ADSORPTION MECHANISMS OF BIOCHAR FOR REMOVAL OF ORGANIC CONTAMINANTS IN WATER

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The effect that biomass plays in determining the adsorptive properties of the biochar for organic contaminants in water was investigated for four wood based and four grass based biomasses. This was done using ibuprofen (IBU), acetaminophen (ACT), methyl orange (MO), and methylene blue (MB) as representative test molecules of adsorbate organic contaminants. They were chosen based on varying electron-donating and withdrawing properties, as well as different ionic charges, depending on the pH of the aqueous solution. This allowed for certain adsorption mechanisms, such as π-π electron donor-acceptor (EDA) interactions, to be isolated by comparing the differing trends in adsorption with the increasing pH of the solution. A correlation was found between pyrolysis temperature and π-stacking interactions, due to the increased aromaticity with processing temperature. This was confirmed using ATR-FTIR. However, it was also found that the aromaticity did not correlate with π-π EDA interactions. Investigation of the surface area, porosity and functionality revealed that greater amounts of carbonyl groups were responsible for greater electron withdrawing characteristics allowing for improved adsorption of contaminants with electron donating groups, such as ACT. The absence of these carbonyl groups resulted in a greater adsorption of contaminants with electron withdrawing groups, such as MO. Further investigation of the surface modification of biochar with H_2O_2 showed that treatment with oxidizing agents increase adsorption by increasing oxygen containing functional groups on the surface. However, a much more significant increase in adsorption was found after treatment with KOH, as both oxygen containing functional groups and aromaticity were found to greatly increase. This indicates that π-π EDA interactions may be the dominant mechanism responsible for the increase in adsorption after KOH treatment. This project allows for a greater understanding of the connection between surface functionality and the overall adsorptive properties of biochar, which allows for future development of custom-designed biochars best suited for adsorption of specific emerging contaminants, either through surface modification or by adjusting the pyrolysis process.