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Adsorption study of Pb(II) onto a novel calix[4]resorcinarene-chitosan hybrid

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ABSTRACT

Adsorption of Pb(II) ions by a novel calix[4]resorcinarene-chitosan hybrid (CCH) compared with tetrakis-chloromethyl-C-4-allyloxy-3-methoxyphenylcalix[4]resorcinarene (CAMR) and chitosan adsorbent using the batch method has been carried out under variations of pHs, contact times, and Pb(II) ion concentrations. The optimum conditions of the adsorption of Pb(II) ions occurred at pH of 5 for CCH and CAMR adsorbent with the contact time for 2 h and at pH of 2 for chitosan adsorbent. The results show that the adsorption process of Pb(II) ions by the CCH, CAMR, and chitosan adsorbents is pseudo-second-order kinetic model with the rate constant (k) of 6.86×10^{-2} g/mg min for CCH. In addition, the adsorption model of Pb(II) ions by CCH tends to follow Freundlich adsorption isotherm model, while CAMR and chitosan adsorbent tends to follow Langmuir adsorption isotherm model. Adsorption capacity (X_m) of CCH to Pb(II) ion is the largest than CAMR and chitosan. Thus, the CCH is the potential alternative adsorbent to absorb of Pb(II) ions.

Keywords: Calix[4]resorcinarene-chitosan hybrid; Adsorption; Pb(II) ion

1. Introduction

Industrial growth besides having a positive impact also has a negative impact, especially industries that produce waste containing heavy metals such as Pb. Compounds of Pb are mostly found in the form of Pb(II) and some Pb(IV). Considering that the negative impact caused by waste containing Pb metal is quite large, the treatment of industrial waste before being discharged into the environment becomes very important. One method that has been used in the waste treatment process containing Pb metal is adsorption. This method is quite effective, and it was performed for metal ion adsorption with various adsorbents [1–6]. In addition, there were several natural material products that have been used as adsorbents including agricultural waste such as tea waste [7], rice husks and ash [8], zeolites [9], and activated charcoal [10]. Previous researchers [11] argued that it was difficult to

determine the active compound and the active side of natural adsorbents due to its complex content. Therefore, alternative adsorbents are needed, especially from cheap synthesis processes.

One of the synthesized compounds that have been used as the alternative adsorbents for heavy metal ions is calixarene compounds. One of the derivatives of this compound which has been widely studied as an adsorbent is calix[4]resorcinarene [11–15]. This compound consists of four units of resorcinol in cyclic form connected by a methylene bridge (Fig. 1). Calix[4]resorcinarene was synthesized through a reaction between resorcinol and compounds containing aldehyde groups in an acidic atmosphere [16].

Modification of functional groups of calixarenes allows it to be utilized in a variety of purposes, including: adsorbent of heavy metals [17,18], inhibitor of calcium carbonate [19,20] and calcium sulfate [21] scale formation, sunscreen

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