Transforming Desert Sand Into Fertile Land Using Amine-Functionalized Diatomite Rocks and CO2 Adsorption

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Greenhouse gases, with carbon dioxide (CO2) being the most significant contributor, are the primary causes of climate change. Atmospheric CO2 levels have risen dramatically from pre-industrial levels of approximately 280 ppm to over 419 ppm in 2022, marking a historic high. The escalating concentration of atmospheric CO2 necessitates innovative strategies for reducing carbon emissions. The purpose of this study is to chemically modify diatomite with amines to test it for CO2 adsorption efficiency and soil fertility to enhance water retention and nutrient availability. The study explores the modification of diatomite through chemical and physical treatments using amine groups—specifically polyethyleneimine (PEI) and tetraethylenepentamine (TEPA)—to enhance its adsorption efficiency for CO2. Various concentrations of amines (5%, 10%, and 30% by weight) were tested. The functionalized diatomite was subjected to heat treatment to ensure proper amine binding. CO2 adsorption was conducted under controlled conditions, and the synthesized material was subsequently utilized in sand soil to evaluate its potential as a fertilizer, using coriander seeds to assess plant growth and soil enrichment. Adsorption experiments demonstrated an increase in CO2 uptake compared to unmodified diatomite, with functionalized samples showing enhanced performance, rising from 18 cm^3/g STP in unmodified diatomite to about 120 cm^3/g STP in PEI-30% treated samples. Initial findings indicate that PEI-30% led to the highest height among all samples. This project aims to contribute to global carbon management strategies by providing a dual benefit: reducing atmospheric CO2 levels and enriching sandy soils to utilize dryland areas, such as deserts, for agricultural productivity.

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