THE EFFECT OF MASS OF COAL FLY ASH-CHITOSAN COMPOSITE PELLETS MODIFIED WITH GLUTARALDEHYDE ON THE ADSORPTION OF MERCURY IN SOLUTION

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ABSTRACT

Fly ash can be used and utilized as an adsorbent because it is cheap and effective to adsorb waste in the aquatic environment. Hg also known as Mercury is a carciogenic heavy metal and potentially threatens human health at very low concentrations. In this study, fly ash was applied as the adsorbent for Hg^{2+} in the form of chitosan-fly ash composite pellet and was cross-linked with glutaraldehyde in order to know how much the mass of pellets that can be used to lower the concentration of Hg^{2+} in solution. The results showed that the fly ash can be compositated with chitosan gel after going through the process of physical-chemical activation so that it can be formed into adsorbent pellets/granules. The optimum condition was obtained from adsorbent pellets of fly ash-chitosan composite crosslinked with glutaraldehyde after contacted with a solution containing Hg^{2+} with the pellet mass of 3 g.

Keywords: composite, fly ash, glutaraldehyde, pellets

INTRODUCTION

Fly ash can be used and utilized as an adsorbent because it is cheap and effective to adsorb waste in the aquatic environment (Ramadan *et al.*, 2010). The main component of fly ash is silica (SiO_2), alumina (Al_2O_3), iron oxide (Fe_2O_3) and a number of unburnt carbon. These components have an important role in the adsorption process (Wang and Wu, 2006). Fly ash absobent was used to adsorb phenolic compounds (Aksu and Yener, 1999), together with two types of compounds, polychlorinated biphenyls (PCBs), namely 2,3,4-trichlorobiphenyl and 2,2,3,3,4,5,6-heptachlorobiphenyl (Nollet *et al.*, 2003). Fly ash can also be used as an adsorbent for Ni (II) and Cu (II) (Soco and Kalembkiewicz, 2013), Zn (II) (Wang *et al.*, 2009), Mn (Mohan and Gandhimathi, 2009), Cd (Cho *et al.*, 2005), and Cr (Itskos *et al.*, 2010). Last but not least, fly ash can be used to adsorb ions Hg (II) (Daci *et al.*, 2011), the heavy metal ions with very high toxic properties.

Fly ash is an adsorbent that is reasonably priced, efficient, simple to prepare, and easy to operate. It can also be used to adsorb heavy metal ions. Pure fly ash was used to adsorb Hg and Pb in aqueous solution, but the adsorption capacity for Hg was fairly low at 17% (Kuncoro and Fahmi, 2013). Similar results were also demonstrated in a study conducted by Astuti and Mahatmanti (2010) with the adsorption capacity for Pb ion by 63%. Modification of fly ash into pellets was also conducted by Papandreou *et al.*, (2007), for the adsorption of Cu (II) and Cd (II). This method was less effective because most of the fly ash mass was lost during the process of adsorption. We need materials that can trap fly ash in order to increase the ability of adsorption, and one of the materials is chitosan.

Hg is heavy metal which is carcinogenic and potentially threatens human health at very low concentrations. Some data have shown that Hg can cause damage on brain, kidney, gastrointestinal tract and central nervous system and is toxic to cells by binding the intracellular sulfhydryl groups (Inbaraj *et al.*, 2009). The maximum limit of Hg level in drinking water is 2.0 µg L^{-1} and the total waste of Hg ions allowed was at 10.0 µg L^{-1} (Kumar *et al.*, 2013). The purpose of this study was to determine the optimum mass of fly ash-chitosan composite pellets modified with glurataldehyde to lower the concentration of Hg^{2+} in solution.

MATERIALS AND METHODS

The experiment condition that was set was the operational pressure at atmospheric pressure and normal temperature ± 30°C (room temperature), using composite pellets as the adsorbent during 60 minutes of contact time. Mass of pellets tested was 1 g, 2 g and 3 g.

Adsorption Process Procedures

The first step was preparing the $HgSO_4$ solution of 0.0296 ppm which its pH was set according to the variables specified. The next step was pouring the 100 mL $HgSO_4$ solution into each Erlenmeyer, and then the composite pellets were added based on variables into each 100 mL HgSO4 solution. Each of these Erlenmeyers was put in a shaker, and the speed of shaker of each variable was set for 60 minutes of adsorption time. After the adsorption process was complete, the process was continued to the filtration and the filtrates were analyzed using Atomic Absorption Spectroscopy (AAS).

RESULTS AND DISCUSSION

The composition of pellet mass of fly ash composite will affect the percentage of adsobpted Hg ions in the adsorbent (Azouaou, *et al.*, 2013).

Figure 1 is a curve of the relationship between the mass of pellets and the total percentage of Hg^{2+} adsorbed into fly ash composite pellets. The picture shows that the optimum mass of composite pellets in this study was 2 g because the greatest amount of Hg being adsorpted was shown at this point. The mass of 1 g composite pellets showed very low adsorption of Hg because the small amount of pellet mass caused the fly ash did not stick so firmly on chitosan for the adsorption process. Most of the mass of fly ash would be lost and reduce the ions percentage of adsorbed Hg. Meanwhile, a mass of 3 g pellets decreased the percentage of Hg ions being adsorpted because the great amount of pellet mass will hinder the diffusion process, and thus Hg^{2+} solution can not penetrate the layer of chitosan outside the pellet and can not be adsorpted on the surface of fly ash.

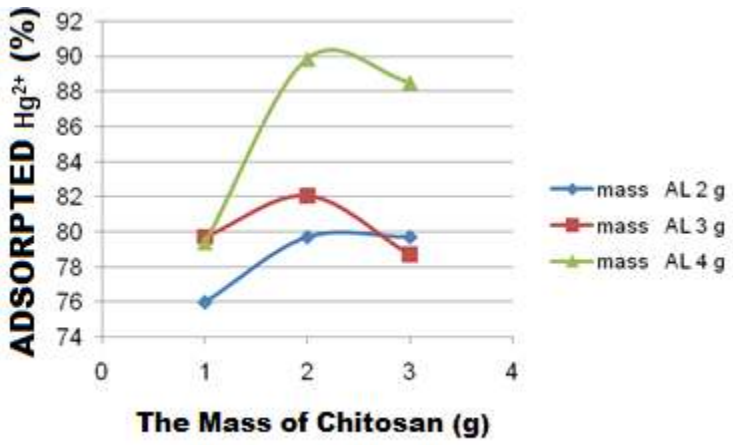

Figure 1 Effect of pellet mass on Hg^{2+} adsorption capacity in fly ash composite p

CONCLUSION

The optimum conditions obtained from the adsorbent pellets composite fly ash-chitosan cross-linked with glutaraldehyde after contacted with a solution containing Hg^{2+} is pH solution at pH 6, 4 g fly ash in 20 ml of chitosan gel; for 2 g pellets that of optimum stirrer speed at 180 rpm. Adsorption of Hg^{2+} in solution using fly ash pellet-chitosan composite reach optimum at fly ash mass 4 g, pH 6 and the stirring speed of 180 rpm with 89.53% adsorption capacity.

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