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Letter to the Editor

Factors for Adsorption Mechanism to Remove 1,2-Dichlorobenzene Using Carbon Nanotubes in a Water Treatment System

***Do Gyun Lee**

Department of Environmental Engineering, Incheon National University, Incheon 22012, South Korea

***Correspondence:** Email: dlee31@inu.ac.kr

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Dear Editor-in-Chief

1,2-Dichlorobenzene (hereafter as "DCB") is used as a solvent for degreasing hides and wool as well as a synthetic reagent for dye manufacture, and have been classified as a priority pollutant by US Environmental Protective Agency (US EPA) (1). DCB in the portable water sources raise potential public health and environmental concern due to its high acute toxicity and bioaccumulation, probably causing the thyroid cancer and soft tissue sarcoma in human body (2). DCB is chemically stable, thus limited to be photochemically degraded in soil and aquatic environments (3). In addition, due to its low solubility, DCB has been detected in water at very low concentrations, thus, and there are often difficulties in removing a trace amount of DCB in water bodies.

Recently, due to the enormous surface area and high adsorption capacity of carbon nanotubes (CNTs), several studies on CNTs as an adsorbent have been reported to achieve the higher removal efficiency of organic pollutants including DCB removal in water treatment process systems (4-6). However, to further improve DCB removal performance by CNTs as an adsorbent in a water treatment plant for the practical purposes, the several aspects of the CNT applications are pointed out below.

Adsorption mechanisms are strongly affected by both pH and ionic strength (7) as well as by temperature (8). Two broad conceptual models have been developed to explain equilibrium between adsorbed species and those in bulk solution; adsorption i) as a surface complexation reaction and ii) as a phase transfer reaction. Both models have the equilibrium constants (K), dependent of temperature. When adsorption constant (K_{ads}) is considered to be derived from two conceptual models, temperature effects on adsorption are profound, thus, most measurements are usually performed at a constant temperature and pH by collecting water samples from the same location in the adsorption reactor, the possibility of the differences in the homogeneity of temperature distribution inside the reactor due to the environmental impact outside cannot be ruled out. Therefore, the adsorption reactor inside in a water treatment plant should be isothermally maintained for the homogeneous constant temperature distribution and if minor changes in the temperature inside the reactor are observed, temperature correction factor for K_{ads} should be considered.

In addition, the possibility of natural organic matter (NOM) to be present in a water treatment system should be considered. NOM, which vary greatly in the size, shape, and composition, is a trace organic matter, a ubiquitous component of natural waters, broken down from microorganisms, humans, animals and plants in the environment by physical, chemically or biological processes (9). Due to its high level of reactivity, NOM can easily bind metal ions and minerals with an important role in the nucleation, then the much larger by-products of NOM are aggregated in the aquatic environment, causing fouling in the membrane filtration system (10). When CNTs and NOM are simultaneously present in an adsorption reactor, the different reactivity of NOM could interfere in the reactivity of CNTs for removing DCB in an adsorption reactor. Furthermore, the direct adsorptive force between NOM and CNTs may cause a loss of CNTs performance for DCB removal. Thus, it is significant to evaluate the adverse effect of the NOM presence on CNT performance to remove DCB, if proven, NOM should be completely eliminated before entering the adsorbent reactor.

The water flow velocity in a water treatment system is one of the most important factors to be considered for the efficiency of CNTs for DCB removal. Because of possible resuspension of DCBs on the surface of CNTs by hydraulic flushing, the distribution of DCB concentrations adsorbed onto CNTs may not be independent of the reactor's physical and operating conditions. Thus, when measuring the amount of DCB adsorbed onto CNTs in a reactor, the flow velocities data are required.

This article aimed to critically consider the several aspects of CNT applications as an adsorbent to improve the removal efficiency of DCB in real water treatment systems, ultimately achieve more healthy and sustainable aquatic ecosystems around us.

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Conflict of interest

The author declares that there is no conflict of interests.

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