Kinetic study of time dependant fixation of $U$(VI) on biochar from aqueous solution

Ahmed Ashry Abdelaal\textsuperscript{1}, Elizabeth H. Bailey\textsuperscript{1}, Simon R.n. Chenery\textsuperscript{2}, and Scott D. Young\textsuperscript{1}

\textsuperscript{1}Environmental Science Division (AES) – The University of Nottingham Sutton Bonington Campus School of Biosciences Environmental Science Division Loughborough, Leicestershire United Kingdom LE12 5RD, United Kingdom
\textsuperscript{2}British Geological Survey (BGS) – British Geological Survey Environmental Science Centre Nicker Hill Keyworth Nottingham NG12 5GG, United Kingdom

Abstract

Biochar, a by-product from the production of biofuel and syngas, was tested as a material for the adsorption and fixation of uranyl ions ($UO_2^{2+}$) from aqueous solutions. A batch experiment was conducted to study the factors that influence the adsorption and time-dependent fixation of $U$VI on biochar material at $20\degree$C, including pH value, initial concentration of $U$VI and contact time. Uranium ($U$VI) adsorption was highly dependent on pH values but it was found that (i) adsorption on biochar was high over a wide range of pH values, from 4.5 to 9.0, and (ii) adsorption strength was time-dependent over several days. The experimental data for pH values $> 7$ were most effectively modelled using a Freundlich adsorption isotherm coupled to a reversible first order kinetic equation to describe the time-dependent fixation of $U$ within the biochar structure. Desorption experiments showed that $U$VI was only sparingly desorbable from the biochar material with time and isotopic dilution with $^{233}U$ confirmed the low, or time-dependent, lability of adsorbed $^{238}U$. Below pH 7.0 the adsorption isotherm trend suggested precipitation, rather than true adsorption, may occur. However, across all pH values (4.5 – 9.0) measured saturation indices suggested that precipitation was possible: autunite below pH 6.5 and either swartzite, liebigite or bayleyite above pH 6.5.

Keywords: biochar, uranium, adsorption, pH, isotherm and kinetics

\textsuperscript{*}Speaker