Correlation between the surface of nanoparticles and their functionality

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Global water pollution is one of the major problems facing the world today. Water can be contaminated with a wide variety of chemicals, including heavy metal ions, dyes, and pharmaceutical compounds. As an adsorbent, various materials can be used, such as membranes, polymers, carbons, and nanostructures. However, depending on the type of material and structure, it has different effectiveness in pollution removal. Current research seeks to demonstrate the correlation between the surface of nanoparticles and their functionality. Among the many methods used in water purification, adsorption is particularly attractive due to its low operating costs and the ease of maintaining adsorbent materials. However, the effectiveness of the materials proposed for adsorption studies depends on experimental conditions, including pH, ionic strength, the presence of additional molecules, as well as contact time and adsorbent dose. Therefore, it has an impact on the maximal adsorption capacity. Due to the interaction between the adsorbent and the pollution. The maximal adsorption capacity is estimated by using different adsorption models, such as Langmuir, which describes the single layer of adsorbed pollutant; Freundlich, which focuses on heterogeneous surface adsorption, and if, during the adsorption process, a new band (chemisorption) is created or not (physisorption). The combination of these two models is the Redlich-Peterson model. Other models are also applied, but in many studies, adsorption is characterized primarily using linear models and kinetics. Nonetheless, it is often necessary to apply non-linear equations to accurately establish equilibrium.

Depending on the active groups on the surface of the material and conditions, the adsorption process can occur twofold. For instance, for biochars, the Redlich-Peterson adsorption model predominates. It is attributed to fairly large pores. On the other hand, for biochars that include magnetic nanoparticles, the adsorption model can be varied. The presence of a negative charge on the surface of the material indicates the possibility of adsorbing the cathodic dye with high efficiency, based on electrostatic interaction. However, these interactions are relatively weak, allowing pollutants to be easily desorbed from the surface by organic solvents. This raises environmental concerns, since pollutants may be reintroduced into the environment during adsorbent regeneration.