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Modified Nylon Fibers with Amino Chelating Groups for Heavy Metal Removal

Patcharin Racho[a]*, and Pinitta Phalathip[b]

[a]*Assistant Professor, School of Environmental Engineering, Institute of Engineering, Suranaree University of Technology, Nakhon Ratchasima, Thailand 30000*

[b]*Master student, School of Environmental Engineering, Institute of Engineering, Suranaree University of Technology, Nakhon Ratchasima, Thailand 30000*

Abstract

This study reports a feasible method for heavy metal ions removal from aqueous via modified nylon fibers**.** Modified nylon fibers were used as sorbent materials in batch experiment. The amine/amide groups on nylon fibers' surface were modifies by acrylic acid graft copolymerization and ethylenediamine solution. Surface modification was observed to enhanced the sorption capacity of nylon fibers by more than about 90% and 20% for Pb(II) and Cr(IV) removal, respectively. These caused of ability of the amine/amide chelating groups on the fiber. The experiments also investigated the influencing of pH, initial concentration, and contact time. The adsorption mechanisms of Pb(II) and Cr(IV) were following Freundlich's isotherm and pseudo second-order reaction.

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Keywords: modified nylon fibers, graft copolymerization, amino chelating, heavy metal removal, chemisorption

1. Introduction

Now a day, adsorption has become the focus of attention to removes heavy metal ion from water and wastewater**.** New types of adsorbents in recent year are chemisorption because it is high adsorption capacity more than 90% removal, fast adsorption equilibrium and easy to regeneration**.** Past of several researchers were carried out on

* Corresponding author.
E-mail address: patcha@sut.ac.th

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chemically modification of agriculture and industrial wastes biopolymer and polymer fibers or synthetics fibers to an absorbent. Through chemical modification of cellulose, high affinity functional groups including carboxylic, amino, amide and amidoximate for metal binding. Amino chelating group have alone pair of electrons on the nitrogen and may form a covalent bond with a metal and it to be effective in the adsorption of cation and anion heavy metal species because electric charge in the molecule of the amino change when changing pH of solution [1-3]. Dong [1] prepared amino starch derivatives as an adsorbents. These results shown that the amino starch was very effective on Cu^{2+} and Cr^{6+} adsorption within capacities of 8.1 mg/g and 12.1 mg/g, respectively. Cheng [2] modified starch by ethylenediamine and employed to remove hexavalent chromium from aqueous solution. The maximum adsorption capacity was observed at pH 4.0 was about 9.5 mg/g for Cr^{6+} removal.

The commercial synthetic fibers are carbon long chain polymer, as cellulose it can be modified to adsorbents likes several past study. With these advantages are more durable and sticky than natural cellulose. Furthermore, several researchers shown modified synthetic fibers are high specific surface areas, fast adsorption kinetics, introduction of suitable functional groups and its potential to regeneration. Almost, all synthetic fibers with chemical modification were studied on polyester, polyethylene terephthalate (PET [4-5]or polyacrylonitrile fibers. Graft copolymerization is a commonly used method for the modification of surface of polymers, and it is important tool in order to modify the physical or chemical properties of polymer. During grafting the side chain are covalently bonded to the main polymer backbone or substrate to form a copolymer with branched structure. Abdouss [6] grafted PET fibers with acrylic acid/acrylamide as monomer and using benzoyl peroxide as an initiator. The fiber surface was grafting to carboxyl and amino chelating were synthesized. Therefore, this study aimed to chemical modification of nylon fibers with amino bearing. The heavy metal (Pb^{2+}, Cr^{6+}) removal were evaluated through the influencing of pH value, contact time and initial of metal concentration.

2. Material and Methods

2.1 Adsorbent Preparation:

A commercial nylon threads were wash with acetone, and dried at 40ºC in hot air oven before chemical modification. Chemical modification process is carried out as in the following two steps are [5].

- The graft copolymerization of nylon fibers by poly-acrylic acid (PAA) was carried out using free radical polymerization. Briefly, 1.0 g of pretreated PET fiber was soaked in 50 ml distilled water in a conical flask. Then, the redox initiator system [0.1 g of Benzoy Peroxide (BPO)] was added and the mixture was vigorously shaken for 5 min. The 3 M of monomer PAA was added and the reaction was conducted for 8 h with stirring at 363 K. The products were filtered and washed with distilled water. Then, the grafted copolymer was dried at 313 K until constant weight, and the grafting percentage (GP) was calculated that about 56%.
- The finally chelating fibers were prepared by the action of the above Nylon-AA fibers with 1000 mL, 10% (v/v) ethylenediamine solution. The mixture was slowly stirred at 313 K for 8 h. Then, the chelating fibers were filtered and washed with absolute ethanolthen dried at 313 K.

2.2 Preparation of heavy metal solutions

Two stock of heavy metal solutions of 1,000 ppm of $K_2Cr_2O_7$ and $PbCl_2$ were prepared for synthetic wastewater during the study.

2.3 Batch sorption study

The adsorption capacity of the amino chelating fibers for Pb^{2+} and Cr^{6+} ion were investigated by the batch method and single element system. We evaluated with influencing of pH value, contact time and initial of metal concentration, the condition show in Table 1. Dried samples 1.0 g of the chelating fibers were added in 250 mL erlenmeyer flask including volumes of 100 mL of the metal ion solution. The mixture was stirred at 25 ºC. The flask