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Carbon Nanotubes as a Novel Filter Media

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Carbon nanotubes (CNTs) exhibit novel chemical, mechanical and thermal properties, and thus, have been considered for use in numerous fields. In this study, we explored the use of CNTs as a novel filter media to remove bio-hazards (bacteria and viruses). A layer of single-walled carbon nanotubes (SWNTs) was deposited until the thickness to be several micrometers on the porous polymer membrane by the simple vacuum filtration. The results describe a highly permeable SWNT filter which is comparable with the permeability of microfiltration membranes. Further analysis exhibited that the CNT filter was also effective in removing bacteria and viruses from water. The filter was capable of complete retention of model bacteria, Escherichia coli, and subsequent inactivation. Electron microscopy and bacterial membrane integrity test verified that more than 80 % of cells lost their cellular integrity and became flatten on the surface of the filter. The CNT filter was also very effective for model virus (MS2) removal. The viral removal was proportional to the thickness of SWNT layer, indicating a depth-filtration mechanism. This observation supported our hypothesis that viruses were removed from the water sample inside the CNT layer by convective-diffusive transport to the fibrous CNTs. The small diameter of the nanotubes or nanotube bundles (of the order of several nanometers) compared to the CNT layer thickness (the order of a few micrometers) ensured effective depth filtration by the CNT layer, and therefore, a very high viral removal efficiency. The results show promise for reliable water production with high permeability, bacterial inactivation, and viral removal. In addition, we expect that the CNT filter might be also very effective to adsorb trance levels of harmful organic matters by hydrophobic interactions. Furthermore, the CNT filter would be expected to be reusable, as it could be regenerated by thermal and chemical treatment.

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