Heavy metal removal from wastewaters by agricultural waste low-cost adsorbents: hindrances of adsorption technology to the large scale industrial application – a review

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ABSTRACT

This review paper provides a critical examination on heavy metal removal from wastewaters by the agrowaste low-cost adsorbents, with focus on: (i) water pollution by heavy metals and their adverse effects on flora and fauna, (ii) extent and efficiency of the heavy metal removal from the real industrial effluents by agrowaste adsorbents, (iii) advantages and hindrances of adsorption technology to the large scale industrial application, (iv) heavy metal adsorption mechanisms, (v) biosorbents behavior in a multi-metal adsorption system and (vi) biosorbent regeneration and desorptive studies. This was carried out through an extensive examination of relevant published literature on the topic. The review paper found that the agricultural low-cost adsorbents have proven to remove heavy metals from aqueous solutions to some extent and are promising alternatives. However, it is noticeable that the behavior of the low-cost adsorbents with respect to the removal of the heavy metals from the real industrial wastewaters is not well known. In nearly all successful studies, conclusions on these materials potential to treat industrial wastewaters laden with heavy metals are based on the simulations drawn from the treatment of synthetic wastewaters. Furthermore, the prominent agricultural low-cost adsorbents such as *Carica papaya*, maize cob, soybean oil cake, banana peel, walnut shell, sesame leaf and stem, and mango peel, and many others which were proven to have a high adsorption capacity (mg/g): 1,666.67, 495.9, 476.2, 131.56, 151.5, 84.74, and 68.92, respectively, were investigated under the conditions of synthetic wastewaters and not with real industrial effluents. Moreover, the residual metal ion concentrations were higher than the permissible discharge standards. Hence, their applicability to the industrial effluents is still problematic. The main hindrances are: (i) imbalance between laboratory studies and pilot studies at large scale; (ii) low-cost adsorbents have been applied to the solutions which do not reflect the real heavy metals' concentrations found in industrial effluents; (iii) residual concentrations are higher compared with the discharge standard limits and (iv) economic and costs evaluation studies for practical material engineering design and low-cost adsorbents commercialization information are missing. We provide future research directions for efficient removal of heavy metals from the industrial effluents.

Keywords: Adsorption technology; Agricultural waste low-cost adsorbents; Heavy metals; Hindrances; Industrial wastewaters

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