

Treatment of chromate(VI) and vanadate(V) polluted wastewaters using schwertmannite adsorbents

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Extended Abstract

The toxic oxyanions chromate and vanadate found in industrial wastewaters often require expensive and high-maintenance treatment. Passive filterbed systems are a distinctly cheaper alternative. In this contribution we have tested the potential of the ferric oxyhydroxy-sulfate mineral schwertmannite ($\text{Fe}_8\text{O}_8(\text{OH})_x(\text{SO}_4)_y$; $x = 8 - 2y$, $1 < y < 1.75$) as an adsorbent to be used in such systems for treatment of chromate (Cr(VI)) and vanadate (V(V)). Schwertmannite adsorbents can be sustainably produced from a waste product of mining and show good adsorption performance towards arsenic (DE 102 21 756 A1 2003, Janneck *et al.* 2010, Peiffer *et al.* 2012A, Peiffer *et al.* 2012B).

Adsorption kinetics of the two metal oxoanions and their adsorption isotherms were determined in batch experiments at pH 7 ± 1 (Dou *et al.* 2013, Kolbe *et al.* 2011). Samples were taken after different time intervals, were filtered (0.20 μm) and analysed for chromium and vanadium via ICP-OES.

The concentration of both, dissolved chromium and vanadium strongly decreased within the first 24 h and approximately 40 % of the metals were bound to the schwertmannite adsorbent after this time (Figure 1a). Between 24 h and 8 days chromium adsorbed rather slowly, whereas the removal of vanadium continuously increased. Consequently, after 8 days 51 % and 87 % of the initial chromium and vanadium concentration were adsorbed on schwertmannite, respectively.

The adsorption isotherm of chromium possibly converged to a maximum chromium loading on schwertmannite of approximately 35 mmol per mole iron (Figure 1b). In contrast, even at high initial vanadium concentrations the isotherm of vanadium exhibited a linear trend implying a much higher adsorption capacity compared to chromate.

The different adsorption behaviour is probably caused by different adsorption mechanisms of chromate and vanadate on schwertmannite which will be investigated in the future.

Overall, the results of this study provide first insights into the interactions between chromate and vanadate polluted industrial wastewaters and schwertmannite adsorbents.

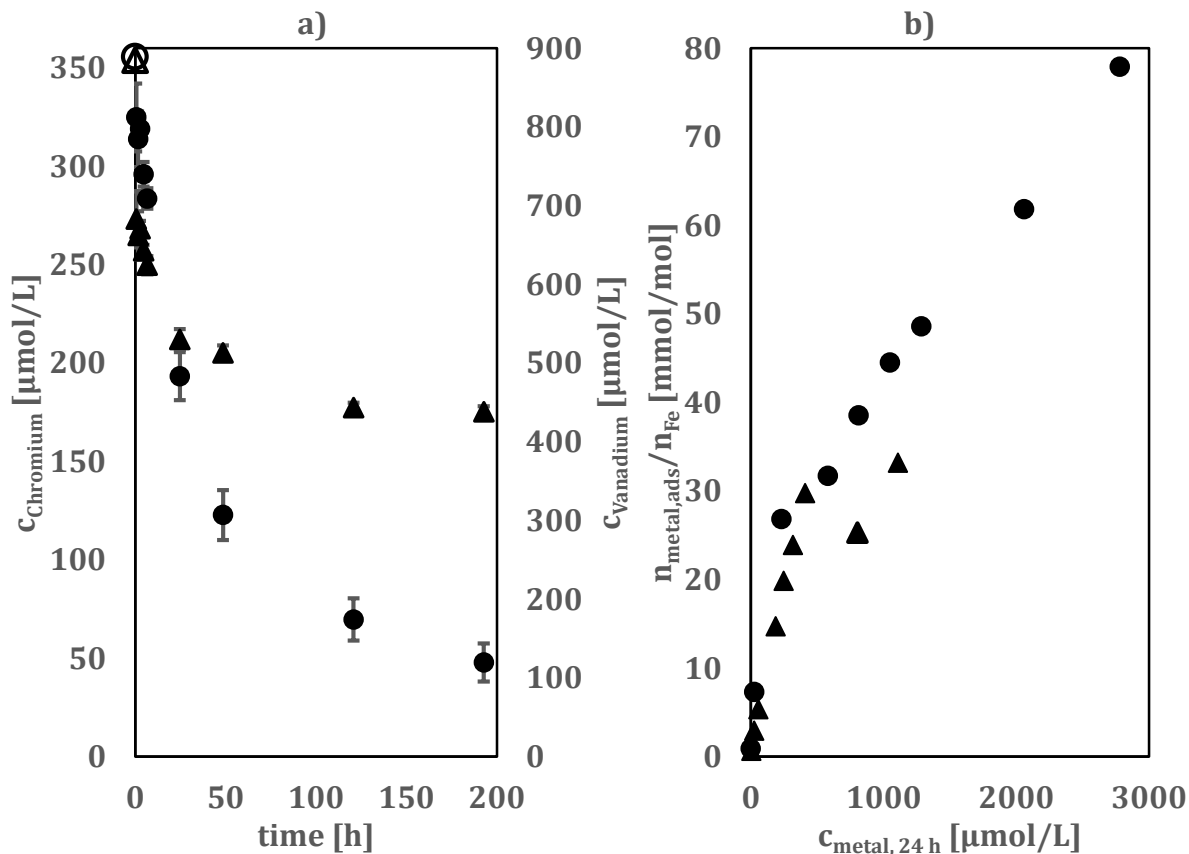


Figure 1 a) Adsorption kinetics of chromium(VI) (filled triangles) and vanadium(V) (filled circles). c_{Chromium} and c_{Vanadium} are the concentrations of dissolved chromium and vanadium, respectively, after different time intervals. The unfilled triangle and circle is the calculated initial concentration of chromium and vanadium, respectively. **b)** Adsorption isotherms of chromium(VI) (filled triangles) and vanadium(V) (filled circles). $c_{\text{metal, 24 h}}$ is the dissolved chromium or dissolved vanadium equilibrium concentration after 24 h reaction time. $n_{\text{metal}}/n_{\text{Fe}}$ is the amount of chromium and vanadium adsorbed per mole of schwertmannite iron (Fe), respectively. n_{metal} was calculated by subtracting $c_{\text{metal, 24 h}}$ from the initial metal concentration.

Key words: Adsorption, vanadate, chromate, iron hydroxide, schwertmannite

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