Ultrasonic modification of adsorbents for enhancement of the performance in dye removal from aqueous solution

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The effect of the ultrasonic modification of the adsorbent towards adsorbent capacity for dye removal from aqueous solutions was tested. A cationic dye, Crystal Violet was chosen as the textile dye. The adsorbents for the experiment included commercially available activated carbon, Albizia sawdust, and dried-areca nut husk (puwak). For each adsorbent, two sets of batch adsorption experiments were carried out, one with and one without ultrasonic treatment, while keeping all the other parameters constant. The experimental results showed an increase in adsorption capacity due to sonication. Sonicated activated carbon, saw dust and areca nut husk showed 93%, 92% and 90% dye removal respectively. Activated carbon showed 33% increase in adsorption capacity compared to non-sonicated material, which was the highest enhancement due to sonication, whereas saw dust and areca nut husk showed only 1% and 5.8% increase. Kinetic analysis showed that 86% of the dye removal from the sonicated activated carbon had taken place within the first 16 minutes of the experiment. Kinetic data was fit to the pseudo-second order model. The intra-particle diffusion model proved that film diffusion was significant in controlling the adsorption of dyes onto the adsorbent in addition to intra-particle diffusion. FTIR analysis showed that the existence of hydrogen bonds, C=C bonds, aromatic rings, aliphatic-iodo compounds, and other molecules contributed to the dye adsorption. SEM analysis showed that adsorption had happened into the resultant enlarged pores due to ultrasonic vibrations. The overall summary of the experiment through the results and analysis revealed that the vibration occurred during the ultrasonic treatment was the biggest contributor to enhancement of adsorption capacity of activated carbon.

Keywords: Batch adsorption, adsorbents, crystal violet, ultrasonic treatment, kinetic analysis