Adsorption and desorption of dimethyl phthalate on carbon nanotubes in aqueous copper(II) solution

Jingwei Wang, Fei Wang, Jun Yao, Ruixia Wang, Haiyan Yuan, Kanaji Masakorala, Martin M.F. Choi

A School of Civil & Environmental Engineering, and National International Cooperation Base on Environment and Energy, University of Science and Technology Beijing, 30 Xueyuan Road, 100083 Beijing, PR China
B Key Laboratory of Biogeology and Environmental Geology of Chinese Ministry of Education and Sino-Hungarian Joint Laboratory of Environmental Science and Health, China University of Geosciences, Wuhan 430074, PR China
C Department of Chemistry, Hong Kong Baptist University, 224 Waterloo Road, Kowloon Tong, Hong Kong SAR, PR China

HIGHLIGHTS
- Copper(II) ions could enhance the adsorption of DMP on CNTs.
- Acidic functional groups produced strong competitive between DMP and copper ions.
- Copper(II) ions could suppress the DMP desorption from CNTs.
- Cu^{2+} caused the most effect for DMP adsorption contrast to other species.
- Effect of adsorption and desorption by Cu^{2+} increased in larger outer diameters.

ABSTRACT
The adsorption and desorption of dimethyl phthalate (DMP) on five types of carbon nanotubes (CNTs) were studied in the absence and presence of 30 mg/L copper(II) (Cu^{2+}) ion. The adsorption and desorption data are well described by the Freundlich model and the first-order two-compartment model, respectively. The adsorption capacity of CNTs for DMP is inversely related to the average outer diameter of the CNTs. The surface acidic functional groups of CNTs increases in the order of lactones < hydroxyl < carboxyl functionalities and decreases with the increase in the outer diameter. The adsorption of DMP on CNTs increases in the presence of Cu^{2+} ions. The adsorption coefficient increases in pH 3–6 and is nearly the same at pH > 6 for all CNTs. The presence of Cu^{2+} ions decreases the amounts of desorbed DMP from CNTs, inferring that Cu^{2+} ions could suppress the DMP desorption from CNTs and reduce DMP toxicity to our environment.

1. Introduction
Because of their unique and tunable properties [1], carbon nanotubes (CNTs) have been demonstrated as promising adsorbents for removing organic pollutants and metal ions [2–9]. Since organic compounds are strongly adsorbed on CNTs, CNTs are widely and critically applied in disposing sewage [10,11] and other solid-phase extraction [11–13]. And the widespread use of CNTs will inevitably enter the aqueous environment, raising serious concerns over the potential environmental impact on living organisms due...