase in volume from the equivalent of an open water faucet to that of a broken water main.

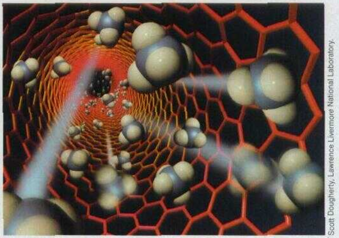

Fig. 1—Methane molecules flowing through a nanotube

Scott Dougherty, Lawrence Livermore National Laboratory

Recalling the Facts

1. What did Julius Caesar use to distill sea water in 49 B.C.E.?

2. Name and describe the technologies currently used to turn sea water into drinking water.

3. In what process will nanotube chips eventually be used?

Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit www.technologytoday.us for past columns and teacher resources.