Biomimetic zeolite for the removal of heavy metal ions and harmful dye from wastewater

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Abstract

The effectiveness of various treatments in enhancing the adsorption capacity of zeolite for the removal of Cu^{2+} and Pb^{2+} and methylene blue dye (MB) was studied and the results were used to construct a working water filtration prototype for wastewater treatment. Clinoptilolite was treated with either citric acid (zeo-C) or sodium dodecyl sulfate (zeo-S) or a combination of both (zeo-CS). The zeolite adsorbent dose was kept at 10 g/L for the adsorption of MB dye and Cu^{2+} and Pb^{2+} ions. The most effective adsorbent was zeo-S, followed by zeo-CS, followed by zeo-C. The adsorption equilibrium data for zeo-S fitted well to Langmuir isotherm. Subsequently, a prototype consisting of a floating device and 'tentacles' that contain zeo-S was constructed. 3 different ways to contain zeo-S was tested to investigate the best way to contain zeolite in order to maximise adsorption: stainless steel metal infusers (MI), teabags (TB) and a hybrid combination of MI and TB designs where one tea bag was placed inside a tea infuser (HY). The HY design had the highest adsorption capacity in adsorbing heavy metal ions and MB due to its ability to contain 2 layers of zeolite, thus increasing the number of monolayer adsorption sites exposed to the adsorbate solution. Zeo-s is found to be a very viable, low cost and effective adsorbent that can be built into a sustainable wastewater treatment device.