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Insight into Enhancement of CO2 Capture by Clay Minerals

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Abstract : Climate change and global warming recently became significant concerns due to the massive emissions of greenhouse gases into the atmosphere, predominantly CO2 gases. Therefore, it is necessary to find sustainable and inexpensive methods to capture the greenhouse gasses and protect the environment for live species. The application of naturally available and cheap adsorbents of carbon such as clay minerals became a great interest. However, the minerals prone to low storage capacity despite their high affinity to adsorb carbon. This paper aims to explore ways to improve the pore volume and surface area of two selected clay minerals, 'montmorillonite and kaolinite' by acid treatment to overcome their low storage capacity. Montmorillonite and kaolinite samples were treated with different sulfuric acid concentrations (0.5, 1.2 and 2.5 M) at 40 °C for 8 hours to achieve the above aim. The grain size distribution and morphology of clay minerals before and after acid treatment were explored with Scanning Electron Microscope to evaluate surface area improvement. The ImageJ software was used to find the porosity and pore volume of treated and untreated clay samples. The structure of the clay minerals was also analyzed using an X-ray Diffraction machine. The results showed that the pore volume and surface area were increased substantially through acid treatment, which speeded up the rate of carbon dioxide adsorption. XRD pattern of kaolinite did not change after sulfuric acid treatment, which indicates that acid treatment would not affect the structure of kaolinite. It was also discovered that kaolinite had a higher pore volume and porosity than montmorillonite before and after acid treatment. For example, the pore volume of untreated kaolinite was equal to 30.498 um3 with a porosity of 23.49%. Raising the concentration of acid from 0.5 M to 2.5 M in 8 hours' time reaction led to increased pore volume from 30.498 um3 to 34.73 um3. The pore volume of raw montmorillonite was equal to 15.610 um3 with a porosity of 12.7%. When the acid concentration was raised from 0.5 M to 2.5 M for the same reaction time, pore volume also increased from 15.610 um3 to 20.538 um3. However, montmorillonite had a higher specific surface area than kaolinite. This study concludes that clay minerals are inexpensive and available material sources to model the realistic conditions and apply the results of carbon capture to prevent global warming, which is one of the most critical and urgent problems in the world.

Keywords : acid treatment, kaolinite, montmorillonite, pore volume, porosity, surface area
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