U.S. Army Public Health Command (Provisional)
formerly U.S. Army Center for Health Promotion and Preventive Medicine

31-013-0410

Just the Facts...

Carbon Nanotubes in Drinking Water Treatment

What are Carbon Nanotubes?

Carbon nanotubes are very thin, hollow cylinders made of carbon atoms. They are about 10,000 times thinner than a human hair. Carbon nanotubes are produced using various thermal processes to strip carbon atoms from carbon-bearing materials and use them to form a hexagonal network of carbon atoms that is rolled up into a cylinder, or tube. Carbon nanotubes have exceptional thermal, electrical, and mechanical properties, allowing for potential wide applications in numerous industries (references 1, 2).

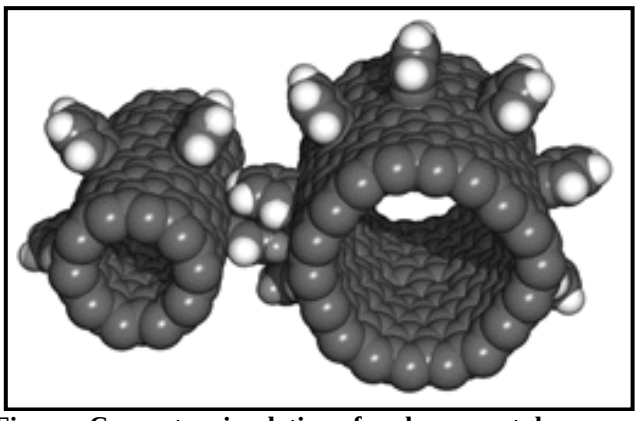

Figure. Computer simulation of carbon nanotubes. Source: NASA Ames Research Center, Center for Nanotechnology; www.ipt.arc.nasa.gov/carbonnano.html

How are Carbon Nanotubes Used for Treating Drinking Water?

Researchers suggest that carbon nanotubes could provide a significant advantage over current membrane technologies, such as reverse osmosis and ultrafiltration. The unique properties of carbon nanotubes would allow water molecules to pass through the interior of the cylinders while chemical and microbial contaminants could not. This is a filtration process called size exclusion. This could be accomplished at a high rate of flow with very little energy (pressure) input to "push" the water through the nanotubes – thus a big advantage over current membrane technologies. Additionally, research has shown carbon nanotubes have a strong ability to adsorb many types of chemical and microbial contaminants (references 3-6).

While research shows significant potential for using carbon nanotubes in drinking water treatment, currently their use is limited. The main reason is the inability to construct very well-defined carbon nanotube arrangements where the carbon nanotubes would be lined up facing one direction all right next to each other in a filtration device. Current carbon nanotube production results in their formation in "mats of ropes" where the ropes are bundles of carbon nanotubes pointing in different directions (references 1, 7). This production technique prevents the water from passing through the interior of the carbon nanotubes, thereby limiting their use for drinking water treatment.

Even so, there are drinking water treatment products already developed that use carbon nanotube technology. One manufacturer has developed carbon nanotube filters to take advantage of their useful properties in light of the current inability to construct well-defined carbon nanotube arrangements. The filter consists of a mat or mesh of carbon nanotubes stacked on each other, pointing in different directions, and wrapped around a carbon block filter structure (reference 8). This resulting filter is one with very small pore openings that is on the micrometer scale, but larger than the interior nanometer pore openings of the carbon nanotubes.

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Do Carbon Nanotubes Pose Any Human Health or Environmental Health Risks?

Health risks, both human and environmental must be considered for any new technology produced or employed on an industrial or commercial scale. The properties that make carbon nanotubes attractive for numerous applications may also make it a potential health risk concern. Current research on human and environmental health risks is limited. Results are conflicting and inconsistent making it difficult to draw any conclusions. There are concerns that carbon nanotubes may interfere or damage DNA, could cause harmful effects to organs if introduced into the body, and could adversely affect natural ecosystems (references 2, 9-13). The bottom line is carbon nanotubes may cause adverse human or environmental health effects but further studies are necessary to determine the impact, if any, carbon nanotubes have on humans and the environment.

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