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Uranium sorption on various forms of TiO₂ - influence of surface area, surface charge and impurities

Titanium dioxide has properties that make it an excellent substrate for experimental study and theoretical development of adsorption models, including negligible solubility and a near neutral point of zero charge[1]. A number of different forms of Ti-oxide have been used in experimental studies, including hydrous Ti-oxide, anatase, rutile and various commercially available samples that contain a mixture of anatase and rutile. The aim of our work is to investigate uranium sorption phenomena and the influence of surface area, surface charge and impurities for a range of thoroughly characterised Ti-oxide surfaces.

We have undertaken uranium(VI) sorption studies on a number of commercially available Ti oxides, some of which were aggressively pre-treated to remove inherent impurities. Characterisations performed on the various Ti-oxides comprised a range of chemical and physical methods including XRD, XRF, ATR FT-IR, chemical assays, BET determinations, and electroacoustic measurements. The sorption of U on these Ti oxides was studied by a batch sorption method and the effect of pH, ionic strength, mass loading, and U concentration on uranium sorption was also investigated for several of these Ti-oxides.

We found that the sorption of uranium (VI) on these Ti-oxides was extremely strong and much greater than many other common environmental sorbents on a surface area basis. Aggressive pre-treatment of one Ti-oxide significantly altered its isoelectric point, but did not appear to significantly impact its sorption behaviour. Differences in sorption behaviour between the various Ti-oxides were related to the surface area of these materials. The data provide insights into the effect of different source materials and surface properties on radionuclide sorption, and will be useful in assessing data obtained in diverse experimental studies involving Ti oxides.

[1] Kosmulski, M. (2002). Advances in Colloid and Interface Science 99: 255-264.

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