



Coprecipitation of vanadium with iron(III) in drinking water: a pilot-scale study

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ABSTRACT

Vanadium concentrations higher than the Maximum Contaminant Level (MCL) of 50 µg/L set by the Italian Regulation were found in the groundwater of Mount Etna (Italy). Vanadium removal from this natural water by coprecipitation with iron(III) has been investigated in this study. Preliminary experiments were carried out at bench scale, while a large part of the study was conducted using a continuous flow pilot plant, operated in both in-line filtration (in-line iron(III) dosage followed by sand filtration with two sand filters in series) and direct filtration (iron(III) dosage in a flash mixed reactor, flocculation, sand filtration with two sand filters in series). Vanadium was effectively removed below the MCL by coprecipitation with iron (hydr) oxides produced by dosing ferric chloride. The pre-oxidation with chlorine has improved the vanadium removal by more than 25%, possibly due to the change in vanadium speciation. The breakthrough of iron micro-precipitates, with coprecipitated vanadium, has limited the duration of the process cycle because it resulted in iron concentration in the effluent higher than its MCL (0.2 mg/L). The addition of a cationic polyelectrolyte as flocculant aid has improved the flocs removal and therefore both iron and vanadium were removed well below their respective MCLs. The operating conditions were also optimized at pilot scale to minimize the sludge production while achieving the target vanadium effectiveness. Overall, the optimal condition to remove vanadium below its MCL (removal effectiveness >85%) requires a direct filtration scheme, a pre-oxidation with NaOCl = 0.3 mg/L, a FeCl₃ dose of 5 mg/L, a flocculation time of 20 min, and the addition of 0.3 mg/L of a cationic polyelectrolyte as flocculant aid.

Keywords: Adsorption; Cationic polyelectrolyte; Direct filtration; Emerging inorganic contaminant; Oxidation; Sludge production

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