Arsenic and phosphate removal by adsorption onto iron and aluminium oxyhydroxides

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Plan

- Introduction
- Presentation of work carried out
- Main results
- Conclusions and impacts

1. Introduction

Arsenic groundwater contamination

- Arsenic is a deadly component at high concentration
- Groundwater arsenic contamination is a dilute pollution
- As accumulates in organisms because of its similarity with P
- Typical arsenic groundwater levels are 100 – 1000 ppb
- The WHO recommendation level is 10 ppb!
- Fe, Al and Ti oxides/hydroxides have good affinity toward As

Figure 1 : Arsenicosis [1]

Figure 2 : POE treatment [2]

Figure 3 : POU treatment [3]

1. Introduction

- Diffusion in a bed packed column

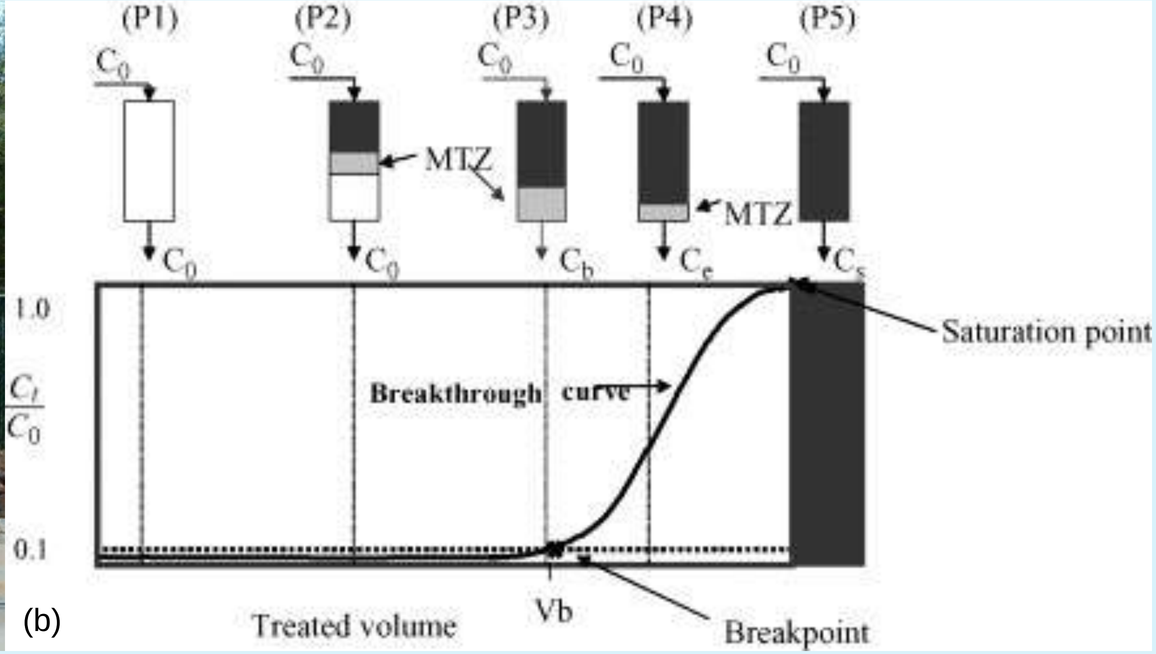

Figure 4 : (a) POE treatment [2] and (b) Mass Transfer Zone in a bed-packed column system [4]

2. Presentation of work carried out

- Batch experiment to continuous experiments

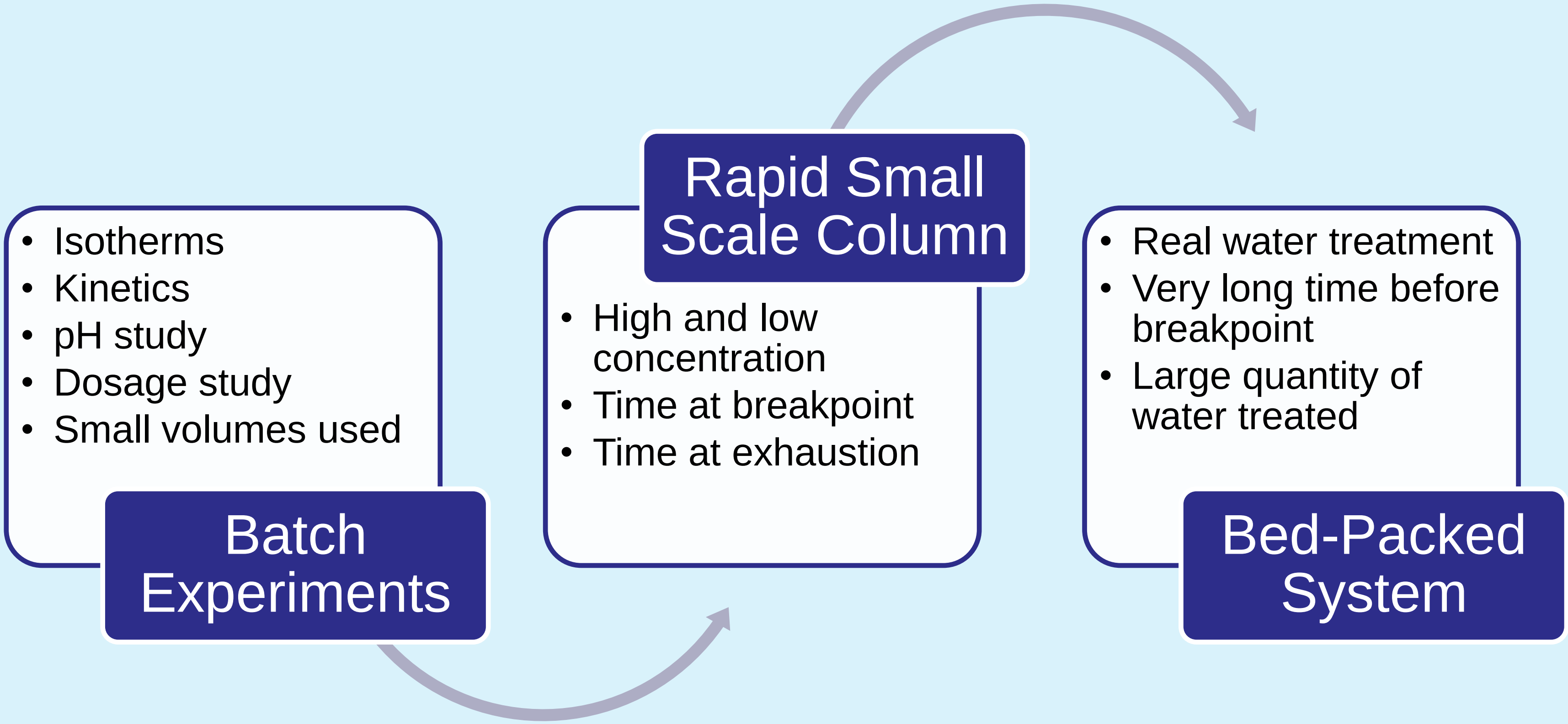

Figure 5 : Experiments links form batch to full scale plant

2. Presentation of work carried out

Table 1: Removal capacity of materials produced to remove arsenic. Capacity at 0.1 mg As.L^{-1}

Adsorbent	$q_{e\ at\ 100\ ppb}$ in mg As (V).g^{-1}	$q_{e\ at\ 100\ ppb}$ in mg As (III).g^{-1}
Laterite	0.127	0.171
Acidified laterite (ALS)	0.301	0.923
3D-organised silica-Fe	0.161	0.207
3D-organised silica-Al	7.402	0.018
Ferric Sulphate oxides - 10	3.620	6.330
Alum Sulphate oxides - 10	6.790	0.040
FAS oxides - 4	7.800	0.360

2. Presentation of work carried out

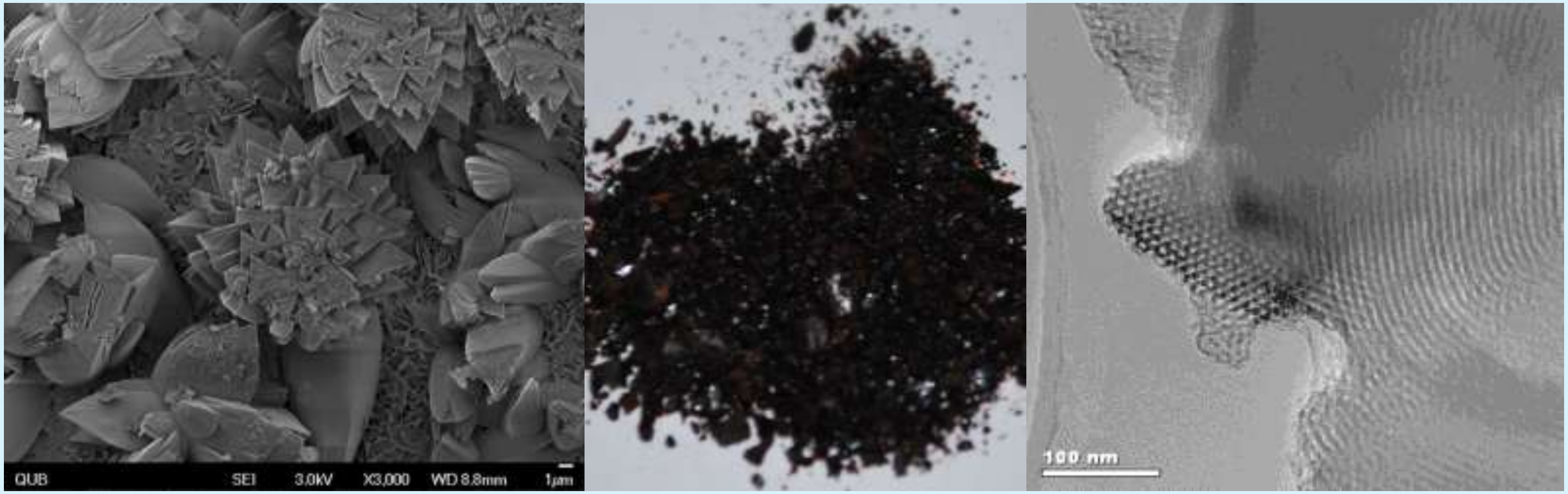

Figure 6: SEM, picture and TEM image of different materials produced

Table 2: Removal capacity of materials produced to remove phosphate. Capacity at 3.5 and 10 mg $P.L^{-1}$

Adsorbent	$q_{e\ at\ 3.5\ ppm}$ in mg $P.g^{-1}$	$q_{e\ at\ 10\ ppm}$ in mg $P.g^{-1}$
Ferric Sulphate oxides - 10	10.00	21.60
Alum Sulphate oxides - 10	21.19	33.64
FAS oxides - 4	27.04	43.51

3. Main results

- Column study

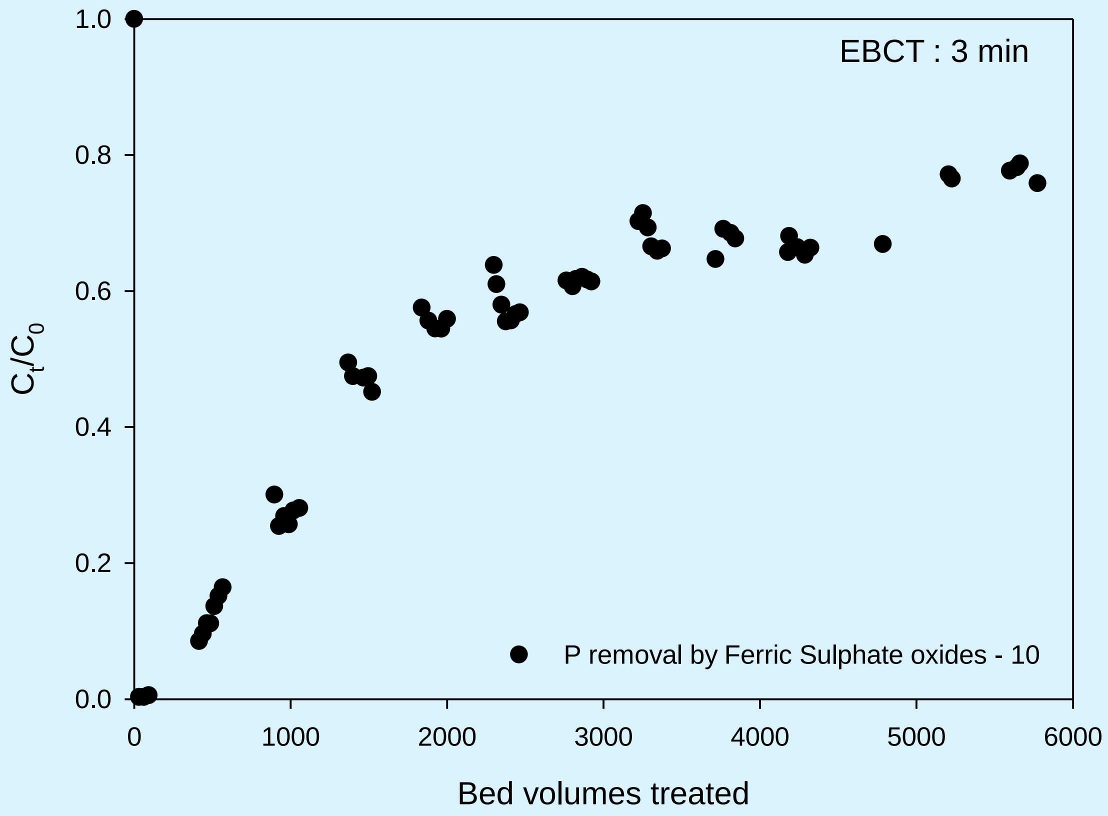

Figure 6: P removal by Ferric Sulphate oxides-10 C_0 = 3.5 ppm of P

Figure 7: Column study set up

3. Main results

- Column study

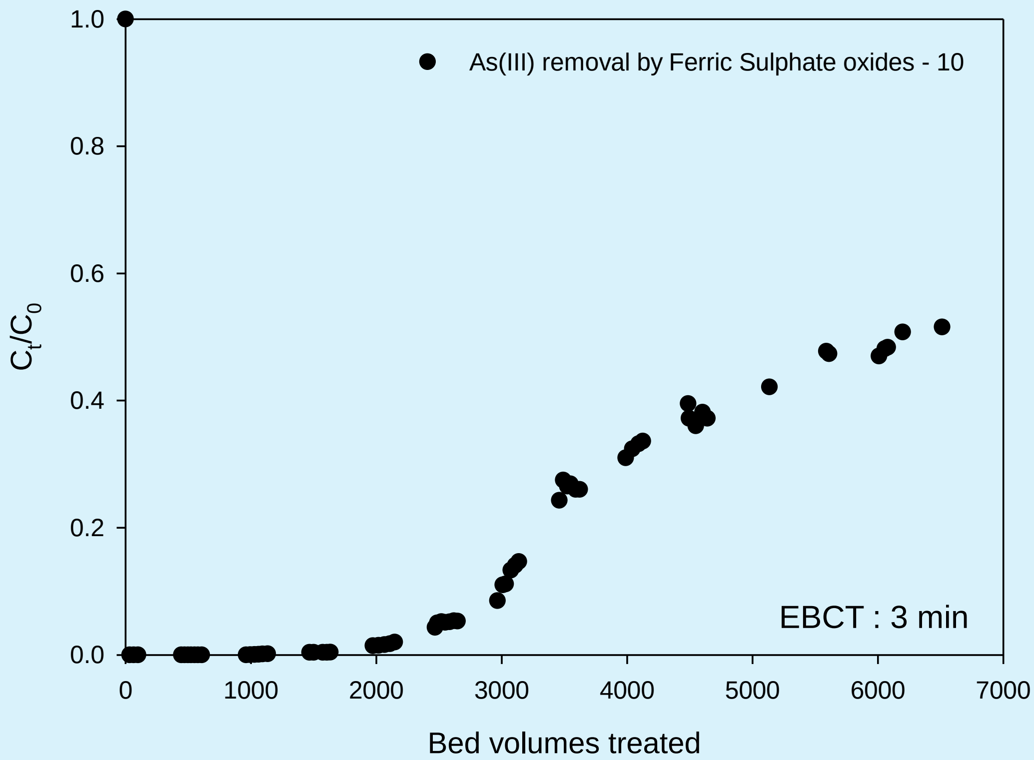

Figure 8: As(III) removal by Ferric Sulphate oxides-10 C_0 = 10 ppm of As

Table 3: Removal capacity of Ferric Sulphate oxides - 10 in column (EBCT is 3 min)

Adsorbate	P	As(V)	As(III)
Capacity at $C_t = 0.1\ C_0$	470 BV	380 BV	3000 BV
C_0 in ppm	3.5	10	10

4. Conclusion and impacts

Keys findings

- The use of commercial coagulants unable the successful production of adsorbent for both As and P removal
- Oxides produced from Ferric Sulphate were able to treat very efficiently As(III), while oxides produced from Alum Sulphate better removed As(V) and P

Future results expected

- Columns study carried out at lower concentration (1 ppm)
- Regeneration of materials
- Precipitation of As and P in the forms of oxides
- Economics study

Papers produced

- Y. Glocheux, S. Allen, and G. Walker, ‘Development of porous iron and aluminium oxides from laterite for arsenic adsorption’, in *Part II: Environment and Clean Technologies*, Dublin, 2012, pp. 303 – 308.
- Y. Glocheux, Z. Gholamvand, K. Nolan, A. Morrissey, S. J. Allen, and G. M. Walker, ‘Optimisation of 3D-Organized Mesoporous Silica Containing Iron and Aluminium Oxides for the Removal of Arsenic from Groundwater’, in *Chemical Engineering Transactions*, Milan, 2013, vol. 32.
- Y. Glocheux, Martin Méndez Pasarín, Ahmad B. Albadarin, Stephen J. Allen, and Gavin M. Walker, ‘Removal of arsenic from groundwater by adsorption onto an acidified laterite by-product’, *Chem. Eng. J.*, 2013.

References

- [1] A. H. Smith, E. O. Lingas, M. Rahman, and others, ‘Contamination of drinking-water by arsenic in Bangladesh: a public health emergency’, *Bull. World Health Organ.*, vol. 78, no. 9, pp. 1093–1103, 2000.
- [2] J. Valigore, A. S. . Chen, L. Wang, N. R. M. R. L. (US). O. of Research, Development, and B. M. Institute, ‘Arsenic Removal from Drinking Water by Adsorptive Media: US EPA Demonstration Project at Rimrock, AZ: Final Performance Evaluation Report’, National Risk Management Research Laboratory, Office of Research and Development, US Environmental Protection Agency, 2008.
- [3] S. Kommineni, H. Durbin, and R. Narasimhan, ‘Point-of-use, Point-of-entry Treatment for Arsenic Removal: Operational Issues and Costs’, 2003.
- [4] V. C. Taty-Costodes, H. Fauduet, C. Porte, and Y.-S. Ho, ‘Removal of lead (II) ions from synthetic and real effluents using immobilized Pinus sylvestris sawdust: Adsorption on a fixed-bed column’, *J. Hazard. Mater.*, vol. 123, no. 1–3, pp. 135–144, Aug. 2005.

Any questions ?

Thank you for listening !