



Improvement of Fe(II)-Adsorption Capacity of Feooh-Coated Brick in Solutions, and Kinetics Aspects

PDF (Size: 380KB) PP. 464-473 DOI : 10.4236/jwarp.2012.47054

Author(s)

Saint Charles Dehou, Joseph Mabingui, Ludovic Lesven, Michel Wartel, Abdel Boughriet

ABSTRACT

The adsorbent, iron oxy-hydroxide coated brick, was used in the present work for removal of iron(II) from aqueous solutions. The adsorption performances of this composite were significantly improved when brick pellets (as a support material) were pre-treated in a 6 M HCl solution at 90° C for 6 hours, when compared to untreated ones and those pre-washed in a 1M HCl solution at RT for 1 day. This phenomenon was attributed to larger surface areas measured for modified brick by BET, thus enabling a better FeOOH deposition. The ability of this new composite to better adsorb Fe²⁺ ions from synthetic solutions was evidenced from fixed-bed column experiments: data were compared to those obtained from raw brick and iron oxides - coated sand columns. The adsorption mechanism followed better pseudosecond-order reaction kinetics, suggesting a chemisorption process, and the rate constant increased with a temperature increase, revealing the endothermic nature of Fe(II) adsorption. Furthermore, the equilibrium data fitted the Langmuir isotherm model with a maximum monolayer sorption capacity $Q_{max} = 0.669$ mg/g and a Langmuir constant $K_L = 0.659$ L/mg at room temperature. The activation energy (Ea) of Fe(II) adsorption and the changes in entropy (ΔS), enthalpy (ΔH) and free energy (ΔG) of activation were determined, with values suggesting the involvement of an activated chemical adsorption and an associative mechanism.

KEYWORDS

Brick; Ferrous Ion; Iron Oxyhydroxide; Acid Activation; Adsorption; Kinetics; Activation Energy; Water Treatment

Cite this paper

S. Charles Dehou, J. Mabingui, L. Lesven, M. Wartel and A. Boughriet, "Improvement of Fe(II)-Adsorption Capacity of Feooh-Coated Brick in Solutions, and Kinetics Aspects," *Journal of Water Resource and Protection*, Vol. 4 No. 7, 2012, pp. 464-473. doi: 10.4236/jwarp.2012.47054.

References

- [1] D. van Halem, D. H. Moed, J. Q. J. C. Verberk, G. L. Amy and J. C. van Dijk, " Cation Exchange during Subsurface Iron Removal," *Water Research*, Vol. 46, No. 2, 2012, pp. 307-315. doi: 10.1016/j.watres.2011.10.015
- [2] R. P. Bailey, T. Bennett and M. M. Benjamin, " Sorption onto and Recovery of Cr (VI) Using Iron Oxide-Coated Sand," *Water Science & Technology*, Vol. 26, No. 5-6, 1992, pp. 1239-1244.
- [3] S. Khaodhiar, M. F. Azizian, K. Osathaphan and P. E. Nelson, " Copper, Chromium and Arsenic Adsorption and Equilibrium Modeling in an Iron-Oxide-Coated Sand, Background Electrolyte System," *Water, Air, Soil Pollution*, Vol. 119, No. 1-4, 2000, pp. 105-120. doi: 10.1023/A: 1005109325539
- [4] A. Joshi and M. Chaudhuri, " Removal of Arsenic from Ground Water by Iron-Oxide-Coated Sand," *Journal of Environmental Engineering*, Vol. 122, No. 8, 1996, pp. 769-800. doi:10.1061/(ASCE)0733-9372(1996)122:8(769)
- [5] M. M. Benjamin, R. S. Sletten, R. P. Bailey and T. Bennett, " Sorption and Filtration of Metals Using Iron-Oxide-Coated Sand," *Water Research*, Vol. 30, No. 11, 1996, pp. 2609-2620. doi: 10.1016/S0043-1354(96)00161-3

- [Open Special Issues](#)
- [Published Special Issues](#)
- [Special Issues Guideline](#)

[JWARP Subscription](#)
[Most popular papers in JWARP](#)
[About JWARP News](#)
[Frequently Asked Questions](#)
[Recommend to Peers](#)
[Recommend to Library](#)
[Contact Us](#)

Downloads:	402,240
------------	---------

Visits:	1,009,594
---------	-----------

Sponsors, Associates, and
 Links >>

- [6] M. M. Ahammed and K. Davra, " Performance Evaluation of Biosand Filter Modified with Iron Oxide-Coated Sand for Household Treatment of Drinking Water," *Desalination*, Vol. 276, No. 1-3, 2011, pp. 287-293. doi:10.1016/j.desal.2011.03.065
- [7] B. Rusch, K. Hanna and B. Humbert, " Coating of Quartz Silica with Iron Oxides: Characterization and Surface Reactivity of Iron Coating Phases," *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, Vol. 353, No. 2-3, 2010, pp. 172-180. doi:10.1016/j.colsurfa.2009.11.009
- [8] M. M. Ahammed and V. Meera, " Metal Oxide/Hydroxide-Coated Dual-Media Filter for Simultaneous Removal of Bacteria and Heavy Metals from Natural Waters," *Journal of Hazardous Materials*, Vol. 181, No. 1-3, 2010, pp. 788-793. doi:10.1016/j.jhazmat.2010.05.082
- [9] C.-S. Jeon, K. Back, J.-K. Park, Y.-K. Oh and S.-D. Lee, " Adsorption Characteristics of As(V) on Iron-Coated Zeolite," *Journal of Hazardous Materials*, Vol. 163, No. 2-3, 2009, pp. 804-808. doi:10.1016/j.jhazmat.2008.07.052
- [10] R. Han, L. Zou, X. Hao, Y. Xu, F. Xu, Y. Li and Y. Wang, " Characterization and Properties of Iron-Oxide-Coated Zeolite as Adsorbent for Removal of Copper(II) from Solution in Fixed Bed Column," *Chemical Engineering Journal*, Vol. 149, No. 1-3, 2009, pp. 123-139. doi:10.1016/j.cej.2008.10.015
- [11] E. Eren and H. Gumus, " Characterization of the Structural Properties and Pb(II) Adsorption Behavior of Iron Oxide Coated Sepiolite," *Desalination*, Vol. 273, No. 2-3, 2011, pp. 276-284. doi:10.1016/j.desal.2011.01.004
- [12] S. C. Dehou, M. Wartel, P. Recourt, B. Revel, J. Mabingui, A. Montiel and A. Boughriet, " Physicochemical, Crystalline, and Morphological Characteristics of Bricks Used for Ground Waters Purification in Bangui Region (Central African Republic)," *Applied Clay Science*, Vol. 59-60, 2012, pp. 69-75. doi:10.1016/j.clay.2012.02.009
- [13] G. Wang, X. Wang, X. Chai, J. Liu and N. Deng, " Adsorption of Uranium (VI) from Aqueous Solution on Calcined and Acid-Activated Kaolin," *Applied Clay Science*, Vol. 47, No. 3-4, 2010, pp. 448-451. doi:10.1016/j.clay.2009.11.003
- [14] A. G. San Cristobal, R. Castello, M. A. M. Luengo and C. Viscayno, " Acid Activation of Mechanically and Thermally Modified Kaolins," *Materials Research Bulletin*, Vol. 44, No. 11, 2009, pp. 2103-2111. doi:10.1016/j.materresbull.2009.07.016
- [15] K. Bhattacharyya and S. S. Gupta, " Removal of Cu(II) by Natural and Acid-Activated Clays: An insight of Adsorption Isotherm, Kinetic and Thermodynamics," *Desalination*, Vol. 272, No. 1-3, 2011, pp. 66-75. doi:10.1016/j.desal.2011.01.001
- [16] G. Suraj, C. S. P. Lyer and M. Lalithambika, " Adsorption of Cadmium and Copper by Modified Kaolinites," *Applied Clay Science*, Vol. 13, No. 4, 1998, pp. 293-306. doi:10.1016/S0169-1317(98)00043-X
- [17] S. C. Dehou, " Etude des Propriétés d' Adsorption des Oxyhydroxydes de fer Déposés sur un Support Naturel (la Brique): Application à l' Elimination du fer dans les eaux de Forages en République Centrafricaine," Thesis, University of Lille, France, 2011, p. 157.
- [18] S. S. Gupta and K. G. Bhattacharyya, " Kinetics of Adsorption of Metal Ions on Inorganic Materials: A Review," *Advances in Colloid and Interface Science*, Vol. 162, No. 1-2, 2011, pp. 39-58.
- [19] W. J. Weber and J. C. Morris, " Kinetics of Adsorption on Carbon from Solutions," *Journal of the Sanitary Engineering Division*, Vol. 89, No. 2, 1963, pp. 31-63.
- [20] K. Y. Foo and B. H. Hameed, " Insights into the Modeling of Adsorption Isotherm Systems," *Chemical Engineering Journal*, Vol. 156, No. 1, 2010, pp. 2-10. doi:10.1016/j.cej.2009.09.013
- [21] K. R. Hall, L. C. Eagleton, A. Acrivos and T. Vermeulen, " Pore- and Solid-Diffusion Kinetics in Fixed-Bed Adsorption under Constant-Pattern Conditions," *Industrial & Engineering Chemistry Fundamentals*, Vol. 5, No. 2, 1966, pp. 212-213. doi:10.1021/i160018a011
- [22] W. Zou, R. Han, Z. Chen, Z. Jinghna and J. Shi, " Kinetic study of Adsorption of Cu(II) and Pb(II) from Aqueous Solution Using Manganese Oxide Coated Zeolite in Batch Mode," *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, Vol. 279, No. 1-3, 2006, pp. 238-246. doi:10.1016/j.colsurfa.2006.01.008
- [23] Z. Aksu, " Determination of the Equilibrium, Kinetic and Thermodynamic Parameters of the Batch Adsorption of Lead(II) Ions onto *Chlorella Vulgaris*," *Process Biochemistry*, Vol. 38, No. 1, 2002, pp.

- [24] R. Han, W. Zou, Z. Thang, J. Shi and J. Yang, " Removal of Copper(II) and Lead(II) from Aqueous Solution by Manganese Oxide-Coated-Sand: I. Characterization and Kinetic Study," Journal of Hazardous Materials, Vol. 137, No. 1, 2006, pp. 384-393. doi:10.1016/j.jhazmat.2006.02.021
- [25] M. M. Abu-Mesalam, " Sorption Kinetics of Copper, Zinc, Cadmium and Nickel Ions on Synthesized Silico-Antimonate Ion Exchanger," Colloids and Surfaces A: Physicochemical and Engineering Aspects, Vol. 225, No. 1-3, 2003, pp. 85-94. doi:10.1016/S0927-7757(03)00191-2
- [26] R. S. Juang and J. Y. Chung, " Equilibrium Sorption of Heavy Metals and Phosphate from Single- and