Nitrate removal from water using electrostatic regeneration of functionalized adsorbent

James W. Palko, Diego I. Oyarzun, Byunghang Ha, Michael Stadermann, Juan G. Santiago

PII: S1385-8947(17)31885-5
DOI: https://doi.org/10.1016/j.cej.2017.10.161
Reference: CEJ 17945

To appear in: *Chemical Engineering Journal*

Received Date: 15 September 2017
Revised Date: 26 October 2017
Accepted Date: 27 October 2017

Please cite this article as: J.W. Palko, D.I. Oyarzun, B. Ha, M. Stadermann, J.G. Santiago, Nitrate removal from water using electrostatic regeneration of functionalized adsorbent, *Chemical Engineering Journal* (2017), doi: https://doi.org/10.1016/j.cej.2017.10.161

Nitrate removal from water using electrostatic regeneration of functionalized adsorbent

James W. Palko[a,b,1], Diego I. Oyarzun[a,1], Byunghang Ha[a], Michael Stadermann[c], Juan G. Santiago[a,*]

[a] *Department of Mechanical Engineering, Stanford University, Stanford, CA 94305, USA*

[b] *Department of Mechanical Engineering, University of California, Merced, CA 95343, USA*

[c] *Lawrence Livermore National Laboratory, Livermore, CA 94550, USA*

[1] *contributed equally*

[*] *corresponding author*

Abstract

Nitrate is an important pollutant in drinking water worldwide, and a number of methods exist for its removal from water including ion exchange and reverse osmosis. However, these approaches suffer from a variety of disadvantages including requirements for supply and disposal of brine used for regeneration in ion exchange and low water recovery ratio for reverse osmosis. Here, we demonstrate the use of high surface area activated carbon electrodes functionalized with moieties having high affinity for adsorption of nitrate from aqueous solution, such as those used in ion exchange. Adsorption of surfactant molecules having a quaternary amine ionic group to the activated carbon surfaces provides functionalization of the surfaces without complex chemistries. The functionalized electrodes have adsorption capacities of about 80 mg $NaNO_3$ per gram of activated carbon material. Unlike a traditional ion exchanger, the functionalized surfaces can be repeatedly regenerated by the application of an electrostatic potential which displaces the bound NO_3^- while leaving an excess of electronic charge on the electrode. The cell is completed by a counter electrode passing current via Faradaic reactions during regeneration. The proposed system is a hybrid form of capacitive deionization, wherein one electrode is strongly capacitive and the counter electrode is dominated by Faradaic reactions. Up to approximately 40% of the initial capacity of the electrode is accessible following electrical regeneration.

Kewords: Nitrate adsorption; Activated carbon; Quaternary amine functionalization; Electrostatic regeneration