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A Sustainable Amine Magnetic Biocomposite Based on Rice Husk–Sugarcane Bagasse Fiber for Lead and Contaminant Adsorption in Aqueous Solution

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Abstract: Biomass is a material that can be potentially used as a natural fiber resource. Rice husk (RH) and sugarcane bagasse (SB), respectively containing 36.6% and 60% cellulose, are fibers that have the potential for biocomposite formation. In this study, an amine magnetic biocomposite (B-MNH_2) was prepared by a one-step solvothermal reaction. Delignified RH and SB fibers at a ratio of 1:1 were added to a mixture of ethylene glycol, iron chloride, and 1,6-hexanediamine, and kept in a stainless steel autoclave reactor at 200 °C for 6 h. The obtained B-MNH_2 contained 64.5% of Fe and 2.63 mmol/g of amine. Its surface area increased significantly from 9.11 m^2/g to 25.81 m^2/g after amine functionalization, and its optimum adsorption for Pb(II) ions was achieved within 360 min at 596.82 mg/g and pH 5. Moreover, the pseudo-first-order mechanism fitted well to the adsorption model. Other parameters, such as chemical oxygen demand (COD), total suspended solid (TSS), and dye during adsorption were also reduced by about 67.7%, 95.6%, and 89%, respectively. B-MNH_2 showed a slight decrease in performance by only 8% after the fourth repeated use. The amine magnetic biocomposite led to the development of a potential adsorbent due to the high surface area, stable material, and easy separation, and was capable of absorbing contaminants from an aqueous solution.

Keywords: biocomposite; Pb(II) ion; amine magnetic; rice husk; sugarcane bagasse; solvothermal

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1. Introduction

South Kalimantan has a typical type of rice called "Beras Banjar" as one of their largest agricultural products. Biomass waste as rice husk (RH) resulted from the utilization of paddy containing cellulose at approximately 34.34–43.80% [1]. Sugarcane bagasse (SB) is another organic material that is rich in cellulose at about 35.3–45.5% [2]. Biomass wastes produced from agricultural activities can affect the environment. Biomass wastes, such as rice husk, are used to either compress soft soil, or they are just burned, which could also later lead to air pollution. Sugarcane bagasse, on the other hand, is generally used for animal feed [3], paper making, and in inseminators as fuel. The possibility of exploring the fibers of these materials is interesting. Fibers are good materials for biocomposites since they have a matrix structure that provides them with a high surface area and high-performance of physical properties [4]. Both these materials are natural fibers that have potential as materials for biocomposite production. In addition, biomass waste is applied to a wide range of applications, not only for having a good specific strength, but also for being lightweight, environmentally friendly, and abundant in nature [5]. Based on the biomass technology approach, isolated fibers could be collected from biomass through a delignification process. RH and SB fibers were applied as a matrix to a biocomposite as