学 位 論 文 審 査 の 要 旨

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学 位 論 文 題 名

Development of high-performance spongiform adsorbents with caged Prussian blue as the absorbing elements for radioactive cesium decontamination

（プルシアンブルーを内包した放射性セシウムを除染するための高性能スポンジ型吸着材の開発）

The candidate, in this study, had developed a spongiform adsorbent with Prussian blue particles being caged into the cell-walls as the functioning element for the elimination of radioactive cesium. Radioactive cesium has been introduced into our environment since the nuclear weapon testing during the 1950s and 1960s and the nuclear power plants accidents in recent years such as Chernobyl and Fukushima disaster. Concerns associated with radioactive cesium are main focusing on the long half-life species (Cesium-137, $T_{1/2}$=30 years; Cesium-134, $T_{1/2}$=2.06 years) and thereby the strong gamma radiation emission, their high solubility and the high potential mobility in environment, their high selectivity toward the biological systems due to the metabolic similarity with potassium and the cause of thyroid cancer. Hence, the elimination of radioactive cesium from a certain contaminated environment is one of the most important tasks towards achieving the goal of environmental remediation.

In this study, the candidate had firstly introduced a caging approach to immobilization of Prussian blue. Diatomite, the non-toxic, low-cost and the naturally occurred abundance with cylindrical shapes as well as the ultra-high porous structures was used as a micro-meter sized container for immobilization of Prussian blue through an *in situ* synthesizing approach. An additional nano-sized network which consisted of highly-dispersed carbon nanotubes (CNTs) was then created over the surface of the diatomite; this CNT-network had sealed the Prussian blue particles firmly inside the diatomite cavities. Moreover, the candidate had observed that the CNT-networks were capable of enhancing water uptake into the absorbing element, namely, the caged Prussian-blue. The ternary (CNT-network/diatomite/Prussian-blue) composites were then mixed with polyurethane pre-polymers to produce the spongiform adsorbents through an *in situ* foaming procedure. The

CNT-network/diatomite/Prussian-blue composites were permanently immobilized into the cell-walls of the polyurethane foam. Macro-sized, durable, and flexible spongiform adsorbent was established. Cesium-133 was used for studying the adsorptive capabilities of the Prussian-blue based spongiform absorbent and the caged Prussian blue showed a theoretical capacity of 167mg/g for cesium, indicating a fact that the Prussian blue based spongiform is an excellent adsorbent for cesium. Adsorption isotherms plotted based on Langmuir equation gave liner line, suggesting that the caged Prussian blue adsorbed cesium in the Langmuir adsorption manner. Cesium was absorbed primarily by ion-exchange mechanism. For evaluating the practical application of the spongiform adsorbent, deionized water and seawater, each containing 1.50 Bq cesium-137 were decontaminated with the spongiform adsorbent. The elimination efficiency was found to be 99.93% for the deionized water sample and 99.47% for the seawater sample, respectively; indicating the high selectivity and the high capacity for the adsorption of radioactive cesium-137.

In conclusion, the candidate showed familiarity with, and critical understanding of the relevant literatures; the methods adopted were appropriate to the subject matter and properly applied; the research findings were suitable set out, accompanied by adequate exposition and discussion, and the quality of English and the general presentation were satisfactory. The recommendation of the examination committee was that “the degree be awarded”.