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Metal Extraction Capability for Hybrid Polymers Consisted of β-Cyclodextrin and Diatomite

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Hybrid polymers consisted of β-cyclodextrin and diatomite were made in order to examine a metal extraction capability, where the weight mixture ratio of β-cyclodextrin and diatomite were changed from 1:0.5 to 1:5. It was recognized that polymer A obtained from mixing ratio of 1:1 shows highly extraction capability to platinum ion (Pt) with almost 80% extraction ability. On the other hand, polymer, which was made from mixing ratio of 1:5 of β-cyclodextrin and diatomite shows lower capability to Pt with 10%. Diatomite shows only 1.3% extraction ability to Pt, otherwise β-cyclodextrin polymer shows almost 20% extraction capability to Pt.

Key Words : Diatomite, polymer, β-cyclodextrin, metal extraction, hybrid polymer

1. Introduction

Diatomite is a siliceous, sedimentary rock consisting principally of the fossilized diatom skeleton, and resembles opal or hydrous, silica in composition ($SiO_2 \cdot nH_2O$) [1]. Diatomite's high porous structure, low density and high surface area results in a number of industrial applications such as filtration media for various inorganic and organic chemicals, absorbent, catalyst carrier, filter and so on [2]. In aqueous solution, diatomite shows negatively charge and possesses strong adsorption ability for positively charged species [3]. It was reported that amorphous silica can adsorb cesium and heavy metal ions [4]. Many chemical modified diatomite such as ferrihydrite-modified diatomite [5], inorganic composite diatomite by Hadijar et al [6], diatomite-TiO_2 composite for photo degradation of bisphenol-A [7], manganese oxide modified diatomite by Al-Degas et al [8], polyethyleneimine modified diatomite for trapping phenol [3], conducting diatomite fillers by modification with polyaniline [9] and so on have been reported in order to develop further increasing the functionality of diatomite originally. On the other hand, cyclodextrins (CyDs) are torus-shaped cyclic oligomers of D-glucopyranose unit named α-, β-, and γ- for 6, 7, and 8 units, respectively. The most interesting ability of CyDs is to exhibit inclusion with various organic molecules into the hydrophobic cavity in aqueous solution and has been widely used ass functional units of supramolecular and molecular recognition systems [10]. When we can make new hybrid polymer made from diatomite and CyD that becomes the material which can adsorb metal and an organic substance simultaneously. A couple years ago, we have reported hybrid polymer consisted of β-cyclodextrin (β-CyD) and rice hunks ash, of which main component is natural amorphous silica [11]. In that report, we discussed the extraction ability for endocrine disruptor such as bisphenol A, not tried to study for metal ions, because it is well known that β-CyD can include organic substances more nearly rather than an inorganic compound in the cavity in aqueous media. In this contribution, we would like to discuss a metal affinity capability of hybrid polymers consisted of β-CyD and diatomite, which we named as polymer A, B, C, D and E.

2. Experimental

2.1 Materials

Diatomite was gifted from Showa Chemical Industry Co., Ltd. General characteristic data of diatomite were shown in Table 1. β-CyD and epichlorohydrin were commercially obtained from NIHON SHOKUHIN KAKO CO., LTD. and Wako Pure Chemical Industries, LTD., respectively.

2.2 Synthesis

2.2.1 Preparation of hybrid polymer (polymer A-E)

A typical procedure is carried out as follows. To a sodium hydroxide aqueous solution, β-CyD and diatomite were added. An epichlorohydrin was dropped into the reaction mixture over 30 min and then the reaction mixture was stirred at 80℃ for another 6 h. The stirring condition is 320 rotations per minute at stirring blades. After cooling to an ambient temperature, the reaction mixture was neutralized with 2N-HCl aqueous solution. Water insoluble