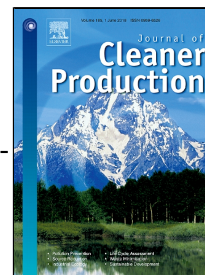


# Accepted Manuscript

Efficient removal of arsenate from oxic contaminated water by colloidal humic acid-coated goethite: batch and column experiments



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PII: S0959-6526(18)31074-6  
DOI: 10.1016/j.jclepro.2018.04.055  
Reference: JCLP 12636  
To appear in: *Journal of Cleaner Production*  
Received Date: 24 October 2017  
Revised Date: 05 April 2018  
Accepted Date: 06 April 2018

Please cite this article as: Daniela Montalvo, Ruth Vanderschueren, Andreas Fritzsche, Rainer U. Meckenstock, Erik Smolders, Efficient removal of arsenate from oxic contaminated water by colloidal humic acid-coated goethite: batch and column experiments, *Journal of Cleaner Production* (2018), doi: 10.1016/j.jclepro.2018.04.055

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1 **Word count:7572**

2 **Efficient removal of arsenate from oxalic acid contaminated water by colloidal humic acid-**  
3 **coated goethite: batch and column experiments**

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12

13 **Abstract**

14 Arsenic (As) contamination of groundwater frequently occurs and there is a need for cost-  
15 effective *in situ* remediation techniques. The injection of iron oxide colloids coated with  
16 humic substances has been proposed. This technology is based on injecting mobile humic  
17 acid-coated goethite colloids that are subsequently deposited by aggregation in the  
18 contaminated zone where the ionic strength is large, thereby creating an *in situ* reactive  
19 barrier for As. While coagulation and deposition are desirable for colloid immobilization, its  
20 effect on adsorption properties have been previously overlooked. This study was set up to  
21 investigate if i) humic acid-coated goethite colloids retain their As(V) adsorption properties  
22 after coagulation in quartz sand and ii) if batch As(V) adsorption data can predict As  
23 immobilization in columns at variable flow conditions. Equilibrium batch adsorption  
24 experiments showed that humic acid-coated goethite colloids coagulated and deposited on  
25 quartz sand have equal As(V) adsorption capacity, but two-fold lower affinity than humic  
26 acid-goethite colloids in suspension. This results indicated that there were some interactions  
27 between the sand and colloids but the overall adsorption capacity was not affected. Column  
28 experiments using sand coated with humic acid-goethite colloids (2.80 mg goethite g<sup>-1</sup> sand)  
29 and stepwise injection of As(V) (1–4.9 mg As L<sup>-1</sup>) showed a highly efficient As(V) removal  
30 from the liquid phase as the outflow As(V) concentrations remained below the drinking water  
31 limit (10 µg As L<sup>-1</sup>) until about 45% of the sorbent capacity (30 mg As g<sup>-1</sup> goethite) was  
32 reached. The flow rate dependent leachate As concentrations, including responses to stop-  
33 flow events, illustrated non-equilibrium sorption. The equilibrium batch adsorption

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